Armenian Phonology

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THESIS ACCEPTANCE CERTIFICATE

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Armenian Phonology

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Abstract

This thesis develops an analysis of the phonological system of modern standard Armenian within Rules and Representations Theory, a model of phonology which assumes full specification in underlying representations and rule-driven derivations. I focus on the impact of Armenian data on current theories of underspecification, feature geometry, consonant-vowel interactions, syllabification, vowel harmony, and constraints and repairs. Some of the more interesting theoretical claims of this thesis are that languages can assign consonants to syllable nuclei at an intermediate point in derivations, even though these consonants always surface as syllable margins; uvulars, epiglottals, and pharyngeals are in a relationship analogous to that between high, mid, and low vowels, and the Lower Vocal Tract node dominating these segments occupies a position directly parallel to the traditional Place node; contour segments show only edge effects and no anti-edge effects; voiceless but not voiced fricatives are [+spread glottis]; the common phenomenon of nasal voicing is controlled by a marking statement *[+nasal, +spread glottis], contrary to the traditional view involving the configuration *[+nasal, -continuant]; and voiced aspirates are best viewed as simple segments characterized by the features [-stiff vocal folds, +spread glottis].

The thesis is divided into five chapters: the first sets out the theoretical assumptions on which I base my work; chapter two presents a basic overview of Armenian phonology focusing on stress assignment,

syllabification, and vowel harmony; chapter three develops an account of syllabification and epenthesis in the literary dialects; chapter four considers evidence bearing on the feature geometric component of universal grammar; and chapter five examines the phonological behavior of laryngeal features in the Armenian dialect of New Julfa and presents an analysis of the consonant shifts which occurred in the modern Armenian and Indo-Aryan dialects.

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This thesis is dedicated to Manya, Michele, and all Armenians who died in the Genocide and the war with Azerbaijan.

Preface

A fundamental philosophical tenet underlying this thesis is the notion that superficial linguistic data illustrate deeper truths concerning the structure and behavior of the innate human language facility, sometimes referred to as Universal Grammar (UG). This belief has the important consequence that all human languages can contribute to our understanding of UG. In this thesis I present and analyze a broad range of linguistic phenomena in the modern dialects of Armenian which provide insight into the nature of UG.

My particular goal is to elucidate the status within UG of the speech sound, or what many phonologists refer to as a 'segment'. The traditional Jakobsonian view holds that a segment is a bundle of features which behaves as a single unit in the phonology. I believe segments to be more complex than the Jakobsonian view suggests, involving not only features but also timing units and associations between features and timing units. This view is based on three basic components of segmental behavior: the internal structure of segments, the sequential relationships between segmental components, and the elements that distinctively identify segments as opposed to (for example) timing units or root nodes. These issues are investigated through a phonological analysis of the modern Armenian dialects, both literary and non-literary. The thesis is also intended to provide the first systematic theoretical treatment of Armenian phonology, which to date has not been considered in the phonological literature.

As stated above, I believe that the segment exists at the nexus between melodic structure and syllable structure. Consequently, my analysis focuses on phonological processes in Armenian which provide insight into the workings of feature geometry and syllabification. Some of the more interesting theoretical claims of this thesis are that languages can assign consonants to syllable nuclei at an intermediate point in derivations, even though these consonants always surface as syllable margins; uvulars, epiglottals, and pharyngeals are in a relationship analogous to that between high, mid, and low vowels, and the Lower Vocal Tract node dominating these segments occupies a position directly parallel to the traditional Place node; contour segments show only edge effects and no anti-edge effects; voiceless but not voiced fricatives are [+spread glottis]; and voiced aspirates are best viewed as simple segments characterized by the features [-stiff vocal folds, +spread glottis].

Though the framework of this thesis is highly theoretical, many of the issues considered are equally significant from the perspective of historical linguistics. In order to produce a satisfactory synchronic analysis of linguistic phenomena, I believe helpful to first ascertain the diachronic stages of development which have created them. Consequently, this thesis pays significant attention to the historical changes that have produced the synchronic systems considered. In addition, a significant portion of the Armenian, Altaic, and Semitic data is taken from the inventory of diachronic changes that have occurred in those languages. Some of the more important historical contributions of this thesis include the new historical dialectology of Armenian and the explanations of Adjarian's Law and the consonant shifts, as well as subgrouping problems associated with these processes. The dialect history I propose, based on wave theory of innovation, traces the origin of the dialects to the time Armenia reached its broadest physical expansion under Tigran II in the first century B.C.

The development of the dialects after this time is shown to be characterized by a highly complex series of non-trivial linguistic innovations which spread outward from a single source, rather than developing within consistent subgroups. Two of the most significant of these innovations are Adjarian's Law, which fronts back vowels after voiced obstruents, and the sequence of consonant shifts which produces seven distinct sets of consonant systems among the modern dialects. Adjarian's Law is shown to provide evidence that the tongue root advancement required in the production of voiced obstruents can play a role in the phonology, and that the Syrian and Azeri dialects must have originated in the area south of Lake Van where the other dialects showing Adjarian's Law are located. The consonant shifts in turn are shown to result from a rule associating the feature [+spread glottis] with word-initial obstruents, which has the effect of producing voiced aspirates in Common (Post-Classical) Armenian, which then undergo a series of repair processes discussed in chapter 1, producing the seven consonant inventories found in the modern dialects.

The thesis is divided into five chapters: the first sets out the theoretical assumptions on which I base my work; chapter two presents a basic overview of Armenian phonology, in which I have consciously avoided the use of theoretical machinery for the most part, in order to make the data accessible to Armenologists as well as linguists; chapter three develops an account of syllabification and epenthesis in the literary dialects; chapter four considers evidence bearing on the feature geometric component of universal grammar; and chapter five examines the phonological behavior of laryngeal features in the Armenian dialect of

New Julfa and presents an analysis of the consonant shifts which occurred in the modern Armenian and Indo-Aryan dialects. In the following paragraphs I present the contents of each chapter in more detail.

1 Theoretical assumptions

The model of phonology underlying this thesis is Rules and Representations Theory (RRT), as developed in Halle 1993, Vaux 1993, and Halle and Vaux 1994. RRT makes strong claims about the nature of phonological rules and representations, many of which are evaluated for the first time in this thesis. Within the domain of representations, RRT asserts following Calabrese (forthcoming) that underlying representations are fully specified for all relevant features. The definition of 'relevant' in this context is developed in chapter one of the thesis. The features for which representations are specified and the hierarchical structure into which these features are organized are claimed to derive from the anatomical structures of the human vocal tract and auditory system rather than from abstract functional principles, as has been proposed by Clements 1991 and others. The representation of individual phonemes is developed at length in chapter four. Regarding rules, the version of RRT presented here assumes that processes of assimilation operate solely on terminal features, rather than on intermediate nodes as has traditionally been assumed. Furthermore, I follow Calabrese (forthcoming) in assuming that rules may be sensitive to marked, contrastive, or all feature specifications of both targets and triggers. I also argue contra Idsardi 1992 and others that rules do not have the ability to 'look ahead' in derivations. Subsequent chapters provide new data supporting these assumptions. Finally, I assume the theory of constraints and repairs developed by Calabrese 1988, (forthcoming). In the following chapters I use the model sketched above not only as a basic infrastructure for the analyses presented, but also as a proposal to be tested, revised, and expanded.

2 Basic phonology

This chapter gives the reader a working understanding of the most basic elements of Armenian phonology, in order to provide a context for the more complicated issues discussed in later chapters. I begin with a brief exposition of the Armenian linguistic domain, surveying the number and extent of the ancient and modern dialects, and developing a historical dialectology of the modern dialects. With this general background, I then set out the phonemic inventories of the modern literary dialects, and discuss the allophonic and phonetic manifestations of each phoneme resulting from basic processes such as cluster assimilation and coda laryngeal neutralization. Phonemes found only in non-standard dialects are also presented. I then survey the two basic patterns of primary and secondary stress assignment and exceptions thereto found in Armenian dialects. Though Armenian does not distinguish prosodic weight and generally lacks metrical structure, I demonstrate that certain processes involving vowel reduction and visibility of schwa to stress rules nevertheless shed interesting light on the workings of metrification. I then provide a general survey of syllable types allowed in Armenian surface representations, and present two syllable-related processes previously unstudied in Armenian, fixed-coda reduplication and hypocoristic formation. Finally, I analyse the vowel harmony systems found in the eastern dialects of Agulis and Karchevan.

3 Syllabification

The most interesting aspect of Armenian syllabification is the process of epenthesis which resolves underlying consonant clusters not allowed in surface representations. Previous treatments of Armenian epenthesis have been purely descriptive (e.g. Allen 1950, Ƚaragyulyan 1975), with the implication that the placement of epenthetic schwas is lexically controlled and therefore unpredictable (cf. Bardakjian and Thomson 1977). These analyses also fail to distinguish between epenthetic schwas and schwas which result from reduction of high vowels in unstressed syllables. In this chapter I develop an analysis of Armenian syllabification which demonstrates that epenthesis is in fact rule-governed and entirely predictable. I adopt the syllabification algorithm proposed by Dell and Elmedlaoui 1985 to be a part of universal grammar.

Armenian lexical representations allow consonant clusters of as many as ten members, but the surface syllable structure in the language is relatively simple, allowing only maximal (C)(y)V(C)(C) syllables; consequently, it is interesting to study the mechanisms employed to syllabify clusters of more than three consonants. I argue that Armenian employs a syllabification algorithm similar to that proposed for Berber by Dell and Elmedlaoui 1985, which assigns syllable nuclei and onsets in a series of passes according to sonority, and subsequently incorporates remaining segments as codas or appendices. As in Berber, the cycle of core syllable assignment allows consonants to be syllabified as syllable nuclei, but at a later stage of the derivation syllabic consonants are expelled from the nucleus and replaced by an excrescent vowel, whose position relative to the displaced consonant is determined by universal principles of sonority sequencing. Dell and Elmedlaoui claim that these excrescent vowels only appear at the phonetic level in Berber, and therefore do not need to be accounted for by a phonological theory of syllabification; I show that Armenian schwas, on the other hand, do play a role in the phonology, and must be accounted for.

Armenian also differs from Berber in allowing complex codas, which are not easily accounted for by Dell and Elmedlaoui and require significant revisions of their model. These revisions provide valuable insight into the role of sonority in the syllabification cycle, the expulsion of consonantal nuclei and placement of epenthetic vowels, the controversial status of 'look-ahead' rules, and other important issues in current syllabification theory.

Further issues of interest considered in this chapter are the role of sonority constraints at syllable junctures in syllabifying consonant clusters, constraints on labial specifications in syllable codas, and the peculiar behavior of the passive morpheme and possessive clitics with respect to syllabification.

4 Feature geometry

The Armenian dialects contain a number of phenomena which bear in interesting and significant ways on our understanding of feature geometry, both in terms of what features exist, and how these features interact with one another. In this chapter I focus on the behavior of features produced in the lower vocal tract (i.e. the pharynx and larynx) and the problematic nature of consonant-vowel interactions.

My investigation of pharyngeal and laryngeal features has two main goals: to refute Clements' recent claim that ATR and RTR are 'ersatz' features which actually are symptoms of aperture features associated exclusively with vowels and secondary articulations; and to develop a geometry which accounts for the cross-linguistic inventory and behavior of phonemes produced with pharyngeal or laryngeal articulations. I demonstrate that interactions between vocalic tenseness and consonant voicing in Armenian dialects and many other languages can only be explained in terms of the property of tongue root advancement shared by both features, and not by Clements' model. These facts are placed within a model of the lower vocal tract based primarily on evidence from the Semitic, Amerindian, and Northeast Caucasian languages. In the Semitic languages, uvular, pharyngeal, and laryngeal consonants pattern together in phonological processes, as demonstrated by McCarthy (forthcoming). In Amerindian languages, on the other hand, uvulars and pharyngeals pattern together to the exclusion of laryngeals (Bessell 1993), suggesting a hierarchy in which a lower vocal tract node dominates radical and laryngeal articulators, and the radical articulator in turn dominates [ATR] and [RTR] features, which are involved in the production of voiced stops, uvulars, epiglottals, and pharyngeals and pharyngealized consonants. Furthermore, I suggest that [ATR] and [RTR] stand in a relationship parallel to [high] and [low]: uvulars are [-ATR, -RTR], voiced stops are [+ATR, -RTR], pharyngeals are [-ATR, +RTR], and the configuration [+ATR, +RTR] is physically impossible.

5 Laryngeal features and the consonant shifts

In this chapter I explore the phonological behavior of laryngeal features in the Armenian dialect of New Julfa, concentrating on their series of voiced aspirate consonants. I then employ this theory in conjunction with the historical dialectology developed in chapter 2 to produce an analysis of the extensive series of consonant shifts which occurred in the modern Armenian and Indo-Aryan dialects.

This chapter deals in some detail with traditional contour segments, i.e. affricates, and in particular their role in syllabification and edge effects. I argue based on the behavior of affricates in the Aslanbeg dialect that contour segments manifest only edge effects, and that the so-called anti-edge effects attributed to Basque by Hualde 1987 are in fact the result of syllabic constraints. I also investigate the possibility that laryngeal features of stops and affricates may dock to what Steriade 1992 calls the release phase of these segments. Based on a number of assimilation phenomena in the New Julfa dialect of Armenian, wherein voiced aspirates appear to behave as voiceless with respect to rules sensitive to their left edge and voiced with respect to rules sensitive to their right edge, I consider the possibility that voiced aspirates are contour segments in which the laryngeal features of voice and aspiration are associated with the release phase of the segment. I conclude that this theory is not tenable and that aspirated consonants are properly viewed as simple segments. Furthermore, I offer evidence supporting Halle's suggestion that voiceless fricatives are indeed [+spread glottis] but that voiced fricatives are [-spread], based on the behavior of a number of phonological rules in New Julfa. I also explore the relationship between voicing and aspiration suggested by earlier researchers such as Thráinsson 1978 and Broselow 1994 as it is revealed in rules of aspiration assimilation and delinking in New Julfa.

I then evaluate competing accounts of laryngeal neutralization, such as we find in Sanskrit, Thai, Turkish, Russian, and German, within RRT and Steriade's contour model. I also consider unexpected cases where instead of plain voiceless consonants we find voiceless aspirates, notably in Armenian and Klamath.

Finally, I propose that the phonetic impetus leading to the development of the Armenian voiced aspirates is closely paralleled in modern English, where in word-initial position underlying voiced stops are realized as voiceless, and voiceless stops as voiceless aspirated. The English and Armenian developments are suggested to result from a phonetic process which associates the feature [+spread glottis] with word-initial consonants. In Armenian this process leads to voiced aspirated allophones of plain voiced consonants in initial position, but in English the configuration [+spread, -stiff] is not tolerated and is repaired by negation, which produces [-spread, +stiff] (i.e. plain voiceless) consonants. Similar treatments of voiced aspirates are shown to occur in modern Indo-Aryan languages.

1

Introduction: The Nature of Rules and Representations

The theory of phonology underlying this thesis is Rules and Representations Theory (RRT)[1], as developed in Halle (forthcoming), Vaux 1993a, and Halle and Vaux 1994, which is concerned with the hierarchical organization of phonological features (REPRESENTATIONS) and the ways in which these features interact within and between segments (RULES). I follow Calabrese (forthcoming) in assuming that relevant features are fully specified in underlying representations. Included in my use of the word 'relevant' is the idea that certain features may simply never be activated in a given segment, and thus remain permanently unspecified in the terms of Steriade 1994. In addition, RRT assumes certain conditions regarding rules, most importantly that they apply only to terminal features in the geometry, and may be sensitive to contrastive, marked, or all feature specifications within cyclic, non-cyclic, or all morphemes. This view of rules, initially developed by Calabrese (forthcoming), is elaborated in section II. RRT also adopts from Calabrese (forthcoming) the notion of constraints on feature configurations, and repair strategies designed to resolve violations of these constraints. Subsequent chapters of this thesis

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[1]My selection of this label for the theory of phonology adopted in this thesis is intended to emphasize the contrast with non-derivational approaches such as Optimality Theory, and stress the fact that RRT makes assumptions about the nature of rules and representations which fundamentally differ from those of earlier theories.

are used as a testing ground for the components of RRT presented in this chapter.

1. Representations

Let us first examine the structure of phonological representations. RRT asserts that the features of both consonants and vowels are hierarchically organized in a single tree-like structure, all nodes of which capture phonetic and phonological generalizations concerning natural classes of sounds. Section 1.1 of this chapter justifies the various elements of this tree structure, concentrating on vocalic features and their interactions with consonants; consonantal features are considered in more detail in chapter 4. The theory presented here is contrasted with models of feature geometry proposed by Clements 1993 and Ní Chiosáin and Padgett 1993, which assume that vocalic features occupy a tier independent from consonantal features.

1.1. Rules and Representations Theory[2]

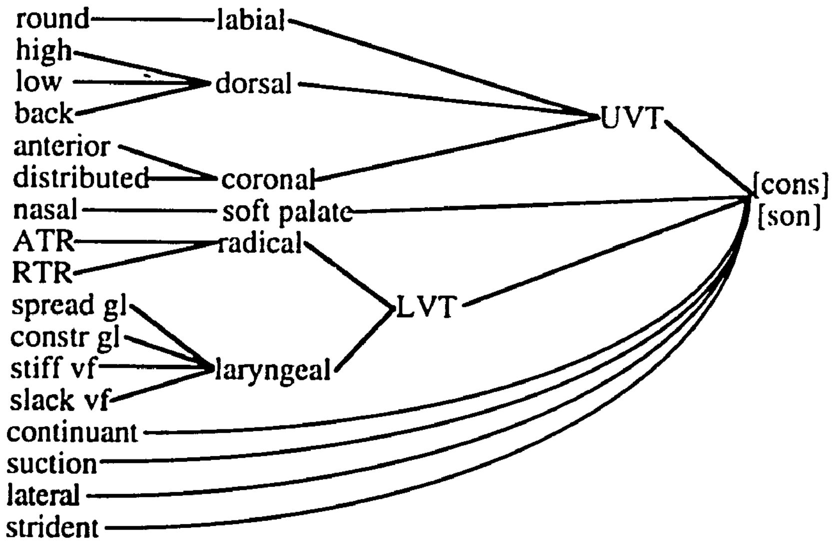
1.1.1. Feature organization

In this section I develop the theory of feature organization initially proposed by Halle (forthcoming), focusing on the representation of features such as [back], [round], [ATR], etc. in vowels. Since the publication of Clements's 1985 paper, there has been general agreement among researchers that the universal set of features is organized into a

[2]Section 1.1 of this chapter is a revised version of Halle and Vaux 1994.

hierarchy that is appropriately represented by means of a tree, as illustrated in (1).

(1)



The central insight motivating the geometry of the feature tree in (1), which I adopt from Halle (forthcoming), is that the tree directly reflects aspects of the human anatomy used in the production of speech. Features executed by the same articulator are therefore grouped together under a common nonterminal node bearing the label of the articulator in question, whereas higher nodes such as Place and Guttural group together anatomically contiguous articulators. That this basically anatomical organization of the features also supplies us with the appropriate feature sets and other machinery for the statement of phonological processes is therefore an important result providing additional support for the approach that underlies the present work.

A good illustration of this proposition is provided, as already noted by Clements 1985, by various assimilatory processes. Clements observed that assimilation characteristically involves spreading of features of the triggering phoneme to a neighboring phoneme. The assimilation may involve any number of features, from the entire feature complex down to a single feature. What is especially interesting about partial assimilation is that there are severe limitations as to the feature sets that can be assimilated. For example, whereas assimilatory processes that involve such feature pairs as those in (2a) are common, assimilations involving the feature pairs in (2b) are totally unknown.

(2) a. { [+stiff vocal folds], [+spread glottis] }
{ [+anterior], [-distributed] }

b. { [+stiff vocal folds], [-anterior] }
{ [+spread glottis], [+round] }
{ [+nasal], [-back] }

Clements's explanation for this observation was that the features were not an unstructured list, but rather were organized into a hierarchical tree of the kind illustrated in (1), and that assimilatory phenomena could only involve single nodes in the tree. This restriction immediately accounts for Clements's three observations cited above: single features can be assimilated because they are the terminal nodes in the tree; total assimilation involves the root node; and partial assimilations involve nodes in the tree that are intermediate between the root and terminal nodes[3].

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[3]It is assumed in Clements 1985 that only contrastive features are specified in underlying phonological representations. As a consequence, not all

As an illustration I consider Clements's example of Coronal assimilation in English, given in (3).

(3)	*t*	*d*	*n*	
_θ	eighth	hundredth	tenth, enthuse	[+ant, +distr]
_*š*, *ž*	courtship	hardship	inch, enjoy	[-ant, +distr]
_*r*	tree	dream	enroll	[-ant, -distr]

When a coronal stop or nasal, which in neutral contexts is [+anterior, -distributed], precedes another coronal consonant, the former assimilates the feature values for [anterior] and [distributed] from the latter. Clements proposed to formalize this process by linking the nonterminal coronal node of the second consonant to the Place node of the first consonant while also delinking the coronal node of the first consonant. I have illustrated this graphically in (4).

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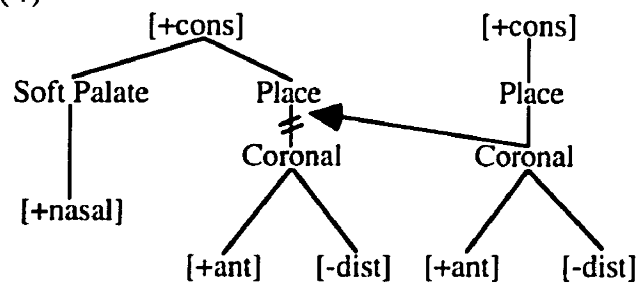
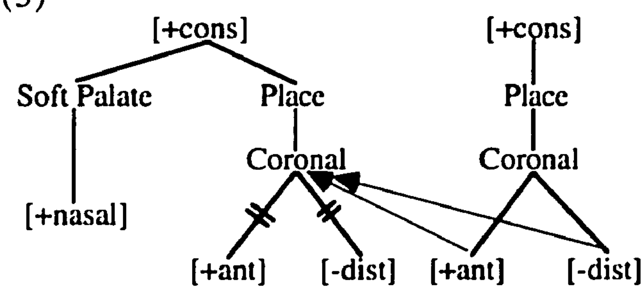
features in (1) are specified in underlying representations of phonemes of every language, but only those features that are contrastive. Following Calabrese (forthcoming), I assume that segments are fully specified in all representations. It is not the case, however, that specified features are visible to all rules. Rather, among the feature complement of a phoneme Calabrese distinguishes a *contrastive* subset from another called *marked*, and assumes that phonological rules may be sensitive to marked, contrastive, or all feature specifications. Thus, the English rule illustrated in (3-5) is sensitive to all features, whereas the vowel copy rules of Ainu and Barra Gaelic in section 4 are sensitive to contrastive features only.

(4)



The same effects can be formally expressed by allowing assimilation of intermediate nodes to be implemented by spreading of their subordinate terminal nodes. The process under discussion would then be formalized as in (5) rather than as in (4).

(5)



It has been argued by Halle (forthcoming) that (5) rather than (4) is the appropriate formalization of assimilation processes. Below I provide additional evidence for this proposition.

McCarthy 1989:76 has objected to terminal feature spreading, remarking that this convention 'exacts a severe price: feature geometry is no longer a characterization of the structural relations among features; instead, it is nothing more than a notation for arbitrary subgroupings of features that exist apart from the geometry itself.' I note that this objection targets the straw man hypothesis that any collection of features may spread, which would indeed go against our most basic notions of feature hierarchy and natural classes. However, in the framework of the present study, the only sets of features that may spread are those that are exhaustively dominated by a common node, and all cases of incomplete spreading result from individual terminal features being blocked by intervening specifications on the same tier. The formal power of terminal feature spreading is therefore no greater than that of Clements's nonterminal counterpart.

In section 1.1.2 I introduce the basic principles of this model, which I shall refer to as A(rticulator) T(heory), and contrast it with a competing hypothesis elaborated in different ways by Clements (forthcoming) and Ní Chiosáin and Padgett 1993, V(owel)-P(lace) T(heory). In section 1.1.3 I examine some of the evidence adduced in support of VPT, summarize its basic claims, and point out basic shortcomings internal to the theory. In section 1.1.4 I develop further certain arguments for supposing that spreading operates only on terminal features, reexamine the evidence adduced in support of VPT in light of this (terminal feature) spreading theory, and demonstrate that RRT is preferable to VPT both in terms of internal consistency and in its ability to account for the data discussed here. Finally, in section 1.1.5 I offer conclusions.

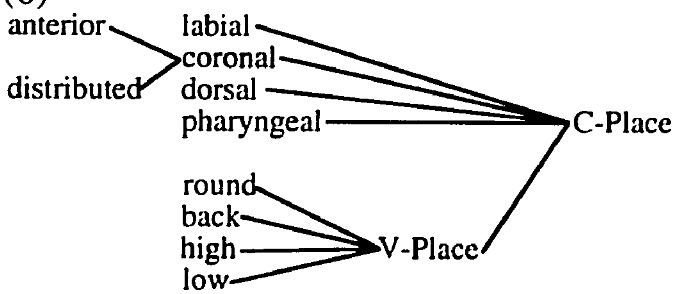
1.1.2. Basic Aspects of Articulator and V-Place Theory

In the model of feature geometry adopted here, features are grouped under the different articulators which execute them. Thus, as shown in (1), the features [back, high, low], which are executed by the tongue dorsum are dominated by the dorsal node; [round], which is executed by the lips, is dominated by the labial node, and [ATR] and [RTR], which are executed by the tongue root, belong to the radical node. Adjacent articulators are grouped together under the intermediate nodes "Place" and "Guttural", and these in turn are dominated by the root node, labelled with the features [consonantal] and [sonorant].

Halle (forthcoming) distinguishes two types of features, articulator-bound and articulator-free. The former are invariably executed by a given articulator. Thus [back], [high], and [low] are always executed by the dorsal articulator, and [round] by the labial articulator. By contrast, articulator-free features such as [consonantal] or [continuant] are executed by the labial articulator in sounds such as {*p f m*}, by the dorsal articulator in {*k x ŋ*}, and by the coronal articulator in {*t d s z š ž n ñ*}. In the universal feature tree of Halle (forthcoming), articulator-free features other than [cons] and [son] are dominated directly by the root node. Since the discussion below does not concern any of these articulator-free features, they have been omitted in (1) and elsewhere in this chapter.

In contrast to the anatomically motivated tree structure sketched above, a functional tree structure has been advocated in recent work by Steriade 1987, Odden 1991, Ní Chiosáin and Padgett 1993, and Clements (forthcoming). These researchers have argued that in order to account for the fact that vowel harmonies of various kinds spread all vowel Place features through consonants, regardless of their Place specifications, consonantal Place features must be distinguished from vocalic Place features, which are grouped together under a common node labelled V-Place. This node is held to be subordinate to C-Place, which also dominates consonantal Place nodes (articulators), as in (6) (from Ní Chiosáin and Padgett 1993; as we shall see in section 1.1.2, Clements (forthcoming) proposes that both C-Place and V-Place dominate the features labial, coronal, dorsal, and radical):

(6)



By creating a V-Place node, which has no clear anatomical status, this proposal crucially abandons the idea that feature geometry should be based on the anatomy of the articulators. It relies instead on the functional assumption that features which form recurrent groupings in phonological rules and constraints must be exhaustively dominated by a common node in the feature geometry, without regard to anatomical considerations.

VPT accepts Clements's original proposal that rules and constraints which target such groupings act on the node immediately dominating the features involved, and not on individual (terminal) features. By contrast, in the present study, as already noted, it is assumed that only terminal features are allowed to spread, with the empirical consequence that incomplete subsets of intermediate nodes in the feature tree must be able to spread. VPT and RRT therefore make drastically different predictions concerning incomplete spreading: VPT states that it is impossible, and RRT predicts that it should occur. I consider some cases which test this prediction in section 1.1.4 (for additional discussion see Halle (forthcoming)).

VPT and RRT also contrast in their treatment of consonant harmony: VPT predicts that it should be impossible, and RRT predicts that it should be possible for all types of consonants except dorsals. In VPT, consonant harmony must be expressed as spreading of the C-Place node or one of its dependents, a process which must be blocked by all vowels since these invariably possess a C-Place node. To the extent that processes of consonant harmony exist, VPT leads us to expect that front vowels block coronal harmony, round vowels block labial harmony, low vowels block pharyngeal harmony, and so on. On the other hand, given RRT and the hypothesis that only terminal features spread, consonant harmony should be blocked only in the case of dorsals, where the spreading of dorsal features should be blocked by the dorsal specifications of intervening vowels. I consider some relevant cases of consonant harmony in section 1.1.3.3.

Clements's U(nified) F(eature) T(heory) differs from Ní Chiosáin and Padgett's VPT model in its treatment of features versus nodes. Within both RRT and Ní Chiosáin and Padgett's version of VPT, features are binary and terminal, whereas nonterminal nodes are privative[4] and may have dependent nodes or features. In Clements's UFT, on the other hand,

[4]The definition of privative I employ here differs from that assumed by Halle (forthcoming). Halle believes that the notion of privativity is only relevant for terminal features, whereas I use the term 'privative' to describe any element in the feature tree--node, feature, or otherwise--which can be either present or absent, but nothing else. In this view the nonterminal node labial for example is privative, because it is present in labial consonants and vowels but not in segments which do not activate the labial articulator, such as coronal consonants.

Place elements such as coronal are neither strictly nonterminal nodes nor terminal features: as discussed in section 1.1.3, they are allowed to have dependents in consonants but not in vowels, where they behave like terminal features. To the extent that a formalism which consistently distinguishes between nonterminal nodes and terminal features is to be preferred over a theory which makes no systematic distinction, then, RRT and other such models are preferrable to UFT.

An interesting side effect of VPT is that only the coronal place of articulation is thought to have dependent features (Clements and Hume 1993:44, Ní Chiosáin and Padgett 1993:47): Clements's version of VPT replaces [round] with labial, [back] with coronal and dorsal, [high] and [ATR] with open, and [low] with pharyngeal; whereas in Ní Chiosáin and Padgett's version all dependent features except [anterior] and [distributed] are actually secondary vowel articulations. I consider various implications of these two systems in the following sections.

1.1.3. V-Place Theory

Central to the two competing versions of VPT are the two postulates:

(7) i. Interactions between consonants and vowels of the type found in Turkish *armVd* --> *armud* 'pear' indicate that there must be a unified set of features encoding place of articulation for consonants and vowels.

ii. Transparency of consonants with respect to rules spreading vocalic features indicates that consonantal Place features must be segregated from vocalic Place features. If this were not the case, we would expect all consonants with Place specifications to block spreading of vocalic Place nodes.

Both versions of VPT considered here accept the latter postulate (7ii). The versions differ with respect to the former postulate, with Clements's UFT accepting (7i), and Ní Chiosáin and Padgett rejecting it. I consider the two proposals in turn, and then turn to the issue of consonant harmony systems, which present difficulties for both theories considered in this chapter as well as for some others.

3.1. Unified Feature Theory

The interactions between labial consonants and round vowels, coronal consonants and front vowels, dorsal consonants and back vowels, and pharyngeal consonants and low vowels are taken by Clements's UFT as evidence that a single set of features characterizes place of articulation in both consonants and vowels. A typical phenomenon cited in support of (7i) is the fronting of vowels by adjacent coronal consonants, as for example in the Akn dialect of Armenian, where the back vowels *o* and *u* become *ö* and *ü* respectively after all coronal consonants (Maxudianz 1911:28-30)[5]:

[5] *ɫ* = [+back] *l*, *c* = [*ts*], *ṙ* = trilled *r*.

(8) a. fronting by coronals

classical Armenian	Akn	gloss
doł	*d^höʁ*	tremor
gałt-uk	*g^haʁdüg*	secret
at^hoṙ	*at^höṙ*	chair
moṙac^{h}oł	*moṙc^{h}öʁ*	forgetting
č^{h}ors	*č^{h}örs*	four
čuχa	*č^{h}üχa*	cloth
ǰur	*ǰ^{h}ür*	water
nor	*nör*	new
χošor	*χošör*	large
soχ	*söχ*	onion
galoł	*g^halöʁ*	coming
heru	*herü*	last year

b. non-coronals do not cause fronting

classical Armenian	Akn	gloss
boc^h	*b^hoc^h*	flame
port	*bord*	navel
p^hołk^h	*p^hoχg*	throat
Muš-eł	*Mušeχ*	person from Mush
koc^h	*g^hoc^h*	closed
k^hoṙ	*k^hoṙ*	unit of grain
gud	*gud*	grain
χuc^h	*χurc^h*	room

Clements analyzes such 'fronting' phenomena as in (9) (intermediate nodes omitted):

(9)

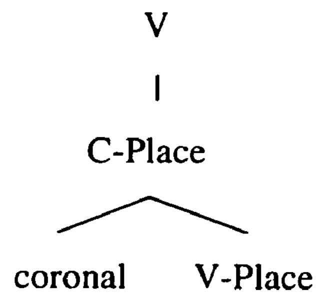
$$
\begin{tikzcd}[row sep=small]
C \arrow[d, dash] & V \arrow[d, dash] \\
\text{C-Place} \arrow[d, dash] & \text{C-Place} \arrow[d, dash] \\
\text{coronal} \arrow[r, bend right] & \text{V-Place}
\end{tikzcd}
$$

Though Clements does not make this explicit, in his system the C-Place coronal feature spreads to the V-Place node rather than to the C-Place node of the vowel. If that were not the case, a demotion rule of the form in (10) would have to be postulated to convert the consonantal features into vocalic features.

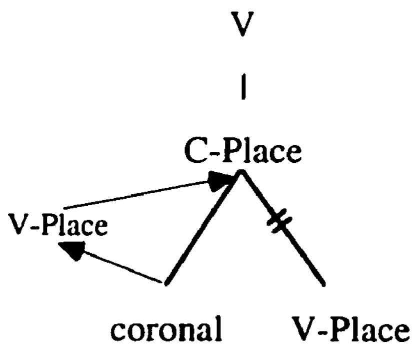
(10) a. spreading

$$
\begin{tikzcd}[row sep=small]
C \arrow[d, dash] & V \arrow[d, dash] \\
\text{C-Place} \arrow[d, dash] & \text{C-Place} \arrow[d, dash] \\
\text{coronal} \arrow[ur] & \text{V-Place}
\end{tikzcd}
$$

b. intermediate representation



c. demotion



Note, however, that in order to make this claim Clements must crucially assume that the C-Place and V-Place nodes are identical in every respect except for their position in the feature tree. It is only because of this fact that the C-Place node of one segment can spread to the V-Place node of another, and vice versa. In defense of this assumption Clements cites a process in Palestinian Arabic illustrated in (11) and analyzed by Herzallah 1990, where emphatic and uvular consonants cause the root vowel in the imperfective (normally *a* or *i*) to become *u* :

(11)	perfective	imperfective	gloss
a. regular verbs	*nidim*	*yi-ndam*	regret
	kibir	*yi-kbar*	grow up
	katab	*yi-ktib*	write
b. *u*-verbs	*qatal*	*yi-qtul*	kill
	saχan	*yi-sχun*	get hot
	nabaʁ	*yi-nbuʁ*	excel
	ṭAlab	*yi-ṭlub*	ask for

According to Herzallah, emphatics and uvulars are characterized by a [dorsal, pharyngeal] secondary articulation under the V-Place node. Consequently, she attributes the *-u-* in the forms in (11b) to a [dorsal] feature spread from emphatics and uvulars within the root. This analysis, however, is far from compelling, for it does not explain why the vowel becomes *u* rather than *a*, nor why only one of the two secondary articulations spreads. Clements also assumes that in consonants coronal dominates the features [anterior] and [distributed], which entails that in (9) these features must spread to the vowel as well. It is, however, not clear within his system how these features are implemented in vowels, or even if they exist for vowels. Since in Clements's framework coronal in vowels is directly equivalent to traditional [-back], we must suppose that he treats coronal as a terminal feature in vowels, whereas it behaves as a nonterminal node in consonants.

Another phenomenon discussed by Clements is the backing of vowels by dorsal consonants. In the Khoisan languages of southern Africa, for example, only back vowels are allowed to follow velars, uvulars, and clicks, which are generally assumed to have a primary dorsal articulation (but see Halle (forthcoming) for a different analysis of the clicks). Clements represents this as a syllable structure constraint spreading the dorsal articulation of consonants to a following vowel, as in (12):

(12)	C	V
	|	|
	C-Place	C-Place
	|	|
	dorsal	V-Place

A typical example of interaction between labial consonants and round vowels is found in Igbo, where the high vowel of the reduplicated syllable in the present participle surfaces as round before labial consonants, and non-round elsewhere (Hyman 1975:53):

(13)	verb stem	present participle	gloss
a.	*bè*	*ò-bù-bè*	cut
	bà	*ɔ̀-bʊ̀-bà*	enter
b.	*lé*	*ò-lí-lé*	look
	lá	*ɔ̀-lì-lá*	return

Parallel to the coronal and dorsal cases just described, Clements treats such cases as spreading of [labial] from the the root consonant to the vowel of the reduplicated syllable[6].

As mentioned above, some advocates of VPT, and Clements (forthcoming) in particular, take C-V interactions of the types reviewed in this section to indicate that vowels and consonants share a common set of features, normally {labial, coronal, dorsal, radical}, corresponding to the traditional vocalic features {round, -back, +back, ATR/low}. The relevant feature geometry he posits is thus as follows (irrelevant nodes omitted):

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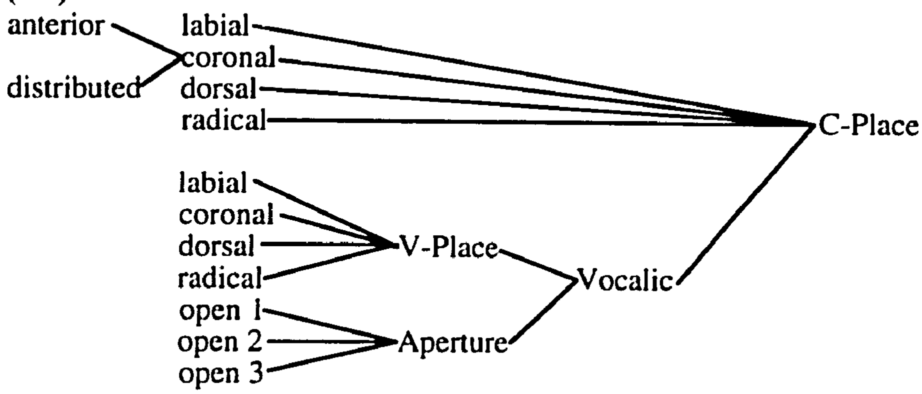
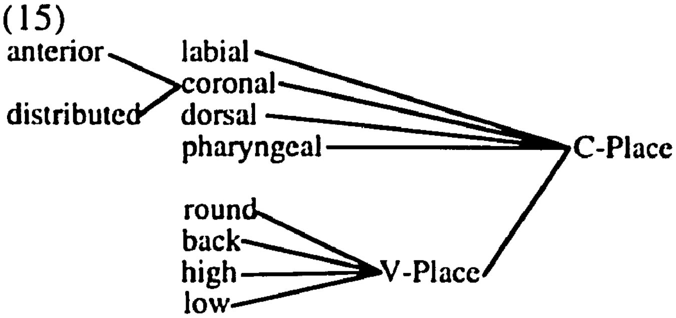
[6]The Igbo data and similar cases of labial consonants rounding adjacent vowels surveyed by Sagey 1986 are problematic for RRT. As I argue later in this chapter, RRT assumes that plain labial consonants are [-round] and that only terminal nodes in the feature tree can spread. Given these constraints, the only labial feature that can spread from a labial consonant to a vowel is [-round]; it is not immediately clear, though, why spreading of [-round] should cause a target vowel to become [+round]. I assume following Calabrese 1992 that there exists a series of equivalencies between consonantal articulators and vocalic place features, e.g. [+consonantal, labial] ≡ [-consonantal, +round], [+cons, coronal] ≡ [-cons, -back], and so on. The basic idea here is that the activation of the lip muscles in labial consonants, for example, is interpreted as activation of [+round] in vowels. This notion essentially duplicates the formal claims of Clements' model, but does not lead us into the string of problems which VPT encounters, as discussed in the rest of this chapter.

(14)



Ní Chiosáin and Padgett 1993 take a more conservative position. Within their theory, as discussed in more detail later in this section, all C-V interactions are interpreted as operations on the V-Place node, so that there is no direct evidence for relations between consonantal Place features and vocalic Place features. Instead, they assert only that there are equivalence relations between labial and [+round], coronal and [-back], dorsal and [+back], and pharyngeal and [+low], and propose the Place geometry in (15):

(15)



In addition to the theory-internal considerations which motivated Ní Chiosáin and Padgett's rejection of UFT, there are a number of other facts which lead us to believe that consonants and vowels must not have separate sets of Place features. First of all, the sets would be devoid of a plausible anatomical interpretation. Moreover, most of the C-V interactions adduced in support of UFT receive equivalent accounts in an RRT model like (1) that lacks such a separation; the labial and dorsal interactions described above, as well as interactions between ATR values of consonants and vowels (discussed in more detail in chapter 4), are simply represented as spreading of the labial, dorsal, and tongue root nodes respectively. So, for example, Igbo rounding could be represented as follows:

(16) V C
| |
Place Place
| |
dorsal labial

The RRT model in (1) fails to account for coronal-front interactions of the kind encountered in palatalization. I note that not all phonological phenomena can or should be explained directly by feature geometry, and I believe that this is one such case where other explanations must be sought. Calabrese 1992 has proposed that there is an equivalency relation between [dorsal, -back] and [coronal, -anterior] in order to account for palatalization processes. On the other hand, if in order to account for these phenomena front vowels are assumed to be coronal and back vowels dorsal, a host of new problems is created. We are forced to assume, for example, that what appear to be unitary processes of [back] harmony found in Turkish, Hungarian, and numerous other languages actually involve two distinct harmonic phenomena, of which one spreads [coronal] and the other spreads [dorsal]. Similarly, it is not clear in UFT why segments with lexical [+back] or [-back] specifications block harmony in such languages. For example, in a word such as Turkish */vak'tl/* 'time' --> *vak'it*, where the *k'* in UFT would be lexically specified as having a [coronal] secondary articulation, the [dorsal] specification of the *a* should be free to associate to the epenthetic vowel, ignoring the [coronal] element of *k'* just as it ignores regular coronal consonants. Clements and Hume 1993 propose that coronal and dorsal are dominated by an intermediate node, which they call "lingual", and that it is the lingual node which is spreading in back harmony systems. The lingual node, it should be noted, is introduced solely to deal with problems that arise from the special treatment of [dorsal] and [coronal] advocated by Clements and Hume. None of these problems arise in the RRT model in (1), where this type of harmony is represented--simply and correctly--as spreading of [αback].

Calabrese 1992 has observed that implicit in the assumption that front vowels are coronal is the prediction that front vowels and the glide *y*, which in Sanskrit is a positional variant of *i*, should block the well-known nati rule, which spreads the coronal node from retroflex consonants to subsequent coronal nasals in a word unless blocked by an intervening coronal segment. This is however not the case, as can be seen in the following examples:

(17) nati (Whitney 1889, Steriade 1986, Halle (forthcoming): 37-8)

a. standard *kṣubh- + -ana- --> kṣóbhaṇa-* 'shaking'

b. blocking *pra- + jan- + -a- --> prajana-* 'begetting'

c. transparency of *y* *pra- + yā- + -na- --> prayā́ṇa* 'advancing'

d. transparency of front vowels *prī- + -na- --> prīṇa-* 'pleased'

In RRT, on the other hand, Sanskrit vowels and *y* bear no coronal features.[7] This conforms to the phonetic evidence and correctly predicts that these sounds will not block nati.

In addition to the difficulties UFT encounters in dealing with coronals and dorsals, it also runs into problems with the traditional features [high] and [ATR]. Clements 1991 replaces vocalic [high] and [ATR] with the family of aperture features [open 1, open 2, open 3], which encode height differences between high, mid, and low vowels respectively. This proposal, for which no phonetic evidence is adduced, also makes incorrect phonological predictions. By separating the aperture features from consonantal and vocalic Place features, Clements predicts they will not show the same interactions between consonants and vowels that we find with Place-dependent features such as coronal, dorsal, etc. The extensive evidence for interactions between consonant voicing and vocalic [ATR] values documented by Trigo 1987 and Vaux 1993a is thus problematic for Clements's theory, whereas it receives a straightforward account within an RRT model (q.v. Vaux 1993a and chapter 4 of this thesis).

Clements 1991 and Odden 1991 have argued that the RRT model (1) has difficulty in accounting for cases where [ATR] and [high] values apparently spread together in Bantu languages such as Kimatuumbi, Kinande, and Esimbi (data and arguments summarized in Kenstowicz

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[7]I assume that in languages where *y* is a positional variant of *i*, such as Sanskrit, *y* must also be dorsal. As suggested by Halle 1993, some *y* 's may be coronal, whereas other *y*'s are dorsal. For example, in Fula dorsal *y* alternates with *g* and *ŋ*, whereas coronal *y* alternates with *ɟ* and *ñɟ*.

1994:476ff). Halle (forthcoming:62ff.) shows that these data can be interpreted without recourse to the feature ATR, and therefore do not pose a problem for RRT.

To summarize thus far, UFT differs substantially from traditional RRT models only in its treatment of the features [-back], which it interprets as [coronal], and [ATR] and [high], which it interprets as a family of [open] aperture features. I have shown in this section that the [coronal] representation of front vowels creates more problems than it solves, and that the problems it intends to remedy are readily manageable within an RRT framework. In addition, the replacement of [ATR] and [high] with [open] makes incorrect predictions about the interaction of consonantal and vocalic [ATR] values. Thus, UFT is clearly inferior to RRT, which moreover has the advantage of being anatomically motivated.

1.1.3.2. Consonantal transparency and V-Place

The tenet (7ii), which is fundamental to all variants of VPT, maintains that the transparency of consonants with respect to rules spreading vocalic features indicates that consonantal Place features must be segregated from vocalic Place features in the feature geometry. In this sub-section I review a number of cases adduced in support of this claim, and discuss some of the problems inherent in the feature geometry which Ní Chiosáin and Padgett 1993 propose based on these data. In section 1.1.4 I then show that these cases of consonantal transparency do not actually require segregation of consonantal and vocalic Place features, once we adopt terminal feature spreading.

The evidence for consonant transparency primarily comes from processes of total vowel assimilation, or "vowel copy", where a vowel takes all of its Place features from a neighboring vowel, regardless of the nature of any intervening consonants. A typical example of vowel copy is found in the Uto-Aztecan language Tarahumara, where the vowel of the deverbal suffix *-kV* is an exact copy of the final vowel of the root (Nída 1949:23):

(18)	verb	gloss	noun	gloss
	mičiru	make shavings	*mičiru-ku*	shavings
	reme	make tortillas	*reme-ke*	tortillas
	pači	grow corn	*pači-ki*	ear of corn
	opača	be dressed	*opača-ka*	garment

If we assume that this process involves spreading of the Place features from the final vowel of the verb root to the vowel of the suffix, then within a traditional RRT model we should expect--incorrectly--that the suffixal *k*, which is dorsal, would block the spreading of the vocalic dorsal node. As shown in section 4.2, however, this problem does not arise if spreading is confined to terminal features, as proposed in this thesis.

Another case of total vowel copy is found in Maltese Arabic, where the vowel of the imperfective prefix is an exact copy of the following stem vowel, except when the first consonant of the stem is a coronal obstruent, in which case the prefix vowel is *-i-* (Hume 1990):

(19)	perfective	imperfective	gloss
a.	*forok*	*yo-frok*	limp
	kotor	*yo-ktor*	abound
b.	*dalam*	*yi-dlam*	grow dark
	čahad	*yi-čahad*	deny

Normally vowel copy processes in Semitic languages are not good diagnostics for feature geometry, because consonants and vowels occupy separate morphemic tiers, and therefore are not expected to interact or interfere with each other (McCarthy 1989). The fact that coronal consonants appear to determine the quality of the vowel in this case, however, may indicate that this particular process applies after tier conflation, at which point consonants and vowels are able to interact. If this is so, the failure of dorsal consonants such as the *k* in *yoktor* to block the spreading of vocalic features would appear to be a problem for RRT, but as just noted, this problem does not arise if spreading is confined to terminal features (see section 1.1.4 for additional discussion).

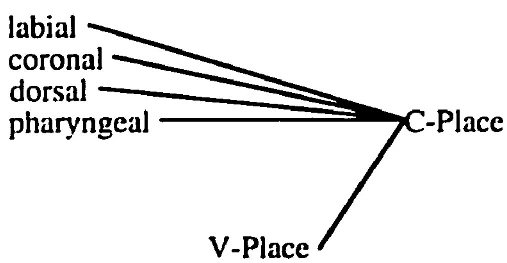
Perhaps the most interesting vowel copy phenomenon of this type is in the Amerindian language Klamath, where the vowel of the causative prefix *snV-* is copied from the leftmost vowel of the verb stem (Barker 1964, Ní Chiosáin and Padgett 1993:4-5):

	causative	gloss
(20)		
	sna-čk'a:Wa	makes cold
	snæ-Gæ:ǰiga	makes tired
	sno-bo:stgi	causes something to turn black
	sni-ǰi:qjiq'a	makes someone ticklish

As observed by Ní Chiosáin and Padgett 1993:5, the spreading of vowel features across velar and uvular consonants, both of which are normally assumed to have primary dorsal articulations, would seem to pose a problem for RRT models. As in the two cases above, I show in section 1.1.4 that these problems are more apparent than real.

Given that [round] spreads together with the dorsal vowel features in all three of these cases, we should assume that it is actually the Place node which is spreading, which should entail that all consonants with Place specifications should block vowel copy. In fact, it appears that consonants are generally transparent to vowel copy. In view of the transparency of consonants with respect to vowel copy, proponents of VPT have suggested that consonantal and vocalic Place features constitute separate tiers, as schematized in (21):

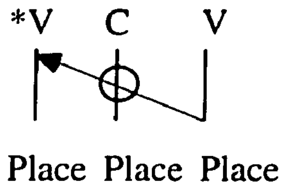
(21)



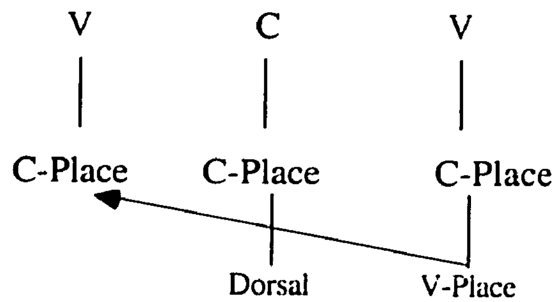
The basic appeal of this type of representation is that it allows us to account for consonantal transparency in vowel copy processes, as shown in (22):

(22) representation of vowel copy

a. pre-terminal spreading RRT



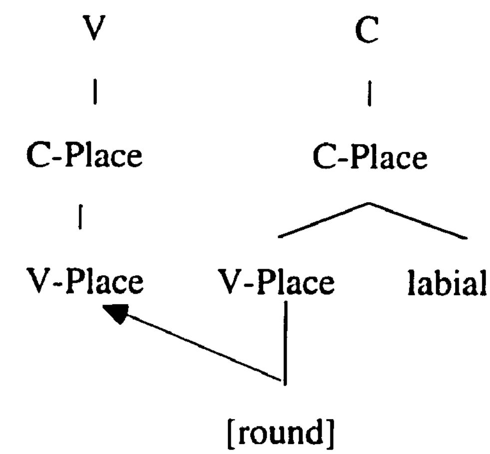
b. V-Place Theory



In (22a), the rightmost vocalic Place node is prevented from spreading to the leftmost vowel by the intervening Place node associated with the consonant, whereas in (22b) the V-Place node is free to spread from the rightmost to the leftmost vowel, because the intervening consonant has no V-Place node.

As mentioned earlier, Clements assumes that the C-Place and V-Place nodes are identical, and freely interact with one another. This assumption allows him to account for apparent cases of primary consonantal Place features spreading to vowels, as in the Armenian, Khoisan, and Igbo processes described above. Ní Chiosáin and Padgett, on the other hand, assume that all C-V interactions occur on the V-Place tier, which forces them to postulate that plain consonants have inherent, redundant secondary V-Place specifications identical to their primary C-Place features, in order to account for the cases just mentioned. In their system, Igbo labial spreading would therefore be analyzed as follows:

(23)



The theory of inherent V-Place encounters many problems. First of all, it renders Ní Chiosáin and Padgett's proposal that all C-V interactions occur at the V-Place level unfalsifiable, because any apparent counterexamples can be explained away as interactions between a redundant V-Place feature in the triggering consonant and vocalic V-Place in the target vowel. In order to falsify their claim that plain consonants can have inherent secondary articulations, we would have to find cases in which plain consonants interacted with vocalic Place features directly, but any such case we might find could always be analyzed by Ní Chiosáin and Padgett as instances of inherent secondary articulations of the plain consonants, thereby rendering this aspect of their theory immune to falsification by the data. Secondly, by postulating inherent [+round] in Turkish labials in order to account for Labial Attraction (*armVd* --> *armut* 'pear', *kabVk* --> *kabuk* 'rind', etc.), Ní Chiosáin and Padgett predict that labials should block labial harmony, which is incorrect, as shown by such forms as *köprü* 'bridge', genitive *köprünün*. Because of forms such as *akšam* 'evening' --> genitive *akšamɨn* (**akšamun*), one cannot argue that labial consonants initiate their own harmonic domain in such cases, as lexically specified [-back] dorsals do. It is also not possible to appeal to rule ordering and say that labial harmony applies before redundant [+round] becomes visible, because the round vowels produced by labial attraction subsequently trigger labial harmony. In addition, if we postulate that (at least in some languages) plain labials actually have a secondary labial articulation, we can no longer distinguish between plain and labialized labials, such as *p* and p^w, which are distinguished in the Melanesian language Nambakaengo (Maddiesson 1984), Nupe (Smith 1967), Ponapean, and Mokilese (Mester 1986), or *m* and m^w, which are distinguished in Washkuk (Maddiesson 1984), Nupe, Ponapean, and Mokilese. Thirdly, Ní Chiosáin and Padgett state that vowels can never have consonantal features. This entails that in their geometry (see (6)) there is no place for pharyngealized vowels, but such vowels are found in Tsakhur and Udi (Catford 1983), Evenki, Neo-Aramaic, Hamer, Lak, and !Xũ (Maddiesson 1984). The RRT theory I adopt also postulates that vowels cannot bear certain features, specifically features such as [continuant], [strident], [lateral], and [suction]. However, it allows vowels to have specifications for features such as [ATR] and [RTR], which are not possible in Ní Chiosáin and Padgett's theory because of their impoverished set of vowel features [high, low, back, round]. In (24) I show how the vowel inventory of the Afro-Asiatic language Hamer (Maddiesson 1984) would be represented within RRT (a) and Ní Chiosáin and Padgett's system (b):

(24) a.

	i	*e*	*a*	*o*	*u*	*ɪˤ*	*eˤ*	*Aˤ*	*ɔˤ*	*ʊˤ*
high	+	-	-	-	+	+	-	-	-	+
low	-	-	+	-	-	-	-	+	-	-
back	-	-	+	+	+	-	-	+	+	+
round	-	-	-	+	+	-	-	-	+	+
RTR	-	-	-	-	-	+	+	+	+	+

b.

high	+	-	-	-	+	+	-	-	-	+
low	-	-	+	-	-	-	-	+	-	-
back	-	-	+	+	+	-	-	+	+	+
round	-	-	-	+	+	-	-	-	+	+

Clearly [RTR] or some other feature expressing pharyngeal constriction is required to distinguish the five pharyngealized vowels from the five regular vowels, but in Ní Chiosáin and Padgett's theory, where [low] is used to express both height and pharyngeal constriction, this distinction is not possible. Clements (to appear:7) circumvents this problem by replacing traditional [ATR] and [RTR] with the feature [radical]. In his framework, all pharyngealized vowels are therefore [radical]. Note, however, that his theory does not distinguish between ATR and RTR, which as argued by Goad 1991, Trigo 1991, and Vaux 1993a must be distinct features (cf. chapter 4 for further discussion).

Finally, VPT cannot capture McCarthy's (in press) generalization that uvulars, pharyngeals, and laryngeals pattern together in rules of Semitic phonology, nor the fact observed for various languages by

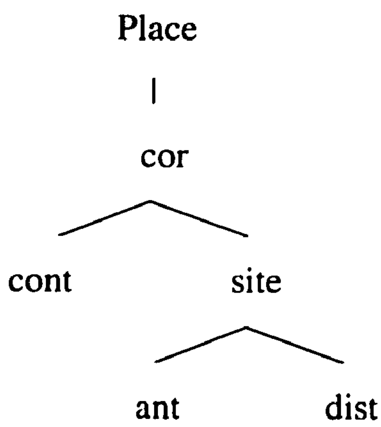
Elorrieta 1991, Bessell 1991, and Vaux 1993a that uvulars and pharyngeals form a subgroup of this class, often patterning together as a class separate from laryngeals. I return to this issue in chapter 4.

1.1.3.3. Consonant harmony and vocalic transparency

Recall that RRT crucially differs from other theories in assuming terminal spreading, full specification, and a different feature tree; consequently, RRT makes a number of predictions that differ from other theories. As mentioned in section 1.1.2, VPT predicts that consonant harmony should be impossible, whereas RRT allows for all types of consonant harmony, except those involving dorsal consonants, because the spreading of dorsal features should be blocked by all vowels. I briefly examine two cases of consonant harmony which appear to bear out the prediction of RRT, and consider a case of consonantal [dorsal] harmony which presents the same--ultimately solvable--problem for all three theories of feature geometry considered here.

Perhaps the most instructive instance of consonant harmony is found in the American Indian language Tahltan, where a process of coronal harmony spreads coronal Place features of consonants from right to left within a word (Shaw 1991, Halle (forthcoming):39-42). This process presents an insurmountable problem for VPT, which explicitly forbids spreading of consonantal features across vowels (Ní Chiosáin and Padgett 1993:46). In order to explain the fact that the coronal features [anterior] and [distributed] can spread through vowels, Ní Chiosáin and Padgett postulate a 'site' node subordinate to coronal, as in (25):

(25)



This is a purely ad hoc move, since no other evidence is cited in support of it. Tahltan coronal harmony is not a problem for the RRT model, however, because vowels have no coronal features to block the spreading consonantal features (for details see Halle (forthcoming)).

Now consider the case of emphasis harmony in some dialects of Berber (Dell and Elmedlaoui 1985, Dell and Tangi 1993), which spreads pharyngealization (I assume this involves the feature RTR) from one consonant, wherever it may be located in the word, to all other segments in that word. Since according to Ní Chiosáin and Padgett 1993:46 pharyngealization is a secondary articulation in such cases, we should expect low vowels to block emphasis harmony, because within Ní Chiosáin and Padgett's system pharyngeality and lowness are expressed by the same feature, [low]. Since this is not the case in Berber, this version of VPT is disconfirmed by the facts. Within Clements's version of VPT, by the same token, we should expect back vowels to block emphasis harmony, since, as we saw in (11) in the examples from Palestinian Arabic, Clements assumes pharyngealization to involve the features [radical] and [dorsal]. Clements's version of VPT is therefore also disconfirmed by the facts. Emphasis harmony is not a problem for RRT, because vowels are not contrastive for the feature [RTR], and emphasis harmony sees only features that are contrastive.

An interesting problem for all geometric models considered here is posed by the northwestern dialect of Karaim, a Turkic language spoken in Lithuania. This dialect has productive consonantal [back] harmony, and intervening vowels are generally not affected (with two important exceptions to be discussed below). All three theories of feature geometry considered here admit consonantal [back] harmony only if intervening vowels are also affected. In the following discussion I argue that intervening vowels are in fact affected by the harmony process, and vowels thereby produced which violate surface well-formedness conditions are repaired by delinking their [back] specifications.

In northwestern Karaim, the original Turkic system of vocalic [back] harmony has been reinterpreted as a feature of consonants, and the vowel system subsequently reduced to the six-vowel surface inventory {*a e i ɨ o u*} (proto-Turkic **ä* (Turkish *e*) merged with *a* in non-initial syllables, **ü* merged with *u*, and **ö* with *o*). As a result, root and suffixal consonants agree in backness with the first root consonant, regardless of the quality of intervening vowels. Representative alternations are given in (26) (Kowalski 1929; C' = palatalized consonant):

(26)	stem	ablative	Turkish	gloss
	/suv/	*suv-dan*	*su-dan*	water
	/k'un/	*k'un'-d'an'*	*gün-den*	day
	/taš/	*taš-tan*	*daš-tan*	stone
	/el'/	*el'-d'an'*	*el-den*	people
	/k'op/	*k'op(')-t'an'*	-----	very

In Ní Chiosáin and Padgett's system, palatalization is treated as a secondary [-back] V-Place articulation, and hence all vowels should block the spreading of this feature, since vowels invariably possess [back] specifications. Within Clements's UFT model, the harmonizing element should be the lingual node, as in his analysis of Turkish described earlier; consequently, vowels, which are always specified for lingual features in Clements's system, should block the spreading of consonantal lingual features. One could conceive of an analysis within Clements's framework where the harmonic feature was [coronal], and words such as *suvdan* and *taštan* would therefore be direct manifestations of underlying representations, not involving consonant harmony at all. In such an analysis, we would only expect [coronal] vowels to block the harmony process; this is shown to be false by words such as *m'en'd'an'* 'from me', where palatalization spreads through the [coronal] vowel *e*. Karaim consonant harmony is equally problematic for RRT (without the mechanism of terminal spreading). In this system, both consonantal and vocalic [back] features belong to the dorsal node, and consequently vocalic [back] specifications are predicted to block spreading of consonantal [back] harmony.

Given that the Karaim harmony rule presents the same difficulty for all theories considered here, we must either develop a new theory or revise our analysis of the Karaim facts. Now consider the alternations in (27):

	stem	genitive	Turkish	gloss
(27)	*/tav/*	*tav-nɨn*	*dağ-ɨn*	mountain
	/el'/	*el'-n'in'*	*el-nin*	hand

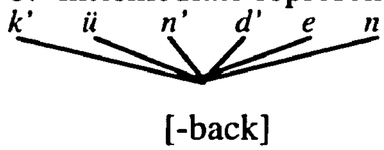
We can see from these cases that *i* in fact alternates with *ɨ* in the same manner as in Turkish; thus, we cannot assume as in the case of the Semitic languages that consonants and vowels occupy separate tiers in Karaim, because the consonantal [back] values affect neighboring *i*'s. The same is true of *a* ~ *e*, where *a* occurs with back consonants and *e* with palatalized consonants, e.g. *k'eč'a* 'night' vs. *kaš* 'eyebrow', but this alternation does not surface in suffixes because *e* becomes *a* in non-initial syllables. In light of the alternations in (27), I propose that Karaim consonantal [back] harmony actually spreads to all vowels as well, and that at a later stage in the derivation the illicit configurations *[+round, -back] and *[+low, -back] produced by this process are repaired by delinking the harmonic [-back] value (see Calabrese (forthcoming) for further discussion of marking statements and repair rules). A word such as *k'un'd'an* 'day-Abl' would then undergo the derivation in (28)[8]:

(28) a. underlying representation

```
k'          u            n          d          a         n
|           |            |          |          |         |
Place      Place        Place      Place      Place     Place
|          /   \         |          |          |         |
dorsal   dorsal  labial coronal    coronal    dorsal    coronal
|          |       |                           |
[-back]  [+high] [+round]                    [+low]
```

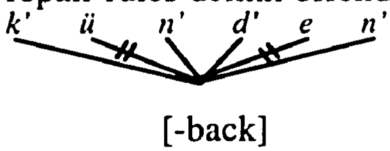
[8] I assume that the features dominated by the dorsal, coronal, and labial articulators represented in (28a) are fully specified in the underlying representation, but for ease of presentation I have omitted all features that do not play a part in the phenomenon under discussion.

b. intermediate representation: **k'ün'd'en*



c. *ü* disallowed, *e* disallowed in non-initial syllables;

repair rules delink offending [-back] features



Though I assume that the segments in (28a) are fully specified underlyingly, for ease of representation our diagram includes only features relevant to our discussion. It should be noted that the analysis presented in (28) is compatible with VPT theories, and the Karaim case therefore does not serve to distinguish VPT from RRT.

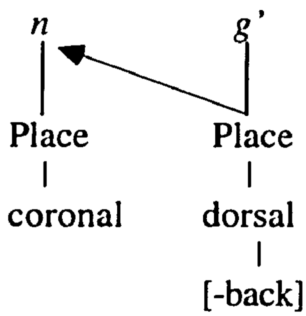
1.1.3.4. Place assimilation

One final item of evidence invoked by Ní Chiosáin and Padgett in support of a V-Place node is the behavior of nasals in modern Irish (de Bhaldraithe 1945, Ní Chiosáin and Padgett 1993:7), illustrated in (29):

(29)	a.	*d'ek'h'in'*	'I would see'
		d'ek'h'iŋ' gan e:	'I would see without it'
	b.	*d'i:lən*	'a diary'
		d'i:ləŋg'i:v'r'i	'a winter's diary'

According to Ní Chiosáin and Padgett, this is an instance of Place assimilation. Hence, if we assume that palatalization in dorsals is represented as a [-back] specification under the dorsal node, we expect that Place assimilation in (29b) should produce **d'i:ləŋ'g'i:v'r'i*, as depicted in (30):

(30)

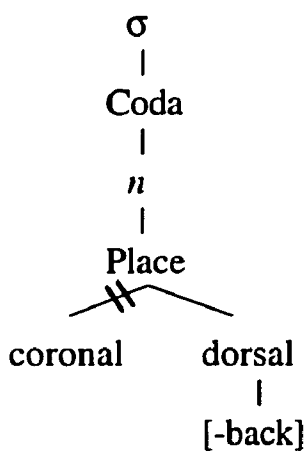


Ní Chiosáin and Padgett assert that in order to account for the non-assimilation of the palatal secondary articulation in (29b) "we must adopt a structure in which the V-Place feature representing palatalization is independent of Dorsal" (1993:7). The V-Place node they propose lacks anatomical support and is motivated exclusively by the needs of their analysis of the Irish facts. If we take seriously the phonetic fact that secondary articulations are implemented simultaneously with primary articulations, as we know they are in Irish (de Bhaldraithe 1945:25-42; cf. Ladefoged 1982:210), and if we consider that [-back] is physically implemented by the tongue dorsum, representations of the type proposed by Ní Chiosáin and Padgett must not be possible, because the tongue dorsum cannot make two simultaneous [back] gestures.

Moreover, Ní Chiosáin and Padgett's analysis itself--i.e. that the phenomena in (29) are instances of Place assimilation--is not the only nor necessarily the best treatment of the data. As an alternative Hall and Vaux

1994 propose that the examples in (29) are instances of Coronal Delinking, a process well-attested in Irish phonology (cf. Ní Chiosáin and Padgett 1993:6-7). Coronal Delinking applies to coronal obstruents in weak (leniting) environments; for example, in word-initial position, {*t t' s s'*} become {*h h' h h'*} respectively. Ní Chiosáin and Padgett 1993:6-7 analyze this change as delinking of the primary coronal articulation, yielding a default consonantal articulation, *h*, which preserves the original secondary articulation. I suggest that Coronal Delinking may exceptionally be active in syllable codas as well, which are also cross-linguistically weak structural positions. In this analysis, (29a) would be represented as follows (irrelevant nodes omitted):

(31)



When the coronal node of the *n'* is delinked, the dorsal specification automatically becomes the primary articulation, yielding the [dorsal, -back] nasal *ŋ'*[9]. In (29b), Coronal Delinking produces a [dorsal, +back] nasal, *ŋ*.

---

[9]Note that delinking of the coronal node does not violate full specification, because dorsal consonants do not require specifications for the other articulators.

One might object that this analysis loses the generalization that the cases in (29) fall under the general rubric of nasal Place assimilation. I in fact consider this to be a desirable result, insofar as Irish nasal Place assimilation operates in a different manner than the process in (29). Consider the facts in (32):

(32) Irish nasal Place assimilation (de Bhaldraithe 1945:48-54)

a. labials

ən 'to'

əm ba:š 'to death'

ən 'the'

(*əs ma:*) *m' f'æ:r* (*e*) 'the man (is good)'

šæ:n 'old'

šæ:m' v'æ:n 'old woman'

b. coronals[10]

---

[10]In this dialect of Irish, the [-back] counterpart of *n* is the palatal nasal *ñ*, not the palatalized alveolar *n'*. De Bhaldraithe 1945:38-9 describes *n* as a velarized (i.e. [+back]) alveolar nasal produced by touching the tongue tip ([-dist]) to the front part of the teeth-ridge ([+ant]); *ñ* is a palatal nasal produced by touching the tongue tip ([-dist]) to the hard palate (i.e. [-ant]); *n'* is a palatalized ([-back]) alveolar ([+ant]) nasal (no further articulatory information given); *ŋ* is a velar nasal produced by touching the tongue dorsum to the back part of the soft palate (i.e. [+back] without any coronal

f æ:miñ 'seaweed'

f æ:mən du 'black seaweed'

ra:n 'bread'

ra:ñ t'e 'warm bread'[11]

e:g'in' 'hardly'

ar' e:g'iñ d'e: 'it was only by the merest chance'

c. dorsals

iərən 'iron'

ə t'-iəriŋ' k'i:ñ 'a head iron'

mu:n' 'turf'

hug še mu:ŋ gə ga:L'ə 'he brought turf to Galway'

p'i:ñ 'penny'

---

involvement); and *ŋ'* is a forward-velar nasal produced by advancing the tongue dorsum to make contact with the front part of the soft palate (i.e. [-back]).

[11]The segment denoted as *t'* is according to De Bhaldraithe 1945:25 an alveo-palatal stop, produced by raising the tongue blade ([+dist]) to make contact with the junction of the teeth-ridge and the hard palate ([-ant]). It would perhaps be more appropriate to represent this sound as *c*, because it causes a preceding coronal nasal to become palatal *ñ*, but we have opted to maintain De Bhaldraithe's transcription.

p'i:ŋ' g'a:r 'short penny'

It is clear from (32a-c) that Irish nasal Place assimilation normally affects secondary palatalization as well as primary place of articulation, even when the triggering consonant is dorsal (32c). In fact, according to de Bhaldraithe 1945:51, the only exception to this generalization is the palatal nasal *ñ*, which often retains its palatal quality before non-palatalized consonants. Given the inconsistent behavior of *ñ*, any analysis must stipulate that either assimilation or non-assimilation in these cases is exceptional. I suggest that nasal Place assimilation is responsible for the cases where the secondary articulation of *ñ* is affected, e.g. *k'i:ñ* 'head-gen.' + *γuwə* → *nə k'i:ŋ γuwə* 'the black ones', and the cases in (29) are distinct, resulting from Coronal Delinking. I believe that this analysis of the Irish facts is preferable to the VPT analysis, because in addition to respecting the phonetic facts it captures the distinct behavior of *ñ*, whereas Ní Chiosáin and Padgett would have to place ad hoc restrictions on one subpart of their nasal Place assimilation rule in order to allow palatalization assimilation in some cases but not others.

1.1.4. Terminal Feature Spreading

Perhaps the most vexing problem for VPT analyses of vowel copy, in addition to the problems discussed in section 1.1.3, is that they predict there will be no cases of incomplete spreading of Place features, because of the assumption that only nodes can spread, and blocking of a spreading node entails blocking of all features contained under that node. In this section I review a number of processes which show this prediction to be false, and indicate how the theory of terminal spreading accounts for both incomplete and complete feature spreading.

1.1.4.1. Incomplete spreading

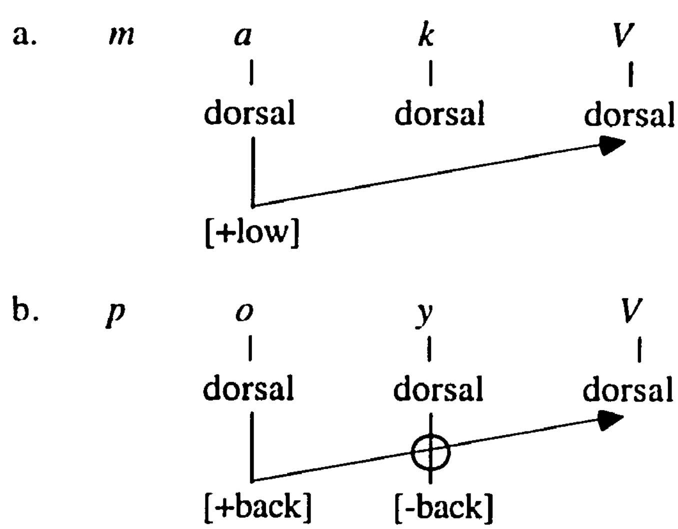
All theories of feature spreading to date have assumed that a) intermediate nodes in the feature tree can spread, and b) features which spread together must be exhaustively dominated by a common node. Halle (forthcoming) adduces evidence from a number of languages showing that both of these assumptions must be modified. I survey two of Halle's more striking examples below.

In Ainu, the transitivizing verb suffix is normally an exact copy of the stem vowel (33a). When the stem ends in a glide, however, the suffix surfaces as *-e* (33b) (Ito 1984):

(33)	a.	*mak-a*	'open'
		ker-e	'touch'
		pis-i	'ask'
		pop-o	'boil'
		tus-u	'shake'
	b.	*ray-e*	'kill'
		chiw-e	'sting'
		poy-e	'mix'
		tuy-e	'cut'

A conventional RRT model would predict that all consonants block spreading of the vowel features from the stem to the suffix, whereas in Ainu, as we have just seen, only the glides *y* and *w* block spreading, in which case the vowel surfaces as the default *e*. VPT is able to account for the transparent consonants in this case, but not for the opaque behavior of the glides. Halle (forthcoming) notes that *y* and *w* are positional variants of *i* and *u* in Ainu, and that none of the features dominated by any Place articulator except coronal is contrastive for Ainu consonants. He then employs these facts to account for both the general transparency of consonants and the opacity of the glides by assuming that only terminal features are allowed to spread, and that the spreading rule is sensitive to contrastive features only. These two assumptions imply that only the glides will block spreading of vowel features, because they themselves possess all the dorsal features of vowels, whereas other consonants should not block vowel features because the consonants have only bare Place nodes. In particular and crucially, *k* does not block spreading of these features, because in *k* the feature complex [+high, +back] is not contrastive. The cases in (33a) and (b) would thus be analyzed as follows (intermediate nodes omitted):

(34)



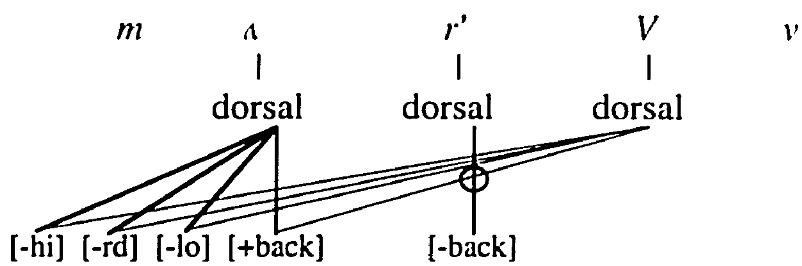
By assuming that assimilation of an intermediate node is executed by spreading of the terminal nodes it dominates, therefore, we are able to provide an elegant account of facts which are unexplainable by traditional RRT or VPT.

Now consider the case of Barra Gaelic (Sagey 1987), which has a vowel copy process quite similar to that of Ainu. Barra Gaelic breaks up certain consonant sequences with an epenthetic vowel which is an exact copy of the preceding vowel, except when the intervening consonant has a contrastive [back] specification, in which case the epenthetic vowel agrees in backness with this consonant. In this dialect, backness is contrastive for all consonants except labials and the coronals /*n*, *R*/. The basic facts are given in (35):

(35)	underlying form	surface form	gloss
a. full copy	*urpel*	*urupel*	tail
	t'imx'al	*t'imix'aL*	round about
	mer'k'	*mer'ek'*	rust
	ɔrm	*ɔrɔm*	on me
	æms'ir'	*æmæs'ir'*	time
	marv	*marav*	dead
b. partial copy	*mʌr'v*	*mʌr'ev*	the dead
	færk	*færak*	anger
	bul'k'	*bul'ik'*	bellows (g. sg.)
	dr'i	*dɨr'i*	fishing line

Again, both VPT and RRT without terminal spreading fail to account for the facts in (35). If, on the other hand, assimilation is represented by spreading terminal features exclusively, as proposed here, a straightforward account is available within RRT: all terminal Place features spread from a preceding vowel to the epenthetic vowel, except when a consonant for which backness is contrastive intervenes; in this case the vocalic [back] feature is blocked by the Line Crossing Prohibition (Sagey 1986). This process is illustrated in (36):

(36)



Halle (forthcoming) cites several more phenomena which can be accounted for only by assuming that terminal features alone can spread.

The problem in the cases just reviewed is not the actual geometry supposed by RRT and VPT, but rather the spreading theory they employ, specifically the admission of spreading of nonterminal nodes in the tree. Once we restrict spreading to terminal features, though, we must reevaluate the data which led to the formulation of these two theories. In the following section I demonstrate that once we assume terminal spreading, the arguments for VPT lose their force, whereas the problems with RRT disappear.

1.1.4.2. Complete spreading

In section 1.1.2 I noted that RRT encountered difficulties in accounting for the general transparency of consonants with respect to vowel copy processes. I showed there that these problems were avoided by VPT. In order to gain this advantage, however, VPT is forced to assume that plain consonants can *never* interfere with spreading of vocalic features. In section 1.1.4.1 I considered several instances where plain consonants do in fact interfere with the spreading of vocalic features and showed how a theory of terminal spreading was able to account for these facts. Since this and a number of other reasons presented in section 1.1.2 led us to abandon VPT in favor of RRT, I now reconsider how RRT might deal with consonantal transparency, given the restriction that only terminal features may spread.

Consider first the case of Tarahumara, recapitulated in (37):

(37)	verb	gloss	noun	gloss
	mičiru	make shavings	*mičiruku*	shavings
	reme	make tortillas	*remeke*	tortillas
	pači	grow corn	*pačiki*	ear of corn
	opača	be dressed	*opačaka*	garment

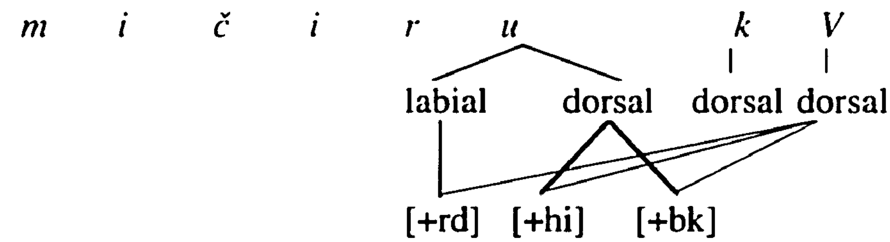
Tarahumara has the following phonemic inventory (Burgess 1984):

(38)

p	*b*		*m*			*w*			*i*		*u*
t		*s*	*n*	*l*	*r*				*e*		*o*
č						*y*				*a*	
k	*g*										
							ʔ	*h*			

In this consonantal system, the only contrast in features subordinate to the Place articulators is between [+anterior] *t* and [-anterior] *č*; crucially, *k* and *g* do not contrast with any other dorsal segments, and therefore do not have any contrastive features that are dorsal dependents. Given these facts, we can now represent the vowel copy process as shown in (39), provided that we assume that only terminal features are spread and that only contrastive features are visible to the harmony rule:

(39)



I conclude that once terminal spreading is assumed, RRT is readily able to account for the observed consonantal transparency in the case of vowel copy. This conclusion is reinforced by the slightly more complicated vowel copy of Klamath, repeated in (40):

(40)	causative	gloss
	sna-čk'a:Wa	makes cold
	sne-ɢe:ǰiga	makes tired
	sno-bo:stgi	causes something to turn black
	sni-ǰi:qjiq'ạ	makes someone ticklish

Given that velars and uvulars contrast in Klamath, we might expect both series to block spreading of [back] and [high], if we accept the traditional representation of uvulars as [dorsal, +back, -high]. The forms *sna-čk'a:Wa* and *sne-ɢe:ǰiga* indicate that vowel features freely spread through both velars and uvulars, however. Halle (forthcoming) has noted, however, that in Klamath [high] is not contrastive in vowels, whereas [high] is contrastive in consonants, distinguishing the velar *k* from the uvular *q*. If we assume further that for the vowel copy rule only contrastive features are visible, this rule can spread the features [low, back] unimpeded across intervening velar and uvular consonants, because neither of the latter two features is contrastive for consonants in Klamath. Another analysis is made possible by the representation of uvulars that I propose in chapter 4, according to which uvulars are [dorsal, -high, +back, -ATR, -RTR]. Given this representation, uvulars are not contrastive for the dorsal features and therefore should not block spreading of contrastive dorsal features.

Several more complicated instances of vowel copy cited by Odden 1991 in which only the features [back] and [round] appear to spread are have been dealt with by Halle (forthcoming) and shown to be consistent with the analysis presented here. To the best of our knowledge, then, an RRT model which employs terminal spreading is able to account for all cases of complete and incomplete vowel copy, and is therefore to be preferred over VPT, which cannot account for incomplete vowel copy, and RRT models employing non-terminal spreading, which cannot account for either type of vowel copy.

1.1.5. Conclusions

In this chapter so far I have considered two models of feature hierarchies (geometries). In the RRT model, all groupings of elements under nonterminal nodes must be anatomically motivated, whereas in the two

VPT models considered, nonterminal nodes are set up on functional grounds alone and without regard to anatomic plausibility. I have shown that Clements's Unified Feature Theory fails to capture the unitary behavior of [±back] which plays a role in many phonological systems, is unable to explain the behavior of Sanskrit nati, and incorrectly predicts that consonant voicing and vocalic [ATR] values will not interact. I have also shown that Ní Chiosáin and Padgett's version of VPT requires them to invoke redundant secondary articulations in plain consonants. This renders their theory of C-V interactions unfalsifiable, makes incorrect predictions about the involvement of labial consonants in Turkish labial harmony, and entails that they cannot represent pharyngealized vowels or the contrast between plain and labialized labials. In addition to these shortcomings, both varieties of VPT are unable to account for the cases of incomplete vowel copy discussed by Halle (forthcoming) and the instances of consonant harmony described in section 1.1.3.3 above. Finally, I have shown that once we assume that only terminal features can spread, we not only gain an explanation for the cases of incomplete vowel copy, but we also acquire the machinery necessary to account for the instances of total vowel copy within RRT. Since these cases, which were the original motivation for the postulation of VPT, are now manageable within RRT, there is no longer any reason to maintain VPT. We have, therefore, gone some distance towards establishing that the anatomically motivated feature hierarchy in (1) provides also the structure required for formalizing the assimilatory processes encountered in languages. This is a result of considerable importance, since it connects two independent factors that play a role in language: the anatomic structures responsible for the phonetic actualization of language (the articulators and their clustering), on the one hand, and the phonological processes, on the other.

1.2. Full specification

As I mentioned at the outset of this chapter, RRT differs from other theories of phonology with respect to three assumptions: the feature tree in (1), terminal spreading, and markedness theory. I discuss the last of these issues in this section.

A satisfactory feature theory must not only capture generalizations concerning feature organization and interaction, but also account for the presence and absence of individual features in different circumstances. As I mentioned briefly in section 1.1, RRT adopts Calabrese (forthcoming)'s markedness theory (MT) in this respect. MT maintains that relevant features are fully specified in underlying representations, and that rules may be sensitive to various subsets of these features. Relevant features are defined as those involved in the articulation of a segment; thus, labial consonants always bear a [round] specification, but never an [anterior] specification, and so on. In table (41) I present the complement of relevant features I assume for the most common phonemes[12].

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[12]The feature specifications I assume for [ATR] and [RTR] are justified in chapter 4.

(4)

	LABIAL						CORONAL																				DORSAL															
	p	b	m	f	v	w	t	ṭ	d	ḍ	n	ṇ	s	z	tˢ	dᶻ	q	ð	š	ž	č	ǰ	ñ	l	ɫ	r	k	g	ŋ	x	γ	y	q	G	χ	ʁ	ħ	H	ʕ	ʔ	ɦ	h
cons	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	-	-	-	-	-	-
son	-	-	+	-	-	+	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	+	+	+	+	-	-	+	-	-	+	-	-	-	-	?	?	?	?	?	?
cont	-	-	-	+	+		-	-	-	-	-	-	+	+	±	±	+	+	+	+	±	±	-	-	-	+	-	-	-	+	+		-	-	+	+						
lat	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-		-	-	-	-						
strid	-	-	-	+	+		-	-	-	-	-	-	+	+	±	±	-	-	+	+	±	±	-	-	-	-	-	-	-	?	?		-	-	+	+						
round	-	-	-	-	-	+																																				
ant							+	-	+	-	+	-	+	+	+	+	+	+	-	-	±	±	-	+	+	±																
dist							-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	-	-	±																
back																											±	±	±	±	±	-	±	±	±	±						
hi																											±	±	±	±	±	+	±	±	±	±						
low																											-	-	-	-	-	-	?	?	?	?						
nasal	-	-	+	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
ATR		+			+	+			+	+				+		+		+		+		+		?	?	?		+			+	+	-	-	-	-	-	-	?	-	?	-
RTR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	-	-	-
stiff	+	-	-	+	-	-	+	+	-	-	-	-	+	-	+	-	+	-	+	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-	+	-	+	-	-	+	-	+
spread	-	-	-	+	-	-	-	-	-	-	-	-	+	-	±	-	+	-	+	-	±	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-	+	+	-	-	+	+
constr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-

	i	ɪ	e	ɛ	æ	a	ɔ	o	ʊ	u	ə	ʌ	ü	ö	ɨ
cons	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
son	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
high	+	+	-	-	-	-	-	-	+	+	-	-	+	-	+
back	-	-	-	-	-	+	+	+	+	+	-	-	-	-	+
low	-	-	-	-	+	+	±	-	-	-	-	-	-	-	-
round	-	-	-	-	-	-	+	+	+	+	-	-	+	+	-
ATR	+	-	+	-	+	-	-	+	-	+	+	-	+	+	-

The theory of relevant features which I propose in (41) crucially depends on a number of assumptions. First of all, I adopt the suggestion of Halle (forthcoming) that only [+consonantal] segments have manner specifications. Secondly, I assume following Halle 1989 that [+consonantal] segments select from the set of articulators dominated by the Upper Vocal Tract node, according to the scheme in (42).

(42)

LABIAL	*p b m f v w*
CORONAL	*t ṭ d ḍ n ṇ s z tˢ dᶻ q ð š ž č ɟ ñ l ł r*
DORSAL	*k g ŋ x γ y q G χ ʁ*

Segments produced by articulators in the lower vocal tract are thus always [-consonantal]. Thirdly, again following Halle 1989, I assume that consonants cannot be [-high, -back]; I return to this notion in chapter 4. Fourthly, as discussed in 1.1 I assume that most vowels are executed by the dorsal articulator, but may also involve the labial, radical, and other articulators. Finally, I assume that articulator-bound features are only relevant and specified in segments executed by the dominating articulator; thus, [round] is only specified for labials, [anterior, distributed] are only specified for coronals, [high, low, back] are only specified for dorsals, and so on.

2. Rules

RRT maintains that the system of features and feature specifications presented in section 1 is manipulated by rules, which possess a number of properties not assumed by other theories of phonology. These properties were initially proposed by Calabrese (forthcoming) and Halle (forthcoming), both of which I draw from here. The overarching properties of rules divide into three areas, which I call sensitivity, terminal spreading, and constraint-and-repair. The motivations for assuming terminal spreading are considered at length by Halle (forthcoming) and in section 1.1. of this chapter, and therefore are not elaborated upon here.

2.1. Sensitivity

Calabrese (forthcoming) proposes that phonological inventories are controlled by a hierarchical set of marking statements provided by Universal Grammar, which take the form of absolute or soft prohibitions on the cooccurrence of particular bipartite feature bundles. Absolute prohibition statements disallow the production of physically impossible configurations such as *[+high, +low] and *[+ATR, +RTR]. In this view, language learners place a series of markers within each branch of the UG markedness hierarchy based on the inventory of segments they are exposed to in their linguistic environment. Phonemes defined by feature pairs below the level of complexity delimited by these markers are allowed to occur in the speaker's phonological system, whereas phonemes involving feature pairs above this level are disallowed. For example, given the complexity hierarchy for vowels in (47), a language may place a marker above *a*, *b*, or *c*, or below *c*.

(47)

a.	*[-low, -high]	less complex
b.	*[-high, +ATR]	
c.	*[+high, -ATR]	more complex

A language which places a marker above *a* does not deactivate marking statements *a, b*, or *c*; such a language allows only the cardinal vowels {*a i u*}. Similarly, languages with canonical five-vowel systems (*i ɛ a ɔ u*) deactivate (47a), canonical seven-vowel systems (*i e ɛ a ɔ o u*) deactivate (47a-b), and canonical nine-vowel systems (*i ɪ e ɛ a ɔ o ʊ u*) deactivate (47a-c).

Crucially, the marking statements in (47) are to be interpreted in the following manner: *[-low, -high] = '[-high] is marked in the context of [-low]'; *[-high, +ATR] = '[+ATR] is marked in the context of [-high]'; and so on--in other words, the second member of marking statements is marked. The marking statements proposed by Calabrese thus serve not only to establish the phonemic inventory of a given language, but also to define markedness relationships within feature bundles. Calabrese distinguishes two classes of relationships defined in this way: markedness and contrast. Contrast is defined as follows (cf. Calabrese (forthcoming:14)).

(48) Given the marking statement M = *[αF, βG]:

a. bG and its opposite are contrastive in M iff M is deactivated.

b. aF is *not* contrastive in [αF, -βG] if -βG is contrastive and there is an active marking statement *[-αF, -βG]. Otherwise, αF is always contrastive.

Furthermore, Calabrese proposes that phonological rules may be sensitive to these relationships; thus, some rules are sensitive to marked feature specifications, some to contrastive specifications, and some to all specifications. In the following subsections I consider examples of (mostly Armenian) rules sensitive to the various subsets of features.

2.1.1. Features

The majority of rules appear to be sensitive to contrastive specifications. Rules sensitive to marked features or all features are less common, but all three types are attested in Armenian.

2.1.1.1. contrastive features

An interesting case of a rule sensitive to contrastive features is Karchevan palatal harmony, which I discuss in detail in chapter 2. Karchevan has the inventory of vowel phonemes in (49).

(49)			
i	*ü*		*u*
e	*ö*		*o*
ɛ			
ä		*a*	

In this system, the feature [back] is contrastive in the pairs *a : ä, o : ö, and u : ü*, but is not contrastive for {*i e ɛ*}. These vowels are also neutral with respect to Karchevan palatal harmony, which spreads [back] specifications from the leftmost root vowel iteratively from left to right within a word. The neutral vowels neither spread their [back] specifications, nor receive them from preceding vowels. Within Calabrese's model, the invariability of Karchevan neutral vowels is produced by the activity of a marking statement *[+back, -round]/_[-low], which blocks spreading of [+back] to {*i e ɛ*}. Their failure to spread [-back] results from the harmony rule being sensitive only to contrastive [back] specifications of triggering segments [NB this predicts that the neutral vowels should be transparent].

2.1.1.2. marked features

Rules may also be sensitive to marked rather than contrastive features. A typical example is the process of rounding harmony which applies to the epenthetic vowel in Karchevan (see chapter 2). In this dialect, the epenthetic vowel surfaces as *ü* when preceded by front round vowels, *i* when preceded by other front vowels, and *ə* elsewhere. Crucially, the epenthetic vowel surfaces as *ə* after *o* and *u*, indicating that they do not spread [+round]. Given the vowel system in (49), MT tells us that in the hierarchy of marking statements involving [round] in (50), where (a) is most complex and (c) is least complex, statement (c) is deactivated but (a) and (b) are active.

(50) a. [+low, +round]
b. [+back, -round] /_[-low]
c. [-back, +round]

Statement (50c) tells us that the feature [+round] is marked in the front round vowels; note that no statement marks rounding in non-low back vowels. Thus, if rounding harmony spreads marked [round] specifications, we expect *ü* and *ö* to act as triggers, but not *o* and *u*. This is exactly the situation we find in Karchevan.

2.1.1.3. all features

The outcomes of the Karchevan epenthetic vowel also illustrate a rule sensitive to all features. Recall that the epenthetic vowel surfaces as *i* after all front vowels, i.e. {*i e ɛ ä*}. Within this set we know that [back] is not contrastive for {*i e ɛ*}, but is contrastive for *ä*; therefore, it cannot be contrastive [-back] that is spreading. Similarly it cannot be marked [-back], since [-back] is not marked for {*i e ɛ*}. In this case, the harmony rule simply spreads all [back] specifications.

A similar case occurs in the New Julfa dialect of Armenian, in which the epenthetic vowel surfaces as *u* after dorsal consonants, and *ə* elsewhere (Adjarian (1940)):

(51)	underlying form	surface form	gloss
a.	*krcel*	*kuṙcel*	gnaw
	oskṙ	*voskuṙ*	bone
	kntel	*kundel*	shave
	g^{h}d^{h}ak	*g^{h}ud^{h}ak*	cap
	χrušak	*χurušak*	nut paste
b.	*zart^{h}nel*	*zart^{h}ənel*	decorate
	dχj^{h}nel	*dəχj^{h}ənel*	grow moldy
	j^{h}njʁay	*j^{h}ənjəʁa*	cymbal

I interpret this rule as a feature-filling process which spreads [+back] to the epenthetic vowel from an immediately preceding segment; a subsequent redundancy rule must fill in the feature [+round] as the default [round] value for non-low back vowels[13]. In the New Julfa inventory (see chapter 5), the feature [+back] is neither marked nor contrastive in dorsal consonants; thus the rule must spread all [back] values.

2.2. Constraints and repairs

Calabrese (1988, forthcoming) demonstrates that negative constraints on feature combinations (marking statements) and rules that repair violations of these constraints play an important role in phonological systems. As stated above, RRT takes this assertion seriously and adopts the results of Calabrese's work on the subject. We have already discussed the effects of marking statements; in this subsection we consider the repair strategies Calabrese proposes: delinking, fission, and negation[14].

Delinking is perhaps the simplest repair procedure to understand. In Calabrese's MT, violations of bipartite marking statements may be repaired by delinking one of the incompatible features (not necessarily the marked one), which results in insertion of the opposite value for that feature. A typical example is the treatment of English [-ATR] high vowels by speakers of languages lacking these vowels, such as French. In languages lacking [-ATR] high vowels, the marking statement *[+high, -ATR] is active (cf. (47)); consequently borrowings possessing [+high, -ATR] vowels cannot be

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[13]This analysis obviously differs from the one proposed for Karchevan, where spreading of [+back] to the epenthetic vowel produces *ə*, not *u*. This could be because *ə* is not [+back] in New Julfa, or because the Karchevan rule spreads only [+back] values.

[14]Calabrese suggests that grammars freely choose between these three strategies to repair violations of constraints.

pronounced as such. Speakers of French regularly pronounce words such as English *ship* and *book* as [*šip*] and [*buk*], rather than the correct [*šɪp*] and [*bʊk*], indicating that [+high, -ATR] vowels are changed to [+high, +ATR]. Within MT, this change results from delinking of the feature [-ATR] and its subsequent replacement by [+ATR].

Another strategy used to repair violations of the filter *[+high, -ATR] is found in Okpe, which employs negation. In Okpe, [-ATR] high vowels occur in underlying forms but surface as [+ATR] mid vowels (their underlying [+high, -ATR] status can be deduced from their behavior with respect to ATR harmony and other phenomena). MT treats this change as an instance of negation, which inverts the values for both features in a disallowed configuration. In the case of Okpe, negation changes the configuration [+high, -ATR] into [-high, +ATR], yielding [+ATR] mid vowels. In chapter 5 I examine an interesting case of negation involving laryngeal features which plays an important role in the Armenian consonant shifts. A close parallel is found in English, where in absolute initial position underlying plain voiceless stops surface as voiceless aspirated, and underlying plain voiced stops surface as plain voiceless. In chapter 5 I suggest that these two changes result from a rule which associates the feature [+spread glottis] with word-initial consonants (in English, the rule actually applies to syllable-initial consonants, but with voiced stops the subsequent change only occurs in initial position). In the case of underlying voiceless stops, this rule directly produces voiceless aspirates. In the case of underlying voiced stops, however, the rule creates the configuration [-stiff, +spread], which violates an active marking statement in English disallowing voiced aspirates. English repairs this violation by means of negation, which produces the licit configuration [+stiff, -spread], a plain voiceless stop.

The final repair strategy proposed by Calabrese is fission, which splits a disallowed feature pair into two units, each containing one of the offending features and the opposite value of the other. A typical example is the treatment of front rounded vowels in classical and modern standard Armenian. Borrowings from languages with front rounded vowels such as French, Greek, and Turkish regularly replace *ü* and *ö* with *iu* and *eo* respectively, as in classical Greek *p*^{h}*ülakē* → classical Armenian *p*^{h}*iuʁakei* 'prison', Turkish *kömürǰü* 'coal seller' → modern Armenian *k*^{h}*eomiurǰ-ean* [*k*^{h}*yomyurǰyan*] (proper name). Front rounded vowels violate the marking statement *[-back, +round], which is deactivated in French and Turkish, but active in standard Armenian. Armenian repairs violations of this marking statement by means of fission, which splits the disallowed configuration *[-back, +round] into two parts, one containing [-back] and [-round], and the other containing [+back] and [+round], giving *iu* or *eo* depending on the [high] value of the original vowel.

2
Survey of Armenian Phonology

In this chapter I present the basic elements of Armenian phonetics and phonology: the phonemes and their allophones, stress, syllable structure, and vowel harmony. This being the first systematic theoretical study of Armenian phonology (useful non-theoretical studies include Fairbanks 1948, Allen 1950, Johnson 1954, Xačʻaturyan 1988), I have drawn all of my material directly from primary sources, which are cited in the appropriate locations. Throughout this thesis I concentrate on standard eastern Armenian (SEA), spoken in Armenia, Georgia, Azerbaijan, and Iran, primarily because it distinguishes in pronunciation the three consonant series (voiced, voiceless, and voiceless aspirated) employed in both western and eastern orthography. I also make use of standard western Armenian (SWA) and various non-literary dialects where they help to shed light on the phenomena under consideration.

2.1. The dialects

Various scholars have put the number of Armenian dialects between 2 and 120. The average Armenian distinguishes two dialects, eastern and western, which basically correspond to what I term SEA and SWA. There are in fact well more than two distinct dialects--many of which are mutually unintelligible, such as the Agulis dialect spoken in eastern Nakhichevan, which is called *Zokerēn* 'the Zok language' by neighboring Armenians. I follow J̌ahukyan 1972 in assuming the existence of 36 basic dialects. These can be divided into two main groups, roughly corresponding to the eastern and western portions of the Armenian linguistic area (basically defined by position relative to Lake Van in eastern Turkey), based on a number of isoglosses including the presence of a locative case (eastern dialects) and present formations employing forms of the particle *ku* (western dialects). The dialects and their basic divisions are listed in (1) (see also map 1 in the Appendix).

(1)	western dialects	eastern dialects
	Akn	Agulis
	Amasia	Aresh
	Arabkir	Artvin
	Cilicia	Astraxan
	Crimea	Erevan
	Erzerum	Julfa
	Eudokia	Karabagh[1]
	Hamshen	Maragha
	Istanbul	Meghri
	Malatia	Shamaxi
	Mush	Tiflis
	Nicomedia	Xoy
	Ordu	
	Poland	
	Rodosto	
	Sebastia	

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[1]Karabagh in many respects is not a single dialect: its dozens of subdialects often disagree with respect to important isoglosses, such as the present formation and Adjarian's Law (v. infra).

Shapin-Karahisar

Smyrna

Syria

Tigranakert

Trebizonde

Van

Xarberd/Erznka

Xotorjur

2.1.1. Historical dialectology

The two subgroups in (1) are further subdivided by a number of isoglosses, of which I will present a few of the most significant here. I concentrate on linguistic innovations (relative to classical Armenian), since common preservations are not valid criteria for historical subgrouping.

Perhaps the most striking innovations in the post-classical dialects occur in the verbal morphology, where excepting the aorist none of the classical formations remain in place. One may consult Vaux 1994 for a synopsis of the changes that have occurred; here I consider only the simple present formation. The classical Armenian present tense was formed by adding one of four thematic vowels directly to the verb root, followed by a set of personal endings, as schematized in (2).

(2) classical Armenian present tense formation

root	thematic vowel	1sg.	surface form	gloss
ber	*e*	*m*	*berem*	I carry
gn	*a*	*m*	*gənam*	I go
tʰoɫ	*u*	*m*	*tʰoɫum*	I allow

This formation is now the standard subjunctive formation in all of the modern dialects, and the present function has been filled by a number of new formations. SWA simply augments the classical present with a particle *ku*, which surfaces in various forms in all of the western dialects (*ku* is used to form the future tense in many eastern dialects). SEA and most of the eastern dialects employ a locative participle in *-um* followed by present forms of the copula to form the present tense. In addition to these formations, which cover the majority of Armenian dialects, we find a number of other developments. The dialects of Artvin, Meghri, and (much of) Karabagh employ a participle in *-lis* combined with the copula; many other eastern dialects including SEA use this formation with monosyllabic verbs. An interesting innovation among the western dialects is a present form which adds various manifestations of the particle *ha* to the classical present, found in Rodosto, Nicomedia, Akn, Malatia, Kesab, Aramo, and Edesia. These developments are summarized in (3), and map 2 in the appendix.

(3) modern present formations

source	underlying form	surface form	gloss
SWA	*gu p^{h}er-e-m*	*gə p^{h}erem*	I carry
SEA	*ber-um e-m*	*berum em*	I carry
Meghri	*mn-a-lis i-m*	*məna(li)s im*	I stay
Kesab	*hay pän-e-m*	*hay pänem*	I work

One can see in map 2 that the geographic distribution of peculiar innovations such as the *ha* present suggests historical movements. For example, one might speculate that the dialects of Nicomedia and Rodosto in northwest Turkey and Aramo and Kesab in Syria migrated from somewhere near Akn, Malatia, and Edesia in central Turkey sometime after their common ancestor developed the *ha* construction. Similarly, the isolation of Artvin from the rest of the *-lis* dialects suggests either that this speech community moved from the Karabagh area sometime after the *-lis* formation developed, or that the area in between Karabagh and Ardvin, which employs *-lis* with monosyllabic verbs, has innovated.

Perhaps the most famous and least understood aspect of Armenian phonology is the extensive series of consonant shifts which occurred between Proto-Indo-European and the modern dialects. The basic developments are schematized in (4) and map 3, with coronal stops representing the outcomes of stops at all places of articulation; representative examples are given in (5).

(4) correspondences in initial position

	d	d^h	*t*	Indo-European
1	*d*	d^h	t^h	Sebastia
2	*t*	d^h	t^h	Erevan
3	*d*	*d*	t^h	Istanbul
4	*d*	*t*	t^h	Sasun, Middle Armenian
5	*d*	t^h	t^h	Malatia, SWA
6	*t*	*d*	t^h	Classical Armenian, Agulis, SEA
7	*t*	*t*	t^h	Van

(5)	*D	*Dh	*T
Indo-European	*dek'm̥* '10'	*bʰeremi* 'I carry'	*ok'tō* '8'
Sebastia	*dasə*	*bʰerem*	*utʰə*
Erevan	*tassə*	*bʰerem*	*utʰ*
Istanbul	*dasə*	*berem*	*útʰu*
Sasun	*das*	*perəm*	*utʰ*
SWA	*/dasn/*	*pʰerem*	*/utʰn/*
Classical	*tasn*	*berem*	*utʰ*
Van	*tas*	*pirem*	*utʰ*

It is interesting to note that the voiceless aspirates remain unchanged in all of the dialects; the distinctions between these dialect groups therefore lie in the first two series alone. Many scholars, most recently Garrett 1991, have suggested that group 1, which most closely resembles the Indo-European system structurally, is in fact a direct descendant of Indo-European, and the other systems are later innovations. There is reason to believe, however, that all of the modern systems developed from the Classical Armenian system (group 6); Agulis, Artvin, Meghri, Tiflis, and Amasia preserve this system intact. One can see in map 3 that group 6 dialects[2] exist in isolated patches throughout the Armenian-speaking area, a typical feature of archaisms, whereas the other consonant systems occupy continuous areas, typical of later innovations. Further evidence for this position is presented

[2]I use the term 'group 6 dialects' in a descriptive sense; I do not believe that the archaism shared by group 6 dialects is a valid criterion for historical subgrouping.

in chapter 5, where I also examine the mechanics and relative chronology of the various consonant shifts.

Another interesting innovation in the consonant system is Adjarian's Law, which describes the fronting of back vowels after voiced obstruents (Vaux 1992). This development occurs in the dialects of Karabagh, Maragha, Meghri, Salmast, Shamaxi, Shatax, Syria, Van, and Xoy; representative examples are provided in (6) (see also map 4).

(6)	classical	Van	gloss
a.	*bah*	*päχ*	spade
	bołk	*pöχk*	radish
	bukʰ	*pükʰʸ*	snowstorm
	gaṙn	*kʸär*	sheep
	goł	*kʸöʁ*	thief
	gund	*kʸünd*	heap
	danak	*tänäk*	knife
	dołal	*töʁal*	tremble
	durs	*tüs*	outside
b.	*paṙaw*	*paṙav*	old woman
	port	*puoṙt*	navel
	putuk	*putuk*	vessel
	kanačʰ	*kanačʰ*	green
	kov	*kov*	cow
	kušt	*kušt*	side
	takʰ	*takʰʸ*	hot
	tokankʰ	*tuokankʰ*	punishment
	tun	*tun*	house

In many of these dialects the original plain voiced series has become voiceless, suggesting that the loss of the voicing distinction is somehow correlated with the vowel fronting process. Meghri and the Kirzan subdialect of Karabagh are particularly interesting in this regard, since they preserve the plain voiced series yet undergoes Adjarian's Law.

(7)	Classical	Meghri	Kirzan	gloss
	bah	*beh*	*bäh*	spade
	gaṙn	*görn*	*g*^{y}*är*	sheep
	darman	*derman*	*därmän*	oats

The Meghri and Kirzan facts indicate that Adjarian's Law was not related to the loss of voicing contrasts (I consider some further theoretical aspects of Adjarian's Law in chapter 4). As for the history of this innovation, one immediately notices in map 4 that most of the Adjarian's Law dialects are located within the triangle formed by lake Van, lake Urmia, and Karabagh, with the exception of Syria, in the southwest corner of the Armenian linguistic area. Given the non-trivial nature of Adjarian's Law, I assume that the Syrian dialect community resided in the above-mentioned triangle at the time the rule applied, and subsequently migrated westward. This being the case, we should be able to date the application of Adjarian's Law based on our knowledge of when the Armenian community in Syria was established. We only know that the Armenian community in Syria was well-established by the eleventh century, however (Sanjian 1964). Adjarian 1952 dates his law between the seventh and eleventh centuries, based on the fact that Arabic loans (seventh century) undergo the rule but

Turkish loans (eleventh century and following) do not. Muradyan 1962 dates Adjarian's Law to the fifth century, for unspecified reasons. With our knowledge of the history of the Syrian Armenian community and the behavior of loanwords, I think it fairly safe to assume a date before the eleventh century, but I do not believe we can safely reconstruct a more specific date than that.

Given the set of innovations discussed above, one wonders whether the isoglosses correspond to geographical or political boundaries in historical Armenia. This is difficult to ascertain, due to the extensive series of migrations and deportations which have occurred in the past 1500 years. Note, for example, that many of the modern western dialects lie outside the fifteen administrative divisions of historical Armenia (map 5), due to a series of migrations in the middle ages to eastern Europe, Crimea, and Astraxan, (perhaps) earlier migrations to Syria and western Turkey, and later deportations in the seventeenth and eighteenth centuries from Karabagh to Burdur, Julfa to Isfahan, Erzerum to Georgia, etc. To take an extreme case, every dialect which shows the *ha* present lies outside of historical Armenia, and unfortunately we know little about the movements of these dialect communities between the time of the Cilician kingdom (11th-15th century) and the present day.

2.2. *Phonetics and phonemics*

Now let us move on to the synchronic phonemic systems found in modern Armenian. The best source for phonetic and phonological information on standard (particularly eastern) Armenian is Xač̣aturyan 1988, which provides minimal pairs for all phonemic contrasts and extensive discussion of phonetic issues such as voice onset time, duration of consonants and vowels in stressed and unstressed syllables, and vowel formants. In the sketch below I focus on phonetic and phonological features of SEA, with some attention given to SWA as well.

2.2.1. SEA

SEA has the phonemic inventory in (8)[3].

(8)

p	p^h	*b*	*m*	*f*	*v*			
t	t^h	*d*	*n*	*s*	*z*	t^s	t^{sh}	d^z
				š	*ž*	$t^{\check{s}}$	$t^{\check{s}h}$	$d^{\check{z}}$
k	k^h	*g*						
				χ	*ʁ*			
				h				
	r	*ṙ*	*l*					

i		*u*
ε[4]		*ɔ*
	a	

In addition to these phonemes, SEA has an epenthetic schwa pronounced much like standard Turkish *ɨ*, which is treated in detail later in this chapter

[3]Throughout this thesis I represent t^s as *c*, d^z as *j*, $t^{\check{s}}$ as *č*, and $d^{\check{z}}$ as *ǰ*, in accordance with Armenological tradition.

[4]For ease of notation, I represent the lax mid vowels as *e* and *o* throughout this thesis.

and in chapter 3. With the exception of this schwa, which in certain positions is reflected in the orthography, Armenian orthography is basically phonemic. The main exception to this is vowel sequences, which in SEA are spelled according to their phonetic realization, whereas their SWA spelling is closer to the phonemics. For example, SEA /*jiun*/ 'snow' [*jyun*] is spelled <*jyun*>, whereas the SWA equivalent /*c*^{h}*iun*/ [*c*^{h}*yun*] is spelled <*jiwn*> (SWA <*w*> regularly represents underlying /*u*/). SWA also has an initial <*y*> corresponding to SEA <*h*>, both of which are pronounced [*h*]; in this case SWA preserves the Classical state of affairs, when this initial *h* was in fact a /*y*/. I take this segment to be an underlying *h* in both SWA and SEA, since there are no alternations to justify postulating an absolute neutralization rule. Both SEA and SWA employ four mid-vowel graphemes, <*e ē o ō*>. Though both forms of *e* and both forms of *o* are phonetically identical, they nevertheless are separate phonemes: /*e*/ and /*o*/ differ from their 'long' counterparts in undergoing initial diphthongization (9), and <*ē*> differs from the other mid vowels in undergoing reduction in unstressed syllables[5] (10).

(9)	orthographic form	surface form	gloss
	eraz	*yeraz*	dream
	ēš	*eš*	donkey
	oč^{h}	*voč*^{h}	no
	ōd	*ot*^{h}	air

---

[5]The diphthong *eu* behaves in the same manner in the one word in which it occurs in unstressed position: *eu* 'and' surfaces as *yev* when stressed, and *u* when unstressed (normally when conjoining NP's).

(10)	root	gloss	derived verb	gloss
	sēr [ser]	love (n)	*sirel*	love
	her	produce (n)	*herel*	carry
	olor [volor]	twisting (adj)	*olorel [volorel]*	twist
	ōžit [ožit]	dowry	*ōžtel [ožtel]*	endow

Based on the ablauting behavior of <*ē*>, I assume it to be an underlying diphthong */ei/*; furthermore, I assume <*ō*> to be an underlying diphthong */au/*. In both cases, my underlying forms recapitulate the historical origins of these vowels. For example, Classical Armenian possessed a diphthong */au/* which synchronically alternated with */ō/* in preconsonantal position (11)[6].

(11)	root	instrumental sg.	instrumental pl.	gloss
	am	*am-a-u [amav]*	*am-a-u-k^h [amōk^h]*	year

At some later date the combinations of suffixes which produced such alternations fell out of use, so that the modern language in fact shows no productive alternations between *au* and *o*. Nevertheless, I assume that the preconsonantal neutralization rule is still active in the language. This being the case, we need no special machinery to account for the failure of <*ō*> to diphthongize in initial position, since at the time the rule applies, words

[6]This *ō* seems to have been different from *o* in classical Armenian (perhaps *o* vs. *ɔ*), judging by their distinction in the orthography and some modern dialects such as Van.

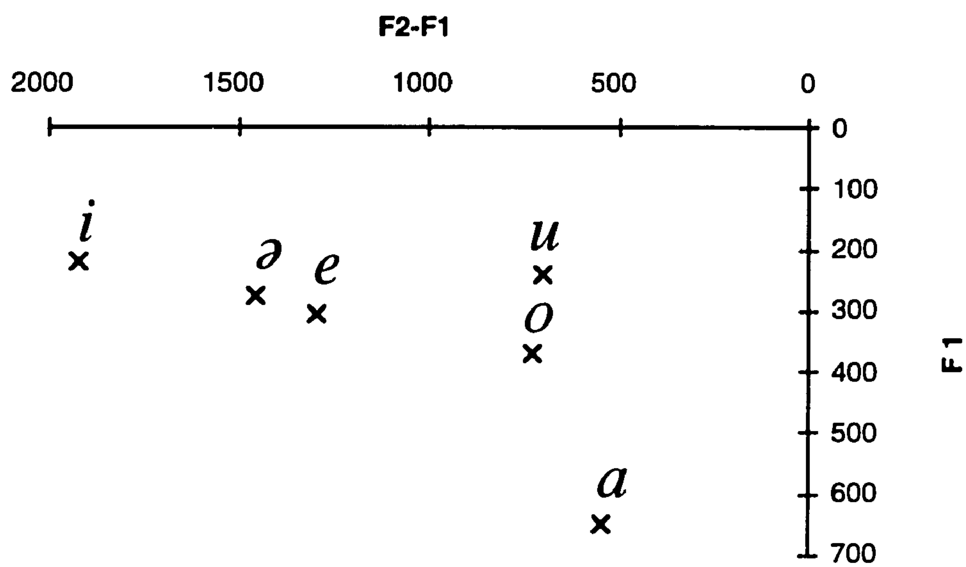
such as [ot^h] 'air' have an initial *au-*, and *a* does not undergo the rule (cf. *akiš* 'shovel' → [*akiš*]). We do need to account for the behavior of initial /ei/, however, which we might expect to surface as *[yey-], based on the syllabification procedures to be discussed in chapter 3. I assume that the diphthongization rule does not apply to segments which are already diphthongs. We must also explain why unstressed */ei/* becomes [*i*] rather than [*e*] and why unstressed */au/* does not become [*a*], which we might expect since unstressed *i* and *u* are generally deleted (cf. 2.3). I am forced to assume that the reduction rule treats [+high] elements of diphthongs differently than simple high vowels.

Some interesting structural features of the SEA inventory are the opposition of three consonant series such as we find in Thai; the existence of uvular but not velar fricatives; two contrastive rhotics, one trilled (*ṙ*) and one flapped (*r*); and the presence of aspirated affricates but not fricatives. Tripartite consonant systems often show interesting laryngeal neutralization effects, as in the well-known case of Thai; SEA presents a more complicated variant of Thai in this respect, as I describe in 2.2. Even more complicated laryngeal behavior is found in the New Julfa dialect, which like Hindi has four stop series. I consider New Julfa laryngeal neutralization and the problem of aspirated affricates and fricatives in chapter 5. Many dialects, including SWA, merge the two varieties of rhotics; SEA neutralizes the opposition to *ṙ* before coronal consonants (cf. 2.2). The uvular fricative *ʁ* is somewhat problematic, in that it behaves as a coronal with respect to a number of phonological rules discussed in chapters 3 and 4. Historically this is not altogether surprising, since it developed from a dark *l* (cf. *aʁ* 'salt' : Latin *sal*, *goʁ* 'thief' : Latin *vol-* 'rob'), but in synchronic terms it is not immediately clear whether to treat ʁ as a uvular with certain special properties or a [+back] coronal lateral which becomes uvular at the phonetic level in all environments.

I know of no contrasts between aspirated consonants and stop + *h* sequences. It is possible to construct a handful of stop + *h* sequences using the prefix <*ənd*> followd by *h*-initial roots, e.g. <*əndhanuṙ*> 'general', but the fact that the surface form [*ənt^{h}anuṙ*] shows a voiceless aspirate is independent of the following *h*: cf. <*əndaṙaǰ*> [*ənt^{h}aṙač^{h}*] 'against'.

The SEA vowels as studied by Xač^{h}aturyan 1988 show an interesting phonetic distribution, which I have schematized in (12).

(12) formant frequencies of SEA vowels



Note that in this diagram, where the difference between the first and second formants (x-axis) basically corresponds to backness and the value of the first formant (y-axis) corresponds to height, *e* and *ə* are closer to central vowels than front vowels. It is not clear how to reconcile these phonetics with the fact that in many dialects, including SEA, *e* behaves as [-back] together with *i*, palatalizing preceding consonants, whereas *ə*, which is strikingly similar to *e* phonetically, does not palatalize (see also 2.2)[7]. The low vowel *a* is very low and back, approaching [ɔ] for many speakers.

2.1.2. SWA

SWA has the phonemic inventory in (13).

(13)

p^h	*b*	*m*	*f*	*v*		
t^h	*d*	*n*	*s*	*z*	t^{sh}	d^z
			š	*ž*	$t^{\check{s}h}$	$d^{\check{z}}$
k^h	*g*					
			χ	*ʁ*		
			h			
	r		*l*			

i		*u*
ɛ		*ɔ*
	a	

The only significant differences from the SEA inventory are the absence of a plain voiceless series, which has merged with the voiceless aspirates, and *ŕ*, which has merged with *r*. The low vowel *a* tends to be less retracted than in SEA.

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[7]According to Xač^{h}aturyan 1988:104, stops are palatalized before *i*, *e*, and *y*, but this palatalization is more noticeable with dorsals than coronals, and more noticeable with coronals than labials.

2.2. *Basic alternations*

The alternations discussed in this section occur in SEA, but many are also true of SWA. As a general rule, SEA pronunciations which deviate from phonological representations directly reflect features of the Erevan dialect, which is only logical since Erevan is the center of eastern Armenian culture. Nevertheless, 'learned' pronunciations which reflect the phonemics more directly are often heard. For example, SEA (like most Armenian dialects) generally changes voiced stops and affricates into voiceless aspirates after *r* (14a) and word-finally after a vowel (14b), but many words are pronounced without this change (14c).

(14)	underlying form	surface form	gloss
a.	*barj*	*barc*^{h}	high
	verǰ	*verč*^{h}	end
	t^h*rǰ-el*	*t*^{h}*ərč*^{h}*el*	soak
	erǰan-ik	*yerč*^{h}*anik*	happy
	šurǰ	*šurč*^{h}	around
	arjagank^h	*arc*^{h}*agaŋk*^{h}	echo
	mard	*mart*^{h}	man
b.	*aǰ*	*ač*^{h}	right (direction)
	meiǰ	*meč*^{h}	in
	auj	*oc*^{h}	snake
	jag	*jak*^{h}	cub
	mug	*muk*^{h}	dark
	t^h*ag*	*thak*^{h}	crown

c.	*gorg*	*gorg*	carpet
	kamurǰ	*kamurǰ*	bridge
	šurǰ-an	*šərǰan*	circuit

Plain voiceless stops and affricates surface as such in these environments.

(15)	underlying form	surface form	gloss
	ač	*ač*	growth
	muk	*muk*	mouse

In this thesis I employ learned pronunciations unless I have positive evidence to the contrary; for example, underlying voiced stops in final position are transcribed as such rather than voiceless aspirated, even though they are often pronounced in this manner (see below).

Some continuants are devoiced in final position, most notably *r*, which as in Turkish is pronounced much like a *š* in this position[8].

(16)	underlying form	surface form	gloss
	hamar	*hamar̥*	for
	už	*uš*	strong
	šaʁ	*šaχ*	dew

Fricatives assimilate in voicing to following consonants, regularly in the case of voiced fricatives (17a) and across word boundaries in the case of voiceless fricatives (17b) (Xačʰaturyan 1988:101-4).

[8]In many dialects, word-final *l* and *r* in fact merge with *š*.

(17)	underlying form	surface form	gloss
a.	*juʁp*	*juχp*	fish egg
	keʁc	*keχc^h*	deceitful
	oʁǰ	*voχč^h*	whole
	aʁb	*aχp*	trash
	χeʁč	*χeχč^h*	miserable
	t^huʁt^h	*t^huχt*	sheet of paper
	vaz-k^h	*vask^h*	race
b.	*čš-grit*	*čəžgrit*	precise
	keis-gišer	*kezgišer*	midnight
	keis beran	*kez beran*	half mouth (??)
	keis žam	*kez žam*	half an hour

With the exception of *vazk^h*, the forms showing devoicing provided by Xač^haturyan are all morpheme-internal, and therefore do not provide evidence for a process of voicing assimilation; one could simply postulate a constraint on underlying clusters requiring that they agree in voicing. There are a number of indications that voicing assimilation is an active process, however. For example, we find cases of assimilation across a morpheme boundary, such as *vazk^h* (cf. *vazel* 'run') and the forms in (17b). In addition, forms such as *aʁb* 'trash' [*aχp*] and *oʁǰ* 'whole' [*voχč^h*] show voicing assimilation, if we assume the orthography represents the phonemic structure of words (if it does not, then we merely have more instances of the constraint discussed above). Note that if the underlying form of 'trash' is in fact /*aʁb*/, voicing assimilation must apply after the rule which devoices and aspirates final voiced stops. We must also assume a rule, also ordered after the voiceless aspiration rule, which deaspirates aspirated stops after uvular fricatives in order to account for forms like [*aχp*] (similar processes are found in many eastern dialects; cf. chapter 5). Affricates, however, always appear as voiceless aspirates after *χ*.

As in many dialects, SEA aspirates stops in position before *s* (Xačhaturyan 1988:106).

(18)	underlying form	surface form	gloss
	apstambel	*apʰstambel*	revolt
	apšel	*apʰšel*	be surprised

In New Julfa dialect, this change is also triggered by *š*, but Xačhaturyan mentions no such cases for SEA.

As in most languages, the coronal nasal *n* undergoes place assimilation (Allen 1950, Xačhaturyan 1988:106).

(19)	underlying form	surface form	gloss
	an-bic	*ambic*	pure
	an-tun	*antun*	homeless
	an-ɟnɟ-eli	*añɟəñɟeli*	indestructible
	an-kar-eli	*aŋkareli*	impossible

The other phonemic nasal, *m*, does not undergo place assimilation.

(20)	underlying form	surface form	gloss
	toms	*toms*	ticket
	kam-kʰ	*kamkʰ*	will

Finally, *r* becomes *ṙ* before coronals (Xačʰaturyan 1988:108).

(21)

	underlying form	surface form	gloss
	hortʰ	*hoṙtʰ*	calf
	Aršak	*Aṙšak*	personal name
	arzni	*aṙzni*	alum
	arž-e-kh	*aṙžekʰ*	value

Unfortunately, Xačʰaturyan provides no examples of alternations produced by this rule. In Classical Armenian, *r* regularly alternated with *ṙ* before *n*, e.g. */lear-n/* 'mountain' [*liyaṙn*], gen. */lear-i-n/* [*lerin*], but it is not clear whether the rule in (21) is related to this or not.

Vocalic alternations are normally produced by stress and syllabification. Syllabification produces alternations between *u* and *v* (22), but there are no productive alternations between *i* and *y* (23).

(22)

	underlying form	surface form	gloss
	lezu-i	*lezvi*	tongue-gen.
	katu-icʰ	*katvicʰ*	cat-abl.
	ju-er	*jəver*	eggs

(23)

	underlying form	surface form	gloss
	Ani-i	*Aniyi*	Ani (personal name)-gen.
	ji-ucʰ	*jiyucʰ*	horse-abl.
	ji-er	*jiyer*	horses

Nevertheless, I assume that *y* is a syllabic variant of *i*, since they occur in complementary environments (*y* adjacent to vowels, *i* elsewhere)[9]. According to this principle, a form such as [*jyun*] 'snow' is underlyingly /*jiun*/. Note that this syllabification differs from that of *jiyuc^h^*, where the high vowel sequence is interrupted by a morpheme boundary. I examine this problem in chapter 3.

The high vowel *i* disappears when it forms the second half of a diphthong in final position of polysyllabic words[10] (24a); monosyllables remain unchanged (24b).

(24)	underlying form	surface form	gloss
a.	*hskay*	*həska*	enormous
	(cf. *həskay-a-k^h^ayl* 'with big strides')		
	cař̇ay	*cař̇a*	servant (cf. *cař̇ay-e-l* 'serve')
b.	*bay*	*bay*	verb
	hay	*hay*	Armenian
	č^h^ay	*č^h^ay*	tea

The other common set of vocalic alternations arises from stress shifts. High vowels which surface in stressed syllables disappear or are replaced by schwa when the stress moves to another syllable.

---

[9]I have employed a transitional *y* in the forms in (23), though this is not represented in the orthography. It is difficult to be sure of its presence between adjacent *i*'s, but it is more noticeable between *i* and other vowels.

[10]Note that the computation of polysyllabicity includes epenthetic schwas, as in *həska*.

(25) root	gloss	derivative	surface form	gloss
gir	*letter*	*gir-e-l*	*gərél*	write
dpir	*scribe*	*dpir-och*	*dəpróch*	school
bun	*natural*	*bun-ak*	*bənák*	inhabitant
makhúr	*clean*	*makhur-e-l*	*makhrél*	clean (v)

The behavior of diphthongs containing high vowels is somewhat different.

(26) root	gloss	derivative	surface form	gloss
lois [*luys*]	light	*lois-a-uor*	*lusavór*	luminous
seir [*ser*]	love	*seir-e-l*	*sirél*	love (v)

We cannot say that underlying */oi/* first becomes *ui* and then loses *i* in the regular manner, for we should then expect the preceding *u* to be deleted as well. Similarly, we must formulate a special rule for */ei/*, since the *i* remains and the *e* is deleted. Note also that there are numerous exceptions to (25), such as *astičan* 'step', in addition to the apparent exceptions produced by diphthong reduction. Forms like *astičan* could be analyzed as containing underlying diphthongs, or simple vowels lexically specified as non-undergoers of high-vowel reduction.

2.3. Stress

Armenian stress systems are of two basic types, conventionally termed 'final stress' and 'penultimate stress' by Armenologists. Final stress systems are found in most dialects, and penultimate stress systems occur in Erevan, (Old) Julfa, Meghri, Agulis, Karabagh, Astraxan, and some subdialects of Mush. With the exception of Syria and Shamaxi, which have developed vowel length contrasts, Armenian dialects appear to be insensitive to prosodic weight distinctions. Nevertheless, a number of phenomena involving irregular stress patterns, vowel reduction, and unstressable vowels reveal that Armenian in fact has an intricate system of metrification similar to those we find in better-known languages such as Cheremis and Chuvash.

2.3.1. The facts

Let us first consider the superficial facts of stress assignment in 'final stress' systems, represented here by the literary dialects. Primary stress is regularly assigned to the final full (i.e. non-epenthetic) vowel in a word, as in (27).

(27)	underlying form	surface form	gloss
a.	*moruk^h*	*morúk^h*	beard
	artasuk^h	*artasúk^h*	tears
	erkir-a-kedron-akan	*yerkrakedronakán*	geocentric
b.	*manr*	*mánər*	small
	erb-emn	*yerp^{h}émən*	sometimes

Ordinal numbers normally stress the final syllable of the root number (28a), unless it has been deleted, in which case the final syllable of the suffix is stressed (28b).

(28)	underlying form	surface form	gloss
a.	*hing-erord*	*híŋgerord*	fifth
	vec^h-erord	*véc^{h}erord*	sixth
	eresun-erord	*yeresúnerord*	thirtieth
	tasn-u-hing-erord	*tasnəhíŋgerord*	fifteenth
b.	*erku-erord*	*yerkrórd*	second
	erek^h-erord	*yerrórd*	third

A number of adverbs may optionally receive initial stress. These are normally bisyllabic (29a), but may be trisyllabic (29b).

(29)	underlying form	surface form	gloss
a.	*gret^{h}ei*	*gərét^{h}e*	almost
	hima	*híma ~ himá*	now
	t^{h}ei-eu	*t^{h}éyev*	although
	darj-ial	*dárjyal ~ darjyál*	again
	inč^{h}peis	*íñč^{h}pes ~ iñč^{h}pés*	how
b.	*sir-eli*	*síreli ~ sirelí*	dear
	man-a-uand	*mánavand ~ manavánd*	especially
	a(ha)-uas-ik	*ávasik ~ ahávasik*	behold

Vocative forms of personal names may also optionally receive initial stress (30a), which is obligatory in hypocoristics (30b).

(30)	underlying form	surface form
a.	*Mkrtič^h*	*Mə'kərtič^h ~ Məkərtíč^h*
	Mariam	*Máryam*
	Simon	*Símon ~ Simón*
b.	*Mariam*	*Máro*
	Karapet	*Káro*
	Step^{h}anos	*Tép^{h}o*

As a general rule, all Armenian stressed words contain at least one full vowel. Nevertheless, there are a number of words which contain no underlying vowels, and surface with one or more epenthetic schwas. Such words receive initial stress[11].

(31)	underlying form	surface form	gloss
	t^{h}rmp^h	*t^{h}ə'rəmp^h*	noise made by something heavy but soft falling
	kṙm	*kə'ṙəm*	chick pea
	čṙvṙ	*čə'ṙvəṙ*	to and fro
	čṙčṙ	*čə'ṙčəṙ*	pulley-like device used in cleaning cotton
	čvl-čvl	*čə'vəlčəvəl*	chirpingly

[11]A problematic word is *slpzt* 'suddenly' [*sələpə'zt*], which shows neither the expected syllabification (*[*səlpəzt*]) nor the expected stress (*[*sə'lpəzt*]). At the moment I have no explanation for this form.

Finally, all Armenian dialects generally have secondary stress on the initial syllable, with some exceptions to be discussed in 2.3.3 and 2.3.4.

Moving on to 'penultimate stress' systems, a typical case is the Karabagh dialect, spoken throughout Azerbaijan and in southern Armenia (Davt^{h}yan 1966). Karabagh has the phonemic inventory in (32).

(32)

p	*p^h*	*b*	*m*	*f*	*v*			
t	*t^h*	*d*	*n*	*s*	*z*	*t^s*	*t^{sh}*	*d^z*
				š	*ž*	*$t^š$*	*$t^{šh}$*	*$d^ž$*
k	*k^h*	*g*						
k^y	*k^{hy}*	*g^y*						
				χ	*ʁ*			
				h				
	r	*ṙ*	*l*					

i	*ü*		*u*
e	*ö*		*o*
ε			
ä		*a*	

As in SEA and SWA, schwa only receives stress in words containing no full vowels, and secondary stress falls on the initial syllable. In words ending with two or more syllables containing full vowels, the penult is stressed (N.B. pretonic vowels normally reduce to schwa or zero in native lexical items).

(33)	underlying form	surface form	gloss
	topr-ak	*tóprak*	bag
	žarovnig	*žaróvnig*^{y}	frying pan (Russian loan)
	verč^{h}*-a-na-l*	*vərč*^{h}*ánal*	finish (work)
	mataʁ-a-c^{h}*u*	*mətəʁác*^{h}*u*	suitable for sacrifice
	avet-aran	*əvətáran*	gospel
	navakateig	*navəkáteig*^{y}	festival
	ires-pašt-ot^{h}*un*	*ərəspəštót*^{h}*un*	adulation

Words ending in two full vowels followed by schwa also stress the penultimate full vowel.

(34)	underlying form	surface form	gloss
	p^{h}*ac*^{h}*aʁn*	*p*^{h}*ác*^{h}*aʁnə*	spleen
	c^{h}*njuʁn*	*c*^{h}*únjuʁnə*	watering pot
	ürt^{h}*-umn*	*ü´rt*^{h}*ümnə*	oath
	kutemn	*kútemnə*	cress

I know of one exception to this principle, *lisəeṙn* 'shin' [*ləsəéṙnə*].

When a schwa intervenes between two full vowels at the end of a word, however, the final syllable is stressed, with one exception I am aware of (35b).

(35)

	underlying form	surface form	gloss
a.	*unǰuk-mt-e*	*unǰukmətḗ*	earwig
	an-skam	*anəskám*	wicked
	pinǰär-psok	*pinǰärpʰəsók*	spring snow
	katʰʁkos	*katʰəʁkós*	catholicos
b.	*alabastr-ak*	*ələbástərak*	hare

Words containing one full and one reduced vowel stress the full vowel.

(36)

underlying form	surface form	gloss
kʸlöχ	*kʸəlö'χ*	head
tʁa	*təʁá*	boy
mt-n-e-l	*mənnél*	enter
tořn	*tóřnə*	door
kärn	*kʸä'řnə*	sheep

Words containing only schwas generally stress the initial syllable (37a), with some exceptions (37b).

(37)

	underlying form	surface form	gloss
a.	*pngl*	*pə'ngəl*	fable
	šəkʰř	*šə'kʰəř*	opening between two feet
	vt-n	*və'nnə*	foot
b.	*əhə*	*əhə'*	aha!
	čr-ə-pzt-pzt	*čərəpə'zt-pəzt*	type of bird often found on the water

Forms of the copula cliticize to the verbal participle, which is assigned stress according to the principles described in (33-34).

(38)	underlying form	surface form	gloss
a.	*ktʰ-um əm*	*kʰətʰəˊməm*	I milk
	hncʰn-um əm	*həncʰnəˊməm*	I cross
	an-um əm	*ánəməm*	I do
	ašχat-um əm	*əšχátəməm*	I work

Note that the *-um* participial suffix optionally surfaces as *-əm* (forms such as *ašχátuməm* are also used), even when it has been assigned stress. I am not sure why this particular reduction occurs in stressed syllables, but it is interesting to note that stress remains on the reduced vowel.

Stress may exceptionally fall on the final syllable.

(39)	underlying form	surface form	gloss
	donluʁ	*donlúʁ*	wages (< Turkish)
	uṙus	*uṙús*	Russian
	sähräd	*sährä´d*	border (< Arabic)
	sarkavakʰ	*sarkavákʰ*	deacon

These exceptions are normally borrowings ('wages') or learned (normally religious) words ('deacon') taken from the literary language.

We can see in (33-39) that Karabagh differs from SA only in its treatment of words ending in a sequence of two or more full vowels followed by any number of schwas. The causes of this difference are examined below.

2.3.2. Theoretical assumptions

Let us now consider how to account for the stress facts just described. In the following discussion I draw on the theory of stress developed by Morris Halle and expounded most recently by Idsardi 1992. Idsardi assumes that universal grammar provides the sequence of metrification parameters in (40):

(40) stress assignment

a.	x projection	project line 0 marks for all stress-bearing elements
b.	bracket projection	project {L, R} bracket for all {Q} elements {L↔R}
c.	edge marking	place {L, R} bracket to {L, R} of {L, R}-most element
d.	grouping	{group/do not group} line 0 marks into {binary, ternary} feet {L↔R}
e.	headedness	associate a line 1 mark with the {L, R}-most member of each line 0 constituent {L↔R}

Steps c-e are then repeated for line 1 marks, which often represent secondary stresses, to produce line 2 marks, which represent primary stresses. In (40b), Q normally represents either full vowels or heavy syllables. The notation {L↔R} represents the idea that bracket projection is iterative, and may apply from right to left or left to right within a word; grouping and headedness marking are also held to be iterative. Idsardi assumes iterative rule application in the case of metrification procedures in order to explain phenomena such as stress clash in terms of constraint blocking, rather than the instantaneous rules and repair strategies employed by Halle and Vergnaud 1987. In this thesis I follow Halle and Vergnaud in assuming that all prominent syllables project brackets simultaneously, and resulting cases of stress clash are repaired by a bracket deletion rule.

I assume that standard Armenian employs the metrification procedure in (41), which applies after syllabification:

(41) Armenian stress assignment

a.	x projection	project line 0 marks for all vowels (including schwa)
b.	bracket projection	project L bracket for all full vowels
c.	edge marking	place L bracket to L of leftmost element
d.	grouping	not employed
e.	heading	associate a line 1 mark with the leftmost member of each line 0 constituent R → L
		associate a line 2 mark with the rightmost member of each line 1 constituent R → L

Three additional assumptions are required: lexical bracket projection, cyclicity, and stress clash deletion. All of these assumptions are justified in the following discussion.

2.3.3. Projection

The first problem we must address is the behavior of schwa, which is never stressed in words containing a full vowel, but can receive stress in words containing only schwas. Since schwas are in fact able to bear stress, they must project line 0 marks on the metrical grid; nevertheless, we want to exclude them from receiving stress in words containing full vowels. Idsardi 1992 implements this distribution by means of a bracket projection procedure, which projects a (in our case left) bracket to the left of line 0 marks associated with full vowels. In (42) I illustrate the application of this procedure to *erb-emn* 'sometimes' [*yerpʰéman*].

(42) bracket projection

a.	x projection	*y*	*e*	*r*	*pʰ*	*e*	*m*	*ə*	*n*
			x			x		x	
b.	bracket projection	*y*	*e*	*r*	*pʰ*	*e*	*m*	*ə*	*n*
			(x			(x		x	

If the rules in (41) then run their course, we obtain the derivation in (43).

(43) edge marking N/A (left edge of both morphemes already has bracket)

grouping N/A

heading	*y*	*e*	*r*	*pʰ*	*e*	*m*	*ə*	*n*
line 0		(x			(x		x	
line 1		x			x			

edge marking	*y*	*e*	*r*	*pʰ*	*e*	*m*	*ə*	*n*
line 0		(x			(x		x	
line 1		(x			x			

grouping N/A

heading	*y*	*e*	*r*	p^h	*e*	*m*	*ə*	*n*
line 0		(x			(x		x	
line 1		(x			x			
line 2					x			

Primary (line 2) stress is thereby associated with the medial vowel, producing the attested surface form. Since Armenian feet (line 1 groupings) are right-headed, schwas to the left of a full vowel do not shed any light on the analysis presented here.

2.3.4. Stress Clash

Penultimate stress dialects present an interesting variant of the system just discussed. Recall that Karabagh stress assignment differs from SA only with respect to words ending in a sequence of two or more full vowels followed by any number of schwas, in which case Karabagh normally stress the penultimate full vowel. Let us assume, then, that Karabagh employs the same metrification procedure as SA, with a special rule accounting for the behavior of final sequences of adjacent full vowels. A word such as *žaróvnig*^{y} would then receive the initial metrification in (44):

(44)

a.	x projection	*ž*	*a*	*r*	*o*	*v*	*n*	*i*	g^y
			x		x			x	
b.	bracket projection		(x		(x			(x	

At this point we have two cases of stress clash, i.e. identical brackets in adjacent syllables. Let us suppose that penultimate stress dialects repair stress clashes by deleting the rightmost bracket in a disallowed *(x(x configuration [i.e. (→ ø/(x_x#]. Such a repair rule can produce a number of different outcomes: if it applies from left to right it can produce x(x(x or xx(x, depending on whether it applies once or iteratively respectively; conversely, if it applies from right to left it can produce (x(xx or (xxx. In order to derive the attested penultimate stress, this procedure must apply once from right to left (Halle (p.c.) in fact suggests that clash deletion is never iterative). We thus obtain the derivation in (45).

(45)

a.	x projection		*ž*	*a*	*r*	*o*	*v*	*n*	*i*	g^y
				x		x			x	
b.	bracket projection			(x		(x			(x	
c.	clash deletion			(x		(x			x	
d.	edge marking			N/A						
e.	heading (L)	line 0		(x		(x			x	
		line 1		x		x				
f.	edge marking	line 0		(x		(x			x	
		line 1		(x		x				

g.	heading (R)	line 0	(x	(x	x
		line 1	(x	x	
		line 2		x	

Now consider a word in which a schwa intervenes between two full vowels at the end of a word, such as *an-ps-ak* 'uncrowned' [*anp^həsák*]. The final stress in such cases must be treated as exceptional in the analysis of Armenologists who have worked on these dialects, because their algorithm assigns stress to the penultimate full vowel (cf. Muradyan 1960:167), giving **ánp^həsak*. In our analysis, however, we predict that such cases receive final stress, since there is no stress clash, as shown in the derivation in (46).

(46)

a.	x projection		*a*	*n*	p^h	*ə*	*s*	*a*	*k*
			x			x		x	
b.	bracket projection		(x			x		(x	
c.	clash deletion		N/A						
d.	edge marking		N/A						
e.	heading (L)	line 0	(x			x		(x	
		line 1	x					x	

f.	edge marking	line 0	(x	x	(x
		line 1	(x		x

g.	heading (R)	line 0	(x	x	(x
		line 1	(x		x
		line 2			x

Final stress words in penultimate stress dialects can be stipulated as not undergoing the clash deletion rule. Conversely, exceptional penultimate stress words in final stress dialects can be said to undergo the clash deletion rule, whereas regular words do not. Thus, the two types of dialects differ only with respect to their employment of stress clash deletion.

Note that the metrification system I have outlined can never produce primary stress to the left of the penult in either type of dialect, except in words containing no full vowels. Consider, for example, the derivation of a hypothetical word with lexical stress on the antepenult in standard Armenian:

(47)

a.	x projection	C	V	C	V	C	V
			(x		x		x
b.	bracket projection		(x		(x		(x
c.	edge marking	N/A					

d.	heading (L)	line 0	(x	(x	(x
		line 1	x	x	x
e.	edge marking	line 0	(x	(x	(x
		line 1	(x	x	x
f.	heading (R)	line 0	(x	(x	(x
		line 1	(x	x	x
		line 2			x

In other words, words with lexical stress on the antepenultimate syllable (and in fact any syllable other than the ultima) would receive final stress, and thus be indistinguishable from words with no lexical stresses.

An interesting case of lexical stress is found in Shatax (a final stress dialect), where negative verbs show the stress behavior in (48) (Muradyan 1962).

(48)

a. stress the initial syllable of the verb root

mi zän-i 'do not hit' → *mə zä´ni*

mi eirt^{h}-ek^{hy} 'do not go' → *mért^{h}ek^{hy}*

b. if the verb root is monosyllabic, stress the negative element

mi tu 'do not give' → *mí tu*

mi la 'do not cry' → *mí la*

I propose that negative verbal constructions in Shatax undergo RLR edge marking before feeding into the stress assignment procedure. If this is the case, forms such as *mə zä´ni* and *mí tu* receive the derivations in (49).

(49)

a.	x projection		*m*	*i*	*z*	*ä*	*n*	*i*
				x		x		)x
	bracket projection			(x		(x		)x[12]
	edge marking		N/A					
	heading (L)	line 0		(x		(x		)x
		line 1		x		x		
	edge marking	line 0		(x		(x		)x
		line 1		(x		x		
	heading (R)	line 0		(x		(x		)x
		line 1		(x		x		
		line 2				x		

---

[12]I assume that placement of a left bracket is blocked in this position, since a right bracket is already present.

			m	*i*	*t*	*u*
b.	x projection			x		)x
	bracket projection			(x		)x
	edge marking		N/A			
	heading (L)	line 0		(x		)x
		line 1		x		
	edge marking	line 0		(x		)x
		line 1		(x		
	heading (R)	line 0		(x		)x
		line 1		(x		
		line 2		x		

We thus obtain the correct surface facts. It is not clear, however, whether postulating an edge marking rule which applies before stress assignment is justified or not.

One drawback of the system I have proposed in this section is that it does not produce secondary initial stress. In order to account for the placement of secondary stress, we must assume a second pass of metrification basically identical to the first but without bracket projection, thereby producing initial stress in all cases. The results of this pass must then be combined with the primary stress produced by the first pass. At this point it is not clear whether such steps are necessary, because the behavior of secondary stress in Armenian has not yet been established, and my informants are unable to provide satisfactory judgements regarding secondary stress.

2.3.5. *Edge marking and Heading*

In the preceding section I argued that it was necessary to assume that full vowels project line 0 brackets, whereas schwas do not. We must then ask how stress is assigned in words containing only schwas. Recall that in such words, stress is assigned to the initial vowel. The simplest means of obtaining this result is to have LLL edge marking, which places a left bracket to the left of the leftmost element in the word. We must also assume that line 0 constituents are left-headed, which was already required for penultimate stress words such as *gəré*t^h*e*. Given these parameters, a vowelless word such as t^h*ə'rəmp*^{h} will have the derivation in (50).

(50)

a.	x projection			t^h	*ə*	*r*	*ə*	*m*	p^h
					x		x		
b.	bracket projection		N/A						
c.	edge marking				(x		x		
d.	heading (L)	line 0			(x		x		
		line 1			x				

e.	edge marking	line 0	(x	x
		line 1	(x	
f.	heading (R)	line 0	(x	x
		line 1	(x	
		line 2	x	

Let us now consider the outputs for vowelless words if we had RRR, RLR, or RRL edge marking. RLR and RRL edge marking produce the correct stress assignment in vowelless words, but cannot produce final stress in words with full vowels[13]. RRR cannot account for the behavior of non-cyclic suffixes.

We saw in (28) that ordinal numbers have root stress unless the vowel initially assigned stress is deleted[14], in which case they have final stress. I believe this fact to be best accounted for by assuming that the

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[13]This statement crucially depends on the assumption that edge markers, unlike conventional brackets, cannot be superseded; in other words, stress can never occur to the right of a right edge mark, or to the left of a left edge mark. This assumption is based on the behavior of Latin stress, which systematically ignores the ultima even when heavy. The Latin facts are best treated by placing an right edge mark to the left of the rightmost syllable. Since Latin is quantity-sensitive, we should expect a heavy ultima to bear stress if the edge mark is no different from other brackets. This not being the case, we stipulate that edge marks cannot be superseded.

[14]No synchronic rule is responsible for the deletions in (28b), which must be stipulated as lexical haplologies.

ordinal suffix does not project line 0 brackets. This being the case, the ordinal suffix generally will not receive stress due to line 1 being left-headed. Consider the sample derivation for *híŋgerord* 'fifth' given below.

(51)

a.	x projection		*h*	*i*	*ŋ*	*g*	*e*	*r*	*o*	*r*	*d*
				x			x		x		
b.	bracket projection			(x			x		x		
c.	edge marking			N/A							
d.	heading (L)	line 0		(x			x		x		
		line 1		x							
e.	edge marking	line 0		(x			x		x		
		line 1		(x							
f.	heading (R)	line 0		(x			x		x		
		line 1		(x							
		line 2		x							

Note that in these cases the vowels of the ordinal suffix belong to an unbounded foot headed by the final vowel of the root. If this head vowel is subsequently deleted, we should expect stress to move to the next available vowel within the foot, which is in fact what occurs. Consider for example the case of *erkrord* 'second':

(52)

a.	x projection		*y*	*e*	*r*	*k*	*u*	*e*	*r*	*o*	*r*	*d*
				x			x	x		x		
b.	bracket projection			x			(x	x		x		
c.	edge marking			N/A								
d.	heading (L)	line 0		x			(x	x		x		
		line 1					x					
e.	edge marking	line 0		x			(x	x		x		
		line 1					(x					
f.	heading (R)	line 0		x			(x	x		x		
		line 1					(x					
		line 2					x					
g.	deletion		*y*	*e*	*r*	*k*	*ø*	*ø*	*r*	*o*	*r*	*d*
		line 0		x			(			x		
		line 1					(					
		line 2					x					

Once deletion occurs, the the closest available line 0 mark in the foot automatically becomes the head of the foot and receives a line 2 mark, resulting in the correct surface form [*yerkrórd*]. This analysis of SWA ordinals crucially requires that words containing only reduced vowels receive initial stress, since line 0 feet must be left-headed. Conversely, in dialects where vowelless words receive final stress, out model predicts that the ordinals will shift stress to the left. The dialect of Erznka appears to be such a case, but unfortunately the grammar (Kostandyan 1979) gives no information on the stress patterns of ordinals. The notion that under certain lexically specified conditions morphemes may not project brackets can also be employed to explain the optional initial stress observed in adverbs, vocatives, and hypocoristics. In each of these cases, we simply state that the morphemes involved do not project brackets, and therefore receive initial stress from the LLL edge marking parameter (similar proposals have been made to deal with the Sanskrit vocative; cf. Halle and Vergnaud 1987).

One last important facet of Armenian stress is its correlation with high vowel reduction. In descriptive terms, with some exceptions (53d) high vowels become schwa (53a) or disappear completely (53b) in unstressed syllables, except when in word-initial position (53c).

(53)	underlying form	surface form	gloss
a.	*gir-el*	*gərél*	write
b.	*mak^{h}ur-el*	*mak^{h}rél*	clean
c.	*imast*	*imást*	wise
d.	*astičan*	*astičán*	step

The diphthongs *oi* and *ei* reduce to *u* and *i* respectively in unstressed syllables.

(54)	underlying form	surface form	gloss
a.	*lois*	*lúys*	light
	lois-a-vor	*lusavór*	luminous
b.	*teir*	*tér*	lord
	teir-a-nal	*tiranál*	rule

Note that diphthong reduction creates surface unstressed high vowels, so that high vowel reduction cannot easily be stated as a constraint on surface representations.

2.4. Syllable structure

Armenian presents a number of interesting phenomena related to syllabification. Perhaps the most complex of these is the process of epenthesis employed to syllabify underlying sequences of consonants not allowed in surface syllables. In this section I survey the range of attested underlying initial and final clusters, together with their surface syllabifications (when different from the underlying form), which reflect the inventory of surface onsets and codas. The disparities between underlying and surface clusters are motivated in chapter 3. The following abbreviations are employed:

(55)

T	stop or affricate
S	fricative
N	nasal
L	liquid
G	glide

The forms cited in the following discussion are taken from Malχasyanc^h 1944, Grigoryan 1976, and Ghazaryan 1982. My survey of initial and final clusters is taken to subsume the set of medial clusters. I also survey a number of other processes relevant to syllabification such as plural selection, passive formation, syllabification of vowel sequences and clitics, prothesis, hiatus, deletion, reduplication, and hypocoristics.

2.4.1. Underlying word-initial clusters

The inventory of underlying onsets is basically unconstrained, as the examples below demonstrate, though I am unaware of any sequences of more than ten consonants, and clusters of six to ten members normally result from reduplication. I have therefore provided a representative rather than exhaustive selection of possible underlying initial clusters. The inventory of surface onsets, however, is complete.

Perhaps the most interesting case of underlying initial clusters is a class of words which have no vowels in their underlying representation (the reasons for assuming that the schwas which appear on the surface are not present in underlying representations are defended in chapter 3). Some representative forms are given in (56) (+ denotes a reduplication boundary; for discussion of parenthesized schwas see chapter 3).

(56)

underlying form	surface form	gloss
ʁr̊	*ʁər̊*	dry
sl	*səl*	surprising
ʁnt^h	*ʁənt^h*	(a) little
zχk	*zəχk*	sound made when heaving a heavy object
ppz	*pəpəz*	fire, light
čnkr̊	*čəŋkər̊*	small
čklt^h	*čəkəlt^h*	slap (n)
ʁr̊vr̊	*ʁər̊vər̊*	noise
t^hr̊r̊	*t^hər̊*	sound heard when flying
čr̊vr̊	*čər̊vər̊*	to and fro
čr̊+čr̊	*čər̊čər̊*	pulley-like device used in cleaning cotton
t^hrnp^h	*t^hərəmp^h*	noise made by heavy but soft object hitting the ground
slpzt	*səl(ə)pəzt*	suddenly
čvl+čvl	*čəvəlčəvəl*	chirpingly
čnkl+mnkl	*čəŋkəlməŋkəl*	decorations worn on woman's head
slnk^h+slnk^h	*sələŋk^hsələŋk^h*	wander aimlessly
plst^hr+plst^hr	*pələst^hərpələst^hər*	brilliant

Obviously many or most of these words are onomatopoetic in some sense, but nevertheless they shed light on the workings of stress and syllable structure, as I demonstrate in chapter 3.

Among words containing full vowels, underlying initial clusters of one and two members are completely unconstrained. One could argue that *y* is not a possible underlying onset, due to the fact that historically all initial *y*'s became *h*, and there is no synchronic evidence that these new *h*'s are underlyingly anything but *h*. Some examples are given in (57).

(57)	classical form	modern surface form	gloss
	i-aǰ-ord	*haǰorth*	next
	i-et-oi	*heto*	after

I assume, however, that *y* is merely a manifestation of underlying *i* in syllable margins, and *i* is in fact allowed in syllable onsets at some point in the derivation, being produced by prothesis and mid vowel raising, as shown in the examples in (58).

(58)	underlying form	surface form	gloss
prothesis	*eothn*	*yothə*	seven
mid vowel raising	*erb*	*yerph*	when

Since the initial *y* in the form *yothə* 'seven' never undergoes any alternations, one could argue that it and similar words in fact have an underlying initial *i/y*. This issue is not important to the topics discussed in this thesis, however. Note that the rule which inserts *y* before initial *e* and *v* before initial *o* is violated on the surface by unstressed diphthong reduction, which produces initial *e*'s from underlying *ei* diphthongs, as in /*eiš*/ 'donkey' [*eš*].

Because the inventory of underlying one and two member onsets is completely unconstrained, I will not attempt to survey the possibilities here. The set of one member surface onsets is similarly unconstrained, with the possible exception of *r*, which is relatively rare in initial position.

The set of two member surface onsets is significantly constrained, however: only obstruent/nasal + *y* sequences surface without epenthesis, as can be seen in (59).

(59)	cluster	underlying form	surface form	gloss
	TT	*ppi*	*pəpi*	big toe
	TS	*psak*	*pəsak*	crown
	TN	*d-n-e-l*	*dənel*	put
	TL	*dram*	*dəram*	money
	TG	*biur*	*byur*	10,000
	NG	*niut^h*	*nyut^h*	subject
	LG	*liard*	*liyard*	liver

This distribution of surface onsets can also be seen in the treatment of underlying initial clusters of three or more members, surveyed below.

In general, two-member clusters other than obstruent/nasal + *y* are syllabified by inserting a schwa between the two consonants (with the stipulation that schwa raises to *i* before *y*), as can be seen in (59). The behavior of sibilant + stop onsets does not always conform to this rule, as I demonstrate below. Sibilant + non-stop consonant and non-sibilant fricative + consonant sequences behave in the expected manner, epenthesizing between the two consonants.

(60)	underlying form	surface form	gloss
	sχal	*səχal*	error
	slak^h	*səlak^h*	arrow
	χt^{h}us	*χət^{h}us*	type of plant

Underlying three member onsets are completely unconstrained. Four consonant sequences behave in a variety of ways; representative cases are given in (61).

(61)	underlying form	surface form	gloss
SLTS	*sl-k-u-e-l*	*səlk(ə)vel*	slip (v)
TSTT	*čvtk-e-l*	*čəftəkel*	prune (v)
TSLT	*bzlt-a-l*	*bəzəltal*	buzz

Of approximately 100 different four-consonant permutations I have examined, none are syllabified with two consecutive open syllables on the left edge, though this is not necessarily significant.

Five consonant sequences are still basically unconstrained.

(62)	underlying form	surface form	gloss
	slχtr-ik	*saləχt(ə)rik*	lewd
	sl-χ-k-u-e-l	*saləχkvel*	be unstable
	plpst-a-l	*pəlpəstal*	flash (v)
	bldrʁan	*bəldərʁan*	a plant (heracleum villosum)
	bršt-k-e-l	*bərəšt(ə)kel*	spread a scent
	gṙst-k-a-l	*gəṙəst(ə)kal*	burp (v)

Six member onsets consist for the most part of reduplicated triconsonantal roots, for example *bṙt^h+bṙt^h-a-l* [*bəṙt^{h}bəṙt^{h}al*] 'poke with hand or foot', but may also constitute single units, as in the forms in (63).

(63)	underlying form	surface form	gloss
	bz-nkʰ-t-u-e-l	*bəzəŋkʰətvel*	rip (intransitive v)
	brdgzn-uk	*bərdgəznuk*	torn
	plʁrt-k-e-l	*pəlʁərtəkel*	not see well

Seven consonant onsets are rare; I know of only one example:

(64)	underlying form	surface form	gloss
	ǰʁb+ǰʁb-n-ot-a-l	*ǰəʁbǰəʁbnotal*	be soaking wet

Eight consonant onsets are fairly common, but always consist of reduplicated four-consonant roots.

(65)	underlying form	surface form	gloss
	drχk+drχk-a-l	*dərəχkdərəχkal*	crash
	zrmpʰ+zrmpʰ-a-l	*zərəmpʰzərəmpʰal*	make walking noises

As mentioned above, sibilant + stop sequences sometimes behave differently than other onset clusters.

(66)	underlying form	surface form	gloss
a.	*st-a-na-l*	*əstanal*	receive
	štap	*əštap*	haste
	zgoiš	*əzguš*	careful
b.	*žpit*	*žəpit*	smile
c.	*sut-e-l*	*sətel*	lie

In (66a) we see that sibilant + stop clusters epenthesize before the sibilant, rather than after; *ž* does not pattern with the other sibilants with respect to epenthesis, however (66b). (66c) shows that sibilant + stop sequences resulting from high vowel reduction, which are orthographically identical to underlying sibilant + stop clusters (e.g. <*stel*>), also epenthesize after the sibilant. One immediately suspects that unstressed high vowels reduce directly to schwa in such cases, rather than being deleted and then undergoing epenthesis. I argue against this interpretation in chapter 3.

Contrary to the sibilant + stop sequences discussed above, sibilant + stop + consonant sequences do *not* epenthesize before the sibilant, with one exception I am aware of (67b).

(67)	underlying form	surface form	gloss
a.	*spʰṙ-ocʰ*	*səpʰṙocʰ*	tablecloth
	skʰtʰ-e-l	*səkʰtʰel*	shrink from the cold
b.	*struk*	*əstruk* (SWA)	serf
		stəruk (SEA)	

I assume that the root of <*sksil*> 'begin' [*əskəsil*] is /*skis*/, judging by its syllabification and the parallel form *skizb* 'beginning'.

Sibilant + stop sequences followed by two consonants may epenthesize before or after the sibilant (SEA does not pronounce the initial schwa in (68a)).

(68)	underlying form	surface form	gloss
a.	*strǰ-a-l*	*əstərǰal*	regret (v)
	stng-a-l	*əstəngal*	have convulsions

b.	*skrt^h-e-l*	*səkərt^{h}el*	scratch (v)
	splχ-e-l	*səpəlχel*	slip (v)

Sibilant + stop sequences followed by three consonants epenthesize between the sibilant and the stop.

(69)	underlying form	surface form	gloss
	sp^{h}rt^{h}n-e-l	*səp^{h}ərt^{h}nel*	blanch, go white
	spltr-ik	*səpəltrik*	feeble
	spl-c^h-n-e-l	*səpəlc^{h}ənel*	polish (v)

2.4.2. Final consonant clusters

Underlying final clusters in Armenian are significantly more constrained than onsets. Though they may disobey sonority sequencing principles, underlying final consonant sequences never contain more than three members, and never require more than one epenthetic vowel. This asymmetry between initial clusters and final clusters results from the historical interaction of stress and vowel reduction. At some point in the prehistory of Armenian, the language lost final syllables unless they contained a liquid or nasal, in which case only the vowel disappeared. The preceding syllable, which generally bears the primary word stress, never reduced, and thus since the language then and now allowed only two-member codas, underlying clusters of more than three members failed to arise. Since the language had final stress (the penultimate stress systems found in Karchevan, Karabagh, etc. must be later developments), any and all preceding high vowels reduced, and thus it was possible to produce exceedingly long strings of consonants at the beginnings of words. When parallel forms preserving the original high vowels disappeared from the lexicon, it was possible for these strings of consonants to be reanalyzed as underlying clusters.

In (70) I summarize all possible underlying word-final consonant clusters.

(70)	underlying form	surface form	gloss
LS	*durs*	*durs*	outside
	duṙ-s	*duṙəš*	my door
ST	*osp*	*vosp*	lentil
GN	*goin*	*guyn*	color
GL	k^h*oir*	k^h*uyr*	sister
GT	*zoig*	*zuyg*	pair
GS	*zgoiš*	*əzguš*	careful
LT	*kerp*	*kerp*	form
NT	*χumb*	*χumb*	group
NS	*toms*	*toms*	ticket
TT	*cack*^{h}	*cack*^{h}	roof[15]
SS	*χorisχ*	*χorisχ*	honeycomb
NN	*omn*	*vomən*	someone
LL	*andorr*	*andorər*	quiet[16]
LN	*buṙn*	*buṙn*	fist
SN	*kazm*	*kazəm*	constitution
SL	*artosr*	*artosər*	tear(drop)

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[15]TT clusters are only allowed when k^h is the second member.

[16]My informants delete one member of final LL clusters in some words.

TS	*makʰs*	*makʰs*	tax
NL	*cunr*	*cunər*	knee
SL	*šifr*	*šifər*	cipher (< French)
TL	*pʰokʰr*	*pʰokʰər*	small
GLT	*spʰiuṙkʰ*	*(ə)spʰyuṙkʰ*	diaspora[17]
GNT	*erkainkʰ*	*yerkʰayŋkʰ*	long things
LST	*šnorhkʰ*	*šənorkʰ*	the Three Graces[18]
LTT	*part-kʰ*	*partkʰ*	debt[19]
NTT	*bṙ-uncʰ-kʰ*	*bəṙuncʰkʰ*	fist[20]
GSN	*aižm*	*ayžəm*	now
STL	*kʰaʁcʰr*	*kʰaχcʰər*	sweet
TTL	*spektr*	*(ə)spektər*	spectre (< English)
LTL	*barjr*	*barcʰər*	high
NTL	*tʰanjr*	*tʰanjər*	thick
TST	*tekʰst*	*tekʰst*	text (< English)
NTS	*angʁ*	*aŋgəʁ*	vulture
NTN	*ais-inkʰn*	*aysiŋkʰən*	i.e.
SNN	*geʁmn*	*geʁmən*	wool
GSN	*doizn*	*duyzən*	little

[17] All such clusters end in *kʰ*.

[18] Only allowed with *kʰ* as the final member in native words (cf. *verst* 'unit of length' [*verst*] < Russian).

[19] Only allowed with *kʰ* as the final member in native words (cf. *infarkt* 'infarct' [*infarkt*] < Russian).

[20] Only allowed with *kʰ* as the final member in native words (cf. *punkt* 'point' [*puŋkt*] < German).

STS	*astʁ*	*astəʁ*	star
LTS	*arkʁ*	*arkəʁ*	box

2.4.3. Vowel sequences

Armenian deals with underlying vowel sequences in a number of ways, including glide formation, hiatus, deletion, and coalescence. Glide formation is generally employed in sequences containing one or more high vowels, in which case the least sonorous high vowel surfaces as a glide[21].

(71)	underlying form	surface form	gloss
	katar-ial	*kataryal*	perfect
	nuag-e-m	*nəvagem*	I play
	gg-u-e-l	*gəg(ə)vel*	fondle
	eu	*yev*	and
	aul-e-l	*avlel*	sweep
	ain	*ayn*	that
	goin	*guyn*	color
	tʰiu	*tʰiv*	number
	tu-i	*təvi*	I gave
	lezu-i	*lezvi*	tongue-gen.

Deletion applies to *i* when the second member of a diphthong in final position of polysyllabic words, as discussed earlier, and also before certain

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[21]As I mentioned at the beginning of this chapter, words whose spellings differ from their surface forms do not always exhibit alternations that allow us to justify postulating abstract underlying representations mirroring the orthography. Nevertheless, enough cases of alternations supporting abstract spellings exist to lead me to employ the orthographic forms as underlying representations unless positive evidence forces me to do otherwise.

vowel-initial suffixes, e.g. *bari-ut^h^iun* 'goodness' → [*barut^h^yun*]. From the last three forms in (71) we can see that in sequences of disparate high vowels the *u* normally vocalizes and the *i* becomes a glide. There are two exceptions to this generalization involving *i-u* sequences, which when separated by a morpheme boundary remain in hiatus (see below), and when followed by a coda consonant syllabify as *-yu-*, as in *jiun* 'snow' [*jyun*]. This is not true across morpheme boundaries, where the regular syllabification applies, as in *t^h^iu-n* 'number-def.' [*t^h^ivən*]. The sequence *-ui-* never appears as [*uy*], though *-uy-* sequences do surface, produced from underlying */oi/* by an independent process discussed earlier. Hiatus is tolerated in borrowings such as *kaos* 'chaos' and *boa* 'boa constrictor', and in native low vowel sequences, as in *haka-ařaǰ-ark* 'counter-proposal' [*hakaařaǰark*], *amena-azniu* 'nicest' [*amenaazniv*][22]. Other potential hiatus configurations are resolved with an epenthetic *y*, as can be seen in (72).

(72)	underlying form	surface form	gloss
	ji-u	*jiyu*	horse-gen.
	ei-i	*eyi*	I was
	gadu-ei-n	*gaduyen*	cat-abl.-def. (SWA)
	Maro-i	*Maroyi*	Maro-gen.
	mi-a-na-l	*miyanal*	unite

[22]An interesting case is *amenaəntir* 'most choice'. In this thesis I assume that words such as SWA *əsel* 'say', *əndir* 'choice, select', and *əst* 'according to' involve underlying empty [-consonantal] root nodes, for reasons to be discussed in chaper 3.

Note, however, that whereas *i*-final monosyllables behave in this manner when followed by the plural suffix *-er* (*ji* 'horse' → *jiyer* 'horses'), *u*-final monosyllables undergo glide formation, as in *ju* 'egg' → *jəver* 'eggs'.

Sequences of *i* + *a* across a morpheme boundary sometimes merge into *e*, as in *gini-a-mol* 'wine-crazy' [*ginemol*], *hogi-a-uor* 'spiritual' [*hogevor*]. This alternation is not productive; most cross-morpheme *i-a* sequences trigger epenthesis (*miyanal* 'unite') and some delete the *i* (*tʰšnami-akan* 'hostile' [*tʰəšnamakan*]).

2.4.4. *Clitics and intransitives*

The behavior of clitics and intransitives with respect to syllabification is striking. We have already observed that the definite article clitic syllabifies differently from tautomorphemic *n*'s in cases such as *jiun* 'snow' [*jyun*] versus *tʰiu-n* 'number-def.' [*tʰivən*]. The same is true for the possessive clitics *-d* 'your' and *-s* 'my', as can be seen in (73).

(73)	underlying form	surface form	gloss
a.	*toms*	*toms*	ticket
	mom-s	*moməs*	my candle
b.	*gund*	*gund*	heap
	tun-d	*tunəd*	your house

These disparities have led Armenologists to assume that the clitics actually begin with a schwa: *-əs, -əd, -ən.* Consequently, they must postulate a deletion rule to account for the forms in (74), where no schwa appears when a vowel-initial clitic follows.

(74)	underlying form	surface form	gloss
	areu-n	*arevən*	sun-def.
	areu-n ei	*arévne*	it is the sun

In chapter 3 I defend the proposal that these clitics do not contain an underlying schwa, and that their special syllabification results from the fact that Armenian syllabification is cyclic.

The behavior of the passive/intransitive morpheme *-v-* (underlying *-u-*) in SEA with respect to syllabification is also interesting. According to Adjarian 1971:273, SWA always epenthesizes directly before the *-v-* when the verb root ends in a consonant sequence that cannot form a coda. In SEA the distribution of the epenthetic schwa is more complicated. According to Gharagyulyan 1975:40, there is no epenthesis when the verb root ends in a possible coda sequence (75a); if the root ends in a consonant + liquid sequence, epenthesis occurs before the liquid (75b); otherwise, epenthesis occurs directly before the *-v-* (75c).

(75)	underlying form	surface form	gloss
a.	*varj-u-e-l*	*varjvel*	be hired
	azd-u-e-l	*azdvel*[23]	be influenced
	air-u-e-l	*ayrvel*	be burned, burn (intr.)
	mkrt-u-e-l	*məkərtvel*	be baptized
b.	*manr-u-el*	*manərvel*	grow smaller
	mak^{h}ur-u-e-l	*mak^{h}ərvel*	be cleaned
	p^{h}χl-u-e-l	*p^{h}əχəlvel*	be plucked out

[23]My SEA informant pronounces this [*az.də.vel*].

c.	*matn-u-e-l*	*matnəvel*	be betrayed
	ankč-u-e-l	*əŋkčəvel*	be overcome
	patiž-u-e-l	*patžəvel*	be punished
	zarn-u-e-l	*zarnəvel*	be hit
	patum-u-e-l	*patməvel*	be told
	χc^h-ik-u-e-l	*χəc^{h}kəvel*	be closed
	uʁiʁ-u-e-l	*uʁəvel*	be corrected
	hašiv-u-e-l	*hašvəvel*	be reckoned
	kočik-u-e-l	*kočkəvel*	be buttoned

In cases such as *mak^{h}ərvel* one could argue that the schwa preserves the location of an underlying vowel which has been reduced, but this is not possible with words such as *manərvel*, which have no underlying vowel in place of the schwa at any stage of the derivation. I assume that the schwas under discussion in fact always result from epenthesis rather than vowel reduction, consistent with analysis of high vowel deletion already alluded to, which is developed in chapter 3.

There is a *-t-* element which attaches to numerous verb roots and also behaves in a curios manner. I assume that this is an autonomous morpheme (though of apparently limited semantic content), and therefore is expected to trigger special syllabification effects.

(76)	underlying form	surface form	gloss
	gǰl-e-l	*gəǰlel*	rip out forcefully
	gǰl-t-e-l	*gəǰəltel*	tear, rip
	bz-ik	*bəzik*	tear (n)
	bz-ik-t-e-l	*bəskətel, bəzəktel*	rip
	gz-e-l	*gəzel*	comb wool, groom, fight
	gz-u-e-l	*gəzvel*	same
	gz-v-t-e-l	*gəzvətel*	same

There is a discrepancy in *bz-ik-t-e-l* , which my informant pronounces *bəskətel* but Malχasyanc^{h} 1944 pronounces as *bəzəktel.* The reasons for this variation are discussed in chapter 3.

2.4.5. Plural formation

The productive rule of plural formation in Armenian selects between two allomorphs: monosyllabic nouns take the suffix *-er* (77a), and polysyllabic nouns take the suffix *-ner* (77b).

(77)	singular	plural	gloss
a.	*čaš*	*čašer*	meal
b.	*dodoš*	*dodošner*	toad

The plural selection algorithm interacts with epenthesis in a curious way. As a general rule, epenthetic syllables count for plural formation, so that underlying monosyllabic nouns which surface with one or more epenthetic syllables take the polysyllabic plural, as in (78):

(78)	singular	plural	gloss
	r̊us	*ər̊usner*	Russian
	gluχ	*gəluχner*	head
	spai	*əspaner* (SWA)	officer
		spaner (SEA)	

Given these facts, a traditional account must assume that syllabification applies before plural formation. Now consider what happens to monosyllabic nouns with final consonant clusters.

(79)	singular	surface form	plural	surface form	gloss
	arkʁ	*arkəʁ*	*arkʁ-er*	*arkʁer*	box
	astʁ	*astəʁ*	*astʁ-er*	*astʁer*	star
	vagr	*vagər*	*vagr-er*	*vagrer*	tiger

Given the above assumption that syllabification and epenthesis apply before plural formation, we should expect the forms in (79) to take the polysyllabic plural *-ner*, but instead we obtain the forms with the monosyllabic plural morpheme. I consider possible explanations for this unexpected pattern in chapter 3.

2.4.6. Reduplication

We have already seen in the discussion of underlying onset clusters that full reduplication of lexical roots is quite common. Several types of partial reduplication also exist, of which I present two of the more common here: *m*-reduplication, e.g. *ptuʁ mtuʁ* 'tutti frutti', and fixed coda reduplication, e.g. *tʰepʰ-tʰaza* 'very fresh'. Both of these reduplication types are also employed in Turkish (cf. *kitap mitap* 'books and things', *dɨm-dɨzlak* 'naked'); Foster 1969 presents a fairly comprehensive survey of Turkish fixed coda reduplication.

2.4.6.1. Armenian reduplication with fixed coda material

Turkish and Armenian share a peculiar reduplication pattern employing a fixed coda segment drawn from the set {*p m n s r*}.

(80)

a.	*yerkar*	'long'	:	*ep-erkar*	'really long'
	sev	'black'	:	*sep-sev*	'very black'
	deʁin	'yellow'	:	*dep-deʁin*	'very yellow'
	kananč^h	'green'	:	*kap-kananč^h*	'very green'
	t^hac^h	'wet'	:	*t^hap-t^hac^h*	'really wet'
	layn	'wide'	:	*lap-layn*	'really wide'
	zor	'dry'	:	*zop-zor*	'really dry'
	geʁ	'pretty'	:	*gep-geʁ*	'really pretty'
	lav	'good'	:	*lap-lav*	'really good'
	geš	'bad'	:	*gep-geš*	'really bad'
	əspitak	'white'	:	*sep-spitak*	'very white'
	kəlor	'round'	:	*kəs-kəlor*	'really round'
b.	*karmir*	'red'	:	*kas-karmir*	'very red'
	kapuyt	'blue'	:	*kas-kapuyt*	'very blue'
	barc^hər	'tall'	:	*bas-barc^hər*	'really tall'
	p^həstik	'small'	:	*p^həs-p^həstik*	'really small'

c.	*karč*	'short'	:	*kap^{h}əs-karč*	'really short'
	nor	'new'	:	*nop^{h}əs-nor*	'really new'
	nihar	'thin'	:	*nips-nihar*	'really thin'
	hin	'old'	:	*hips-hin*	'really old'
d.	*neʁ*	'narrow'	:	*ner(s)-neʁ*	'really narrow'
e.	*daʁ*	'slow'	:	*dan-daʁ*	'very slow'

I assume that Armenian has borrowed the process from Turkish, since the Armenian inventory of coda segments is more restricted (*m* is not employed) and often borrows forms directly from Turkish, whereas few borrowings are documented in the opposite direction. All analyses to date have concluded that the Turkish pattern must be specified in the lexicon, as there is no discernible phonological conditioning; I know of no analysis of the Armenian data. Given that Armenian has borrowed the phenomenon and applied it to scores of new words, we should assume that it is driven by some phonological or morphological rules, and cannot be merely a lexical archaism. I attempt to identify the conditioning factors at work in the reduplication system in chapter 3.

2.4.6.2. M-reduplication

Like fixed coda reduplication, *m*-reduplication is productive and fairly common. Some typical examples are provided below.

(81)	root	gloss	*m*-form	gloss
	pətuʁ	fruit	*pətuʁ mətuʁ*	fruit and stuff, tutti frutti
	č^{h}alik	speckled	*č^{h}alik malik*	speckled
	čnkl	decorations	*čəŋkəlməŋkəl*	decorations worn on woman's head

2.4.7. Hypocoristics

Armenians employ a wealth of hypocoristics. For the most part, these follow a common pattern. Some typical examples are given in (82).

(82)	full name	nickname
	Petros	*Peto, Pepo*
	Tigran	*Tigo*
	Grigor	*Gigo*
	Sarkis	*Sa(r)ko*
	Abraham	*Ab(r)o*
	Andranik	*Ando*
	Gabriyel	*Gabo*
	Mkrtič^{h}	*Mako, Məko*
	Maryam	*Maro*
	Deʁjuhi	*Deʁjo*
	Varsenik	*Varso*
	Vardan	*Vardo*
	Eʁišapet	*Eχšo*
	Ephrakhse	*Eṕo*
	Zarmand	*Zarmo*
	Zardar	*Zardo*
	Artašes	*Arto*
	Armen	*Ar(m)o*
	Arnak	*Arno*
	Harut^{h}*yun*	*Ar(t)o*
	Həmayak	*Hamo*

Hambarjum	*Hambo*
Hovnan	*Huno*
Manvel	*Mano*
Martiros	*Ma(r)to*
Mihran	*Miro*
Bagrat	*Bago*
Samvel	*Samo*
Step^{h}an	*Tep^{h}o*
Sedrak	*Sedo*
Daniel	*Dano*
Dərastamat	*Dəro*
Vazken	*Vazo*

One can make the following generalizations. Each nickname contains two syllables, the first bearing stress and the second ending in *o*. The first syllable may be closed, generally only if closed by a consonant more sonorous than the following onset, but neither syllable has a complex onset as a general rule.

2.5. *Vowel harmony*

Many of the non-literary dialects of Armenian possess vowel harmony systems, normally involving the feature [back] and occasionally [round] as well. For reasons to be discussed in chapter 4, [back] harmony in at least some of these dialects might be better treated as [ATR] harmony, though I have been unable to evaluate this possibility with phonetic data. Armenian harmony systems are found from Cilicia in south central Turkey to Maragha in Iran to Aresh in Azerbaijan near the Caspian Sea; I focus in this section on the eastern dialects of Agulis and Karchevan, which present perhaps the most interesting harmonic systems.

One can make the following generalizations concerning the dialects surveyed here: roots normally share a single value for [back]; *i* and *e* however freely occur in both [+back] and [-back] roots and are not affected by harmony; and *ə* generally does not play a role in harmony processes[24]. The harmonic systems examined below support the assumption that vowel harmony applies iteratively from left to right within words (both roots and suffixes), and may be blocked by active marking statements. Propagation of the harmonic feature through the word is strictly local; that is, a given feature can only affect the immediately following visible feature. This restriction may be further constrained to immediately following syllables, as we shall see in the case of Karchevan. Like the projection of metrical boundaries discussed in 2.3, harmonic spreading occurs in an iterative fashion; in other words, once a given vowel has had its chance to propagate its specification for the harmonic feature, the next vowel to the right gets its own chance, and so on for all the vowels in a word.

I assume based on Steriade's 1994 work on phonological contrasts that harmonic systems may allow underlying contrasts for harmonic feature specifications in the following set of environments: initial (root) syllable, root, or word. Languages which only allow underlying contrasts in initial syllables such as Wolof (Kenstowicz 1994) never have

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[24]I assume that this epenthetic schwa is underlyingly specified as [+high], as in Turkish. I employ the symbol *ə* rather than *ɨ*, however, in order to preserve the Armenological notation and reflect the fact that this vowel is epenthetic.

disharmonic roots, modulo neutral vowels. Languages which only allow underlying contrasts in roots, on the other hand, allow disharmonic roots but draw suffixal vowels from a limited subset of their vowel inventory. Examples of this type of language are Akan (Kenstowicz 1994), Turkish, and the Armenian dialects discussed below. I do not know of any languages with vowel harmony systems which allow the full complement of vowel phonemes to occur in underlying representations of suffixes.

The treatment of harmony presented here assumes that harmonic processes are generally feature-changing, an analysis that is required by the notion of full specification discussed in chapter 1. Nevertheless, I assume that harmony rules may also be feature-filling in order to account for the behavior of the epenthetic vowel in Karchevan, discussed below.

Finally, I assume that the behavior of neutral vowels is determined by three factors. The insusceptibility of neutral vowels to harmonic alternations arises from the blocking of harmonic spreading by marking statements. The fact that neutral vowels may be opaque or transparent results from the locality condition mentioned above: if propagation is sensitive only to adjacent visible features, we expect neutral vowels to be transparent, as in Finnish; if, on the other hand, propagation is restricted to adjacent syllables, we expect neutral vowels to be opaque, as in the Karchevan case discussed below.

2.5.1. Agulis

Agulis, a penultimate stress dialect spoken in Nakhichevan, shows [back] harmony and has the underlying vowel inventory in (83).

(83)	[+back]	*a*	*o*	*u*			
	[-back]	*ä*	*ö*	*ü*	{*e*	*i* }(neutral)	

The chart in (83) should be interpreted as follows: *a* occurs in [+back] spreads, and alternates with *ä* in [-back] spreads, and similarly for *o* ~ *ö* and *u* ~ *ü*. The brackets surrounding *i* and *e* indicate that both are neutral, and can occur after [+back] or [-back] vowels in words (84a)[25], but spread [-back] to following vowels (84b).

(84)	underlying form	surface form	gloss
a.	*gʸaxti*	*gʸáxti*	belt
	kah-e-l	*káhil*[26]	trample
	aʁanj-nér	*aʁanjnér*	roast-pl.
b.	*Avetís-a*	*Avetísä*	Avetis (personal name)-gen.
	aʁanj-nér-av	*aʁanj-nér-äv*[27]	roast-pl.-instr.

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[25]Within roots, however, *e* can only occur after [-back] vowels, except in borrowings from the literary language, e.g. *pátker* 'picture'.

[26]*E* regularly raises to *i* in final syllables of polysyllabic words.

[27]Note that the polysyllabic plural *-ner-* always bears stress, even when followed by another suffix. If we assume as in the Karabagh case that final stress morphemes such as the *-ner-* plural exceptionally block clash deletion, we might expect the stress to move rightward when suffixes are added after *-ner-*. The fact that *-ner-* retains stress in such cases indicates that the blocking of clash deletion only applies on the cycle in which *-ner-* is added, and does not persist in the metrification of subsequent suffixes.

The diphthongs *ey*, *oy*, *ay* and *uy* pattern with the [-back] vowels; this is to be expected in a left-to-right harmony system, where following vowels only see the right half of the diphthong. The epenthetic schwa does not play any role in the harmony system. This assumption is important for our analysis of the neutral vowels *i* and *e*. Following Calabrese 1994, I assume that all vowels are fully specified in underlying representations, and the neutrality of front vowels in Agulis is produced by the activity of a marking statement disallowing the configuration *[+back, -round] in [-low] vowels. Given these assumptions, all non-low front vowels will be specified underlyingly as [-back, -low, -round], and spreading of harmonic [+back] to these vowels will be blocked by the filter, because it would produce the disallowed configuration *[+back, -low, -round]. If schwa, which is [+back, -low, -round], were present in the underlying inventory, we would have to assume that the filter *[+back, -low, -round] was deactivated, and we would be unable to explain the neutrality of *i* and *e*.

Harmony applies iteratively from left to right within roots and suffixes. If the rule were instantaneous rather than iterative, we would be unable to explain the spreading of [back] values from neutral vowels following [+back] vowels, as depicted in (85).

(85) *hac*^{h}*-er-am* 'bread-pl.-instr.' [*hac*^{h}*éräm*]

a. instantaneous

h a c^h *e r a m*

[+back] [-back] [+back]

b. iterative

h *a* *c*^{h} *e* *r* *a* *m*

[+back] [-back] [+back]

1 2

The results of harmony within roots can be seen in the fact that Agulis roots contain only one value for [back] (not including neutral vowels), but the specific activities of harmony within roots which lead to this state of affairs can only be observed by comparison with forms in non-harmonic dialects such as standard Armenian. Some examples are provided below.

(86)	standard Armenian	Agulis	gloss
	č^h*amič*^{h}	*č*^{h}*amuč*^{h}	raisin
	p^h*etur*	*t*^{h}*äp*^{h}*üṙ*	feather
	vičak	*vičäk*	condition

In this section I do not consider the complex series of historical changes which ultimately caused all native Agulis roots to be harmonic.

Vowel harmony in Agulis is not confined to roots, however, as we can see in the alternations undergone by suffixes. Some representative alternations are given in (87).

(87)	suffix	underlying form	surface form	gloss
	-ar	*ton-ar*	*tónar*	houses
	(plural)	*kušt-ar*	*kúštar*	callouses
		diřd-ar	*də´řdar*	dregs
		daʁj-ar	*dáʁjar*	mints
		git-ar	*gʸítär*	rivers
		güg-ar	*gʸü´gʸär*	bosoms
		deʁ-ar	*déʁär*	drugs
		žäng-ar	*žä´ngʸär*	rusts
		öřd-ar	*ö´řdär*	canals
		xuyl-ar	*xúylär*	scirrhi
		hayn-ar	*háynär*	old ones
		deyz-ar	*déyzär*	heaps
		agʸ-ar	*ágʸär*	females
	-avan	*jig-avan*	*jigʸävän*	slightly longer
		karmir-avan	*kərmərävän*	slightly red
		kanančʰ-avan	*kənənčʰavan*	slightly green
	-anucʰ	*muyn-anucʰ*	*muynänücʰ*	first
		čʰurkʰ-anucʰ	*čʰurkʰanucʰ*	fourth
		hing-anucʰ	*həngʸänücʰ*	fifth
	-ac	*sayr-ac*	*sáyräc*	loved
		tʰak-ac	*tʰákac*	mauled
		skʸ-ah-ac	*əskʸä´häc*	dressed
		sur-ac	*səréc*	sharpened
		gir-ac	*gʸəréc*	written
		xm-ac	*xəméc*	drunk

-am	*čar-am*	*čár-am*	means-loc.
	ayc-am	*áycäm*	goat-loc.
	har̃s-anik^h-am	*hər̃sənk^{h}úm*	wedding-loc.
	gir-am	*g^{y}ərü´m*	letter-loc.
-av	*aʁ-av*	*áʁav*	salt-instr.
	ayc-av	*áycäv*	goat-instr.
	har̃s-anik^h-av	*hər̃sənk^{h}óv*	wedding-instr.
	gir-av	*g^{y}ərö´v*	letter-instr.

Harmony interacts with a number of independent rules of Agulis phonology in these forms. In stressed final syllables, *a* becomes *u* before nasals (88a) and *o* elsewhere (88b) except before *ʁ* (88c) and *l* (88d).

(88)	underlying form	surface form	gloss
a.	*žam*	*žum*	hour
	nšan	*nəšún*	sign
	dadastán	*dadastún*	judgement
b.	*sar*	*sor*	mountain
	hrat	*hərót*	advice
	orot-á-l	*ərətól*	thunder (v)
c.	*aʁ*	*aʁ*	salt
	maʁj	*maʁj*	bile
d.	*sal*	*soyl*	anvil
	tal	*toyl*	husband's sister

The underlying forms of the roots in (88) surface when suffixes are added, as we have already seen in (87). In addition, as in Karabagh pretonic vowels delete in a class of roots, as we can see in forms such as *ə̃rətól* (88b), *hər̃sənkʰóv* (87). On the basis of alternations such as *karmir* 'red' ~ *kərmərävän* 'slightly red', we can deduce that harmony applies before pretonic vowel deletion. It is not clear where the changes in (88) undergone by stressed *a* are ordered relative to harmony and vowel deletion. The locative and instrumental singular forms of 'wedding' are problematic, in that they appear to apply deletion before harmony. Another important change involved in (87) is the raising of stressed *a* to *e* in the past participle *-ac*[28]; we know this rule occurs before harmony, because suffixes following *-ec-* are [-back] (e.g. *sur-ac-am* → *sərécäv* 'cut-past ppl.-instr.'). Forms such as *gʸəréc* and *səréc* are somewhat problematic, because the penultimate stress system should produce **gʸíräc*, **súrac*. I assume that high vowels can be specified in the lexicon as non-bracket-projecting, and as a result do not normally receive stress, thereby becoming eligible for high vowel reduction. Assuming for example that the root *sur* contains a non-projecting vowel, we obtain the derivation in (89).

(89)	underlying form	*sur-ac*
1.	palatalization	-----

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[28]I assume that this raising rule is the same we find in the monosyllabic plural suffix *-ar-*, which becomes *-er-* when stressed, e.g. *aʁ* 'salt' : *áʁ-ar* 'salt-pl.' : *aʁ-ér-äv* 'salt-pl.-instr.'.

2.	stress assignment					
a.	x projection	*s*	*u*	*r*	*a*	*c*
			x		x	
b.	bracket projection		x		(x	
c.	edge marking		x		(x)[29]	
d.	heading (L) line 0		x		(x)	
	line 1				x	
e.	edge marking line 0		x		(x)	
	line 1				x)	
f.	heading (R) line 0		x		(x)	
	line 1				x)	
	line 2				x	
3.	raising	*sur-ác* → *sur-éc*				
4.	harmony	-----				
5.	vowel deletion	*sr-éc*				
6.	epenthesis	*səréc*				

[29]Agulis crucially must have RRR edge marking in this analysis, or else we would lose the effects of supposing that high vowels may not project.

Finally, Agulis possesses a number of disharmonic words, primarily consisting of borrowings from the literary language. Some examples are given in (90).

(90)

form	gloss
seʁan	table
gegʸat^h	summit
gʸärunk^h	spring
gʸərezman	tomb
divun	couch

2.5.2. Karchevan

Vowel harmony in Karchevan, an Armenian dialect spoken in the southern finger of Armenia near the Iranian border (Muradyan 1960; a subdialect of Meghri according to the classification in (1)), superficially resembles the Agulis system, but closer examination reveals significant differences of great theoretical interest. Like Agulis and Karabagh, Karchevan is a penultimate stress dialect; words may exceptionally receive final stress, and words containing only schwas receive initial stress. Karchevan has the following inventory of surface vowels:

(91)

i	*ü*	*ə*	*u*
e	*ö*		*o*
ɛ			
ä		*a*	

ε is described as 'a simple vowel pronounced in a position between *ə* and *e*' (Muradyan 1960:15). Muradyan represents this vowel as <*əe*>, but based on his description I assume that this phoneme is [-high, -low, -ATR] *ε*, which has been centralized by virtue of being [-ATR]. The phonetic motivation for this backing and additional reasons for assuming this vowel is [-ATR] are presented in chapter 4. According to Muradyan 1960:73, the ten surface vowels fall into the harmonic classes in (92).

(92)	[+back]	*a*	*o*	*u*	*ε*	*ə*
	[-back]	*ä*	*ö*	*ü*	*e*	*i*

I argue below that the system in (92), based on generalizations concerning the surface distribution of vowels, is better viewed as a product of the phonemic system in (93).

(93)	[-ATR]	*a*	*o*	*u*	{*ε*}	
	[+ATR/-back]	*ä*	*ö*	*ü*	{*e*	*i*}

The system in (93) differs from (92) in several important ways: though *ε* is the counterpart of *e* in terms of [ATR], the two do not contrast in backness; *ə* is not the harmonic counterpart of *i*, nor is it present in the phonemic inventory at all; and {*ε e i*} are placed in brackets. Though in terms of features *e* and *ε* differ only with respect to [ATR], there are in fact no alternations between the two. The only alternations involving *ε* are found in the past participle *-ac-* and the monosyllabic plural *-ar-*, which become *-εc-* and *-εr-* respectively when stressed (94).

(94)	underlying form	surface form	gloss
a.	*as-ac*	*ásac*	say-ppl.
	härb-ac	*hä'rbäc*	drink-ppl.
	xm-ac	*xəmɛ'c*	drink-ppl.
b.	*caŕ-ar*	*cáŕar*	trees
	äc-ar	*ä'cär*	goats
	cäc-ar	*cəcɛ'r*	breasts

I believe the rule in (94) to be related to the Agulis raising rule discussed in 2.5.1; the alternations in (94) should therefore not be viewed as harmonic alternations. For this reason I have represented *ɛ* in (93) as a neutral (opaque) [+back] vowel.

Schwa behaves in basically the same manner as in the other dialects we have examined thus far: it arises solely from epenthesis, does not bear stress except in words containing only schwas, and generally does not play a role in the harmonic system. The Karchevan schwa crucially differs from that found in other dialects, however, in undergoing harmonic alternations with {*i u ü*} under certain conditions to be discussed below. The non-low front vowels *e* and *i* are placed in brackets because they sometimes behave as [-back], and otherwise do not, under conditions discussed below.

Before considering the problems involving {*ɛ e i*}, let us quickly survey the basic working of Karchevan harmony. As in Agulis, harmony applies to all word elements, so that roots and suffixes share a single value for [back], with the exception of neutral vowels. The one productive prefix containing a full vowel, *an-* 'un-', does not undergo harmonic alternations. This could be because harmony applies from left to right, or because the prefix is non-harmonic (cf. (96b)). As in Agulis, the workings of harmony on roots can only be seen by comparison with non-harmonic dialects (95a); *i* and *e* freely occur in both [+back] and [-back] roots (95b). Harmony applies to some suffixes (96a), but not others (96b); *i* and *e* take [+back] suffixes (96c).

(95)	standard Armenian	Karchevan	gloss
a.	*lezu*	*lü'zü*	tongue
	amaṙn	*ámaṙnə*	summer
	čʰoban	*čʰobán*	shepherd
	čʰamičʰ	*čʰímičʰ*	raisin
	aveluk	*üvü'lük*	dock
b.	*hilevur*	*hilévur*	old
	šalak	*šélak*	back
	šabatʰ	*šébätʰ*	sabbath
	aʁves	*áʁvest*	fox
	-----[30]	*širä'čʰepʰ*	measure of wine
	agah	*akahí*	greedy
	aʁavni	*ʁúni*	pigeon
	gerezman	*girízman*	tomb
	gih(uk)	*gihók*	herd of sheep

---

[30]This word derives from Persian *šīra* 'sweet wine' + Armenian *čʰapʰ* 'measure'. I have found no examples of *e* preceded by a front vowel other than *i* and *e* within a root.

(96)	suffix	underlying form	surface form	gloss
a.	*-ar-*	*caṙ-ar*	*cáṙar*	trees
		muc-ar	*múcar*	big ones
		onk^h-ar	*ónk^{h}ar*	eyebrows
		dɛzn	*dɛ´znar*	wild mints
		ton-ar	*tənár*	houses
		äc-ar	*ä´cär*	goats
		g^{y}ül-ar	*g^{y}ü´lär*	wolves
		g^{y}öṙn-ar	*g^{y}öṙnär*	sheep-pl.
		mat^{h}k^{hy}-ar	*mat^{h}k^{hy}är*	minds[31]
	-u-	*anguz-u*	*angúzu*	walnut-dat.
		bün-u	*bü´nü*	nest-dat.
		anguč-u	*əngəčú*	ear-dat.
		sar-u	*sáru*	mountain-dat.
		cɛt-u	*cətú*	sparrow-dat.
		k^{y}ä´c^{h}in	*k^{y}ä´c^{h}nü*	axe-dat.
	-(n)or-	*anguz-nor-u*	*anguznóru*	walnut-pl.-dat.
		aṙǰ-or-u	*aṙǰóru*	bear-pl.-dat.
		bün-or-u	*bünö´rü*	nest-pl.-dat.
b.	*-ná-*	*klox-ná*	*kəloxná*	head-pl.
		büžüž-ná	*büžüžná*	little bell-pl.
		šebät^h-ná	*šebät^{h}ná*	sabbath-pl.

[31]Palatalized consonants regularly spread [-back] to immediately following harmonic vowels; when a consonant intervenes spreading does not occur, e.g. *aʁink^{hy}-nor-u* 'bowel-pl.-dat.').

c.	*izn-ar*	*íznar*	oxen
	beřn-ar	*béřnar*	burdens
	č^{h}imič^{h}-nor-u	*č^{h}imič^{h}nóru*	raisin-pl.-dat.

It is difficult to determine whether *i*, *e*, and *ε* are transparent or opaque. The optimal test case is roots ending in a sequence of harmonic vowel-neutral vowel followed by a harmonic suffix: transparent neutral vowels should allow the harmonic feature of the preceding vowel to spread to the following vowel, whereas opaque neutral vowels should not. Some pertinent examples are given in (97).

(97)	underlying form	surface form	gloss
a.	*parikam*	*paríkam*	friend
	aprišum	*aprísum*	silk
	dabbet^{h}ka	*dabbét^{h}ka*	type of chair
	ap^{h}ic^{h}eř-u	*ap^{h}ic^{h}éřu*	soldier-dat.
b.	*birgädir-u-n*	*birgädírun*	together-dat.-def.
	Säg^{y}in-av	*Säg^{y}inav*	Sargis (personal name)-instr.

The forms in (97a) do not actually allow us to determine whether the neutral vowels are transparent or opaque, because the suffixes could be receiving their [+back] specifications from the [+back] vowel preceding the neutral vowel, or by default (cf. (96a,c)). The forms in (97b) are more helpful: the [+back] value of the suffixes clearly cannot have spread from the [-back] root vowel preceding the neutral vowel. The second form in (97b) is problematic, because the instrumental ending *-av*, despite showing alternations in forms such as *aʁink^{h}y-äv* 'bowel-instr.', *näštäv* 'hungry' (derived from an instrumental *näšt-äv*), does not always alternate--cf. *k^{y}äc^{h}in-av* 'axe-instr.' → [*k^{y}äc^{h}nav*], *p^{h}länk^{h}äs-av* 'someone-instr.'. The first form in (97b) more convincingly indicates that neutral vowels (at least *i*) are opaque rather than transparent.

Let us now consider the behavior of the neutral vowels *i* and *e* in more detail (leaving out *ε*, whose distribution is severely restricted in the language). These vowels show three different behaviors:

(98)

a. can be preceded or followed by front or back vowels within roots

b. followed by back or neutral suffixes

c. spread [-back] to epenthetic vowel

The facts in (98a) follow naturally if we assume that Karchevan harmony spreads contrastive [back] values iteratively from left to right within a word, and that all vowels are fully specified underlyingly. Given the system in (93), the only [back] contrasts are *a : ä*, *o : ö*, and *u : ü*; *e* and *ε* contrast for [ATR] but are both [-back], and *i* has no [+back] counterpart. As in Agulis, the marking statement *[+back, -round]/_[-low] is active, and blocks spreading of [+back] from {*a o u*} to neutral vowels. I further assume that roots draw from the full vocalic inventory in (93), whereas suffixes contain only the cardinal vowels {*a e i o u*} in their underlying representations (similar facts are found in Chumash and other languages; cf. Steriade 1993). This being the case, we can account for the fact that both [+back] and [-back] harmonic vowels can follow neutral vowels root-internally, whereas only cardinal vowels can occur in suffixes after roots ending in one or more neutral vowels. The insight here is that *i* and *e* do not spread [+back] to suffixes such as the plural (as Grigoryan 1957 claimed for Meghri, the mother dialect of Karchevan) but rather do not spread any back value, enabling suffixes to surface in their underlying form. Note how this differs from Agulis harmony, which spreads all [back] values and consequently allows only [-back] vowels to surface after neutral vowels.

We also want to be able to say that *i* and *e* are [-back] in order to account for the harmonic alternations undergone by the epenthetic vowel, as demonstrated by the noun + definite article alternations in (99).

(99)	underlying form	surface form	gloss
a.	*hak^h-n*	*hák^{h}ə*	foot-def.
b.	*värd-n*	*vä'rdi*	rose-def.
	beh-n	*béhi*	spade-def.
	knag^y-n	*kənág^{y}i*	woman-def.
c.	*mürǰüm-n*	*mürǰü'mü*	ant-def.

Muradyan 1960:103 states that the definite article has the allomorphs {*ə i ü*}, each of which may be followed by *n* when preceding a vowel-initial clitic. I assume that as in standard Armenian these alternations result from the addition of a clitic definite article *-n-*, which always triggers epenthesis and then deletes when not followed by a vowel. Karchevan differs from standard Armenian and resembles Turkish in applying two harmonic processes to this vowel, one which spreads [back] and another which spreads [round]. According to Muradyan 1960:103, the definite article surfaces as *ə* after back vowels, *i* after non-round front vowels and roots ending in palatalized consonants or {*ž š č ǰ č^h*} (i.e. [-anterior] coronals), and *ü* after roots having *ü* as their last vowel. Though Muradyan does not give examples of the definite article with roots ending in *ö*, we can tell from forms such as *böjr* → [*bö'jür*] 'high' that *ö* also spreads [+round] to the epenthetic vowel.

The appearance of *ə* after back vowels (99a) is not surprising. The appearance of *i* after neutral vowels (99b, 100b) is somewhat unexpected, however, since if the harmony process affecting the epenthetic vowel were the same as that affecting full vowels, we would not expect neutral vowels to spread [-back]. The harmonic process in (99) must therefore be different from the one in (96). This assumption is further justified by the fact that the harmony rule in (96) applies before epenthesis, whereas the one in (99) applies after epenthesis. This being the case, it is a simple matter to state that the post-epenthesis harmony rule spreads all [back] values[32], and the vowels *i* and *e* therefore freely spread [-back].

The rounding rule, on the other hand, must spread only marked [round]. Since [round] is only marked in [-back] vowels, *o* and *u* are not expected to be triggers. The alternations in the ordinal suffix *-mnǰi* in (100c) confirm that *o* and *u* do not spread rounding.

(100)	underlying form	surface form	gloss
a.	*č^hok^h-mnǰi*	*č^həkʰmənǰi*	fourth
	hangʸ-mnǰi	*hangʸmənǰi*	fifth
	tasn-mnǰi	*təsəmənǰi*	tenth

---

[32]One must stipulate a correlation between {coronal, [-anterior]} and {dorsal, [-back]} in order to account for the behavior of palatals, as has already been discussed in chapter 1. I return to this issue in chapter 4.

b.	*irik^h-mnǰi*	*irik^{hy}-minǰi*	third
	vic^h-mnǰi	*vic^{h}minǰi*	sixth
	innn-mnǰi	*innəminǰi*	ninth
c.	*yorku-mnǰi*	*yorkuməmǰi*	second
	yoxtn-mnǰi	*yoxtəmənǰi*	seventh
	ot^{h}t^{h}n-mnǰi	*ot^{h}t^{h}əmənǰi*	eighth

The forms 'fourth' and 'tenth' demonstrate that [back] spreading does not apply from right to left. If [back] spreading did apply from right to left, we would expect the final *-i* of the ordinal suffix to spread its [-back] vowel to the preceding schwas, which is not the case.

To summarize the above discussion, I propose that Karchevan harmony involves the rules in (101).

(101) a. deletion

b. harmony 1 spread contrastive [back] iteratively L → R

c. epenthesis

d. harmony 2 spread all [back] L → R

e. harmony 3 spread marked [round] L → R

The deletion rule in (101a) closely resembles the one discussed above for Agulis: certain vowels are lexically specified as unable to project brackets, and subsequently undergo unstressed vowel deletion. Unlike in Agulis, Karchevan deletion must occur before harmony in order to account for alternations of the type found in (102).

(102)	underlying form	surface form	gloss
a.	*kä´c*^{h}*in-u*	*k*^{y}*ä´c*^{h}*nü*	axe-dat.
b.	*särt*	*sərtú*	heart-dat.

In (102a), [-back] spreads from the *ä* of the root to the dative suffix *-u-*. If the root *i* were still present at the time harmony applied, we would expect it to block this spreading, and the suffix to surface as *-u*. Similarly in (102b), if harmony applied before deletion we should expect **sərtü*. Given the scheme in (101), harmony should apply to the intermediate form **srt-u*; since the root contains no contrastive [back] specifications, the suffix surfaces in its underlying form.

In my analysis the harmony rules which affect the epenthetic vowel are not crucially ordered relative to each other. I assume that both are feature-filling and therefore apply to the epenthetic vowel, which is only prespecified for the feature [+high] (as in Turkish), but do not affect full vowels.

3
Syllabification

One of the first problems confronted by students of Armenian is the discrepancy between the orthography, which contains consonant clusters of as many as ten members, and the pronunciation, which contains any number of schwas, almost none of which are reflected in the orthography. A typical example is the word for 'brilliant', which is spelled *<plst^{h}rplst^{h}r>* but pronounced [*pə.ləs.t^{h}ər.pə.ləs.t^{h}ər*]. One immediately wonders whether the orthography directly represents underlying lexical representations which are subsequently altered by rules of epenthesis, or alternately that the schwas present in surface pronunciations are already present in underlying representations, and the orthography is under-determined. If schwas are present in underlying representations we expect them to show the same distribution as other vowels in the Armenian inventory, and to defy attempts to predict their occurrence from principles of epenthesis. Conversely, if schwas are not present in underlying representations we expect their occurrences to be predictable from underlying representations by simple and universal principles. I argue in this chapter that the latter hypothesis is correct, and demonstrate that a modified version of the syllabification algorithm postulated as a component of Universal Grammar by Dell and Elmedlaoui 1985 accounts for the occurrence of Armenian schwas in a principled and elegant manner.

The model of syllabification I propose for Armenian in this chapter, which I assume to be an integral component of Universal Grammar, basically consists of the model proposed by Dell and Elmedlaoui 1985 with the following modifications: syllabification consists of cyclic and post-cyclic components (cf. Steriade 1982, Rubach 1990); codas are assigned during each sonority pass, rather than at the end of the derivation; morpheme-final consonants are not syllabified within their cycle (cf. Borowsky 1986, Itô 1986, Kenstowicz 1994); [+consonantal] segments are expelled from syllable nuclei by [-consonantal] root nodes at the end of each cycle; morphemes divide into two classes with respect to syllabification-- those that allow minimal resyllabification, and those that do not; and other phonological rules may occur between the cyclic and post-cyclic levels of syllabification. The general structure I propose for Armenian syllabification is summarized in (1).

(1)

a. ATTACHMENT (R → L)

(i) assign X to a syllable nucleus (X = unsyllabified segment of a given sonority)

(ii) attach an immediately preceding segmental sequence as an onset

(iii) attach an immediately following segmental sequence as a coda or appendix

b. EPENTHESIS

(iv) place a [-cons] root node to the right or left of nuclear [+cons] segments, according to the following principles:

•to the left in open syllable with onset or closed syllable with stop coda

•elsewhere to the right

c. DESYLLABIFICATION

(v) desyllabify syllables containing a [+cons] nucleus

Each of the steps in (1) is subject to universal as well as language-specific constraints; I consider the former in section 3.1 and the latter in section 3.2. In section 3.3 I then summarize the results of this paper, and in section 3.4 I provide a list of the forms employed in constructing the analysis presented in this chapter.

Before beginning, I illustrate the basic workings of the algorithm in (1) as they apply to the word *bldrʁan* 'heracleum villosum' [*bəl.dər.ʁan*][1].

(2)

underlying form	*b*	*l*	*d*	*r*	*ʁ*	*a*	*n*
CYCLIC SYLLABIFICATION	*b*	*l*	*d*	*r*	*ʁ*	*a*	*<n>*[2]

low vowels

(i)	*b*	*l*	*d*	*r*	*ʁ*	*a*	*<n>*
(ii)	*b*	*l*	*d*	*r*	*ʁ*	*a*	*<n>*
(iii)	--						

high vowels --

liquids

(i)	*b*	*l*	*d*	*r*	*ʁ*	*a*	*<n>*
(ii)	*b*	*l*	*d*	*r*	*ʁ*	*a*	*<n>*
(iii)	--						
(i)	*b*	*l*	*d*	*r*	*ʁ*	*a*	*<n>*
(ii)	*b*	*l*	*d*	*r*	*ʁ*	*a*	*<n>*
(iii)	--						

---

[1]I employ the following notation: | = nucleus; = onset + nucleus; = onset + coda.

[2]The brackets represent the fact that morpheme-final consonants are not syllabified in the cycle; cf. Borowsky 1986, Itô 1986, and discussion below.

nasals --
fricatives --
stops --

(iv) *b* □ *l* *d* □ *r* *ʁ* *a* <*n*>

(v) *b* □ *l* *d* □ *r* *ʁ* *a* <*n*>

ATTACHMENT REPEATS AFTER (V)
non-high vowels

(i) *b* □ *l* *d* □ *r* *ʁ* *a* <*n*>

(ii) *b* □ *l* *d* □ *r* *ʁ* *a* <*n*>

(iii) *b* □ *l* *d* □ *r* *ʁ* *a* <*n*>

(i) *b* □ *l* *d* □ *r* *ʁ* *a* <*n*>

(ii) *b* □ *l* *d* □ *r* *ʁ* *a* <*n*>

(iii) *b* □ *l* *d* □ *r* *ʁ* *a* <*n*>

high vowels --
liquids --
nasals --
fricatives --
stops --

POST-CYCLIC SYLLABIFICATION
coda incorporation

b □ *l* *d* □ *r* *ʁ* *a* *n*

melody

b ə l d ə r ʁ a n

The steps involved in (2) are discussed in the next section.

3.1. Basic elements of syllabification

3.1.1. Epenthesis versus deletion

In order to develop a satisfactory analysis of Armenian syllabification, we must first decide whether the schwas occurring in surface forms are present in underlying representations or produced by epenthesis. If we assume that they are present in underlying representations, we encounter several problems. First of all, we must explain why Armenians generally do not employ schwas when spelling consonant clusters, even though they do possess a schwa grapheme which is used under certain conditions (which I argue later in this chapter normally correspond to the positions where schwas are not predictable from underlying consonant clusters). One assumes that they do not employ schwas when they feel their occurrence is predictable from the context. This is supported by the fact that native Armenian speakers pronounce consonant clusters they have never seen before in an entirely predictable manner. During the course of my work on Armenian syllabification, I presented one of my informants, a lifetime resident of Erevan, with a list of words taken from Malχasyanc^{h} 1944, each of which contained long consonant clusters with no visible schwas. My informant recognized less than twenty percent of the words (many of which are archaic or dialectal), yet pronounced each in the manner prescribed by

Malχasyanc^h with seven exceptions[3]. A theory which assumes underlying schwas is unable to account for this striking fact. The Armenian pronunciation of loanwords is also problematic for this theory, which is unable to explain for example why Russian *traktor* 'tractor' is pronounced [*tə.rak.toɽ*].

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[3]Out of approximately 100 words tested, my informant (I) differed from Malχasyanc^h (M) with respect to the following words:

orthography	underlying form	surface form	gloss
slkvel	*sl-k-u-e-l*	I *səlkvel*	slip
		M *səlkəvel*	
slχkvel	*sl-χ-k-u-e-l*	I *sələχkvel*	slip
		M *sələχkəvel*	
sləpzt	*slpzt*	I *səlpəzt*	suddenly
		M *sələpəzt*	
brštkel	*maršt-k-e-l*	I *bərəštkel*	waft (of smells)
		M *bərəštəkel*	
gṙštkal	*gṙšt-k-a-l*	I *gəṙəštkal*	burp
		M *gəṙəštəkal*	
hrmštkel	*hrmšt-k-e-l*	I *hərməštkel*	push
		M *hərməštəkel*	
bzktel	*bzik-t-e-l*	I *bəskətel*	pluck
		M *bəzəktel*	

I discuss these discrepancies in section 3.2.7.

If schwas are phonemic, we should also expect them to occur anywhere full vowels do, and their occurrence should not be predictable from context. I demonstrated above that native speakers are able to predict the proper placement of schwas when given an unfamiliar string of consonants. The converse is also true: given a surface form containing schwas, we can account for their placement with an ordered set of rules of the structure given in (1). Thus, a form such as *ləmənc^hənem* 'I complete' is derivable by (1) from an underlying form *lmn-c^h-n-e-m*. A theory which postulates underlying schwas, on the other hand, cannot explain why surface forms such as **ələmənəc^hənem* and **ləmnəc^hnem* are not also possible.

A third problem with assuming that surface schwas are present in underlying representations is that we would be forced to postulate a number of rules deleting schwas in various contexts. Consider the following alternations (morpheme boundaries indicated by a dash).

(3)

a.	*vagər* 'tiger'	:	*vagr-er* 'tigers'
b.	*p^hər-c^hə-n-e-l* 'break'	:	*χos-e-c^h-n-e-l* 'make talk'
c.	*arev-ən* 'the sun'	:	*arev-n e* 'it is the sun'
d.	*sət-e-l* 'lie'	:	*sut* 'false'

In (3a-c), we see schwa alternating with zero; in (3d), schwa alternates with a full vowel. One might suggest on the basis of (3a,c) that schwa is deleted in open syllables; numerous counterexamples exist to this generalization, however, including the forms *p^hərc^hənel* (3b) and *sətel* (3d). One could account for forms such as *dəṙam* by stipulating that schwas do not delete when deletion would create a syllable structure violation, but this cannot account for forms like *pʰərcʰənel* and *pətətil* 'walk', where deletion would produce acceptable surface forms **pʰərcʰnel* and **pəttil*.

The underlying schwa theory also has difficulty accounting for the behavior of unstressed high vowel reduction, which sometimes leaves a schwa in place of the deleted vowel (4a), sometimes deletes the vowel entirely (4b), and sometimes deletes the vowel and leaves a schwa in another position (4c).

(4)	unreduced form	gloss	reduced form	gloss
a.	*gir*	letter	*gərel*	write
	kʰərkʰij	itch (n)	*kʰərkʰəjal*	itch (v)
b.	*karmir*	red	*karmranal*	blush
c.	*bəzik*	rip (n)	*bəskətel*	rend

The most likely analysis of the facts in (4) would state that high vowels reduce to schwa in unstressed syllables and subsequently undergo any changes targeting regular schwas. This analysis suffers the same problem of formulating the conditions under which schwas delete as we discussed above; furthermore, it cannot account for cases of type (4c), where a schwa occurs in an unexpected position (the underlying form of the suffix following *bəzik* is *-t-*).

Another problem that the deletion analysis must face is posed by alternations of the type in (5).

(5)	singular	definite	gloss
a.	*hat*	*hat-ən*	piece
b.	*təʁa*	*təʁa-n*	boy

A deletion analysis must postulate an underlying form */-ən/* for the definite article and a rule which deletes schwa after a vowel. This rule is contradicted by forms such as *amena-əntir* 'most choice'. In my model, on the other hand, the difference between *amena-əntir* and (5b) is expected: the underlying form of the definite article is *-n*, which triggers epenthesis after a consonant, whereas *əntir* begins with an empty vocalic root node, which like all non-high vowels is allowed to enter into hiatus configurations with low vowels (cf. *kaos* 'chaos').

The systems of plural and genitive formation in the Mush dialect (Baʁdasaryan-T^{h}ap^{h}alc^{h}yan 1958:19-20) present a problem for the underlying schwa hypothesis similar to the one in (4). Mush employs the same syllabification procedures as standard Armenian, but possesses an additional rule which deletes unstressed *-a-* in final stem syllables. This reduction process produces the alternations in (6)[4].

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[4]The mid vowel *e* becomes the diphthong *ie* in stressed syllables; hence, the standard Armenian plural *-ner* corresponds to Mush *-nier*.

(6)

	singular	plural	gloss
a.	*šapʰatʰ*	*šapʰtʰənier*	week
	šalag	*šalgənier*	back
	kʰaʁakʰ	*kʰaχkʰənier*	city
	karas	*karsənier*	pot
	korəngan	*korəngnier*	oregano
	tavar	*tavərnier*	bull
	taχtag	*taχtəgnier*	board
	padankʰ	*padənkʰnier*	shroud
	yergatʰ	*yergətʰnier*	iron
	šaran	*šarnier*	series

	nominative	genitive	gloss
b.	*dʰanag*	*dʰangi*	knife
	hivand	*hivəndi*	sick
	ɦangaǰ	*ɦangəǰi*	ear
	čermag	*čermәgi*	white
	gʰakʰatʰ	*gʰakʰtʰi*	peak
	kakʰav	*kakʰvu*	partridge
	məšag	*məšku*	farmer
	bʰeran	*bʰerni*	mouth
	agrad	*agərdi*	light snack
	ačʰaṙ	*ačʰṙu*	favor
	paṙav	*paṙvu*	old woman
	čagad	*čagdu*	forehead

The forms in (6) show basically the same distribution as in (4): some *a*'s disappear altogether (*šarnier*, *d^h^angi*), some are replaced by a schwa in their former position (*yergət^h^nier*, *hivəndi*), and some are replaced by a schwa in a different location (*karsənier*, *agərdi*). We can see in the last two forms that the unexpected schwa does not even consistently occur in the same location: in *karsənier* it occurs in the syllable following the deleted -*a*-, and in *agərdi* it occurs in the preceding syllable. If we assume that the *a*-reduction rule actually deletes the vowel completely, on the other hand, the rules of syllabification given in (1) will in fact produce exactly the forms in (6).

Finally, a theory which postulates underlying schwas cannot capture dialectal differences in schwa placement. In SWA, for example, initial orthographic sibilant + stop clusters are pronounced with a preceding schwa, whereas in SEA they are not.

(7)	spelling	SWA	SEA	gloss
	spitak	*əspidag*	*spitak*	white
	stanal	*əstanal*	*stanal*	receive
	zgal	*əskal*	*zgal*	feel
	štapel	*əštapel*	*štapel*	hurry

The underlying schwa analysis must stipulate that SWA has systematically changed the underlying representations of all words beginning with sibilant + stop clusters, which essentially is no different from supposing an epenthesis rule applied at some point in the history of SWA. The same reasoning is true for systematic contrasts between standard Armenian and a number of eastern dialects in the treatment of final *n*.

(8)	SEA	Karabagh	gloss
	jukən	*cüknə*	the fish
	mukən	*moknə*	the mouse

By assuming that there is in fact an epenthesis rule which is still active in Armenian with minor differences from dialect to dialect (e.g. SEA allows ST onsets and Karabagh allows epenthesis at word margins), we explain not only the data in (7) and (8) but a wealth of other facts as well.

I conclude from the various factors discussed in this section that it is better to assume that Armenian does not in fact possess a schwa in its phonemic inventory, and that all schwas which appear in surface representations result from a process of epenthesis triggered by syllabification. It must be noted that my usage of the term 'epenthesis' differs somewhat from the conventional usage. In both interpretations epenthesis is employed to repair violations of syllabic constraints; in my system, however, the relevant constraint involves licensing of consonantal nuclei at a certain point in the derivation, whereas the conventional usage invokes epenthesis to repair violations of a constraint disallowing unsyllabified consonants. In the rest of this chapter I present the mechanisms of syllabification and epenthesis necessary to produce the attested surface forms.

3.1.2. The sonority hierarchy

The attachment procedure in (1) assigns segments to syllables in a series of passes based on sonority: the most sonorous segments are scanned first, and the least sonorous are scanned last. Each pass of syllable assignment is able to assign to nuclei segments of a given level of sonority. The sonority scale in (9) on which this analysis is based is taken from Dell and Elmedlaoui 1985, on the assumption that the model of syllabification they propose is a component of UG, undergoing only minimal modifications on a language-particular basis. In the case of Armenian there is one minor difference from the Berber hierarchy: voicing values are not distinguished (Berber distinguishes voiced stops from voiceless stops, for example).

(9) non-high vowels
high vowels
liquids
nasals
fricatives
stops

In this section I consider what evidence is provided by Armenian for the various subdivisions of the sonority hierarchy in (9).

3.1.2.1. Vowels

The non-high vowels {*a e o*} never undergo syllabic alternations in Armenian, suggesting that they are the most sonorous Armenian phonemes. The status of *e* is less clear than that of the other two non-high vowels, however. SWA orthography contains many *e*'s which are pronounced as *y*, for example in the genitive singular of the abstract noun suffix *-ut^h^iun*, which is written <*ut^h^ean*> but pronounced [*ut^h^yan*]. If the orthography indeed reflects phonemic *e*'s in these cases, then we have evidence that low vowels are more sonorous than mid vowels. However, I know of no cases where *e* actually alternates with *y* in paradigms, and since there is no evidence for *o* ever occupying a syllable margin, I have taken the conservative position that alternations such as we find in the abstract suffix involve an underlying *i* phoneme.

The situation with the high vowels is more complicated. The fact that high vowels always become glides adjacent to non-high vowels (e.g. *ail* 'other' [*ayl*], *eu* 'and' [*yev*], *goin* 'color' [*guyn*]) indicates that high vowels are less sonorous than non-high vowels, but some of the particulars of this relationship are difficult to establish. For example, we know that *eu* involves an underlying *u* rather than a *v* because of the unstressed alternant *u* which occurs between conjoined nouns, but we cannot be sure that *goyn* involves an underlying *o* as the orthography suggests or rather an underlying *u*. Conjunction of *o* and *i* at a morpheme boundary results in hiatus (*Maro-i* 'Maro's', *matani-ov* 'ring-instr.'), so we cannot produce any alternations which might settle the question.

3.1.2.2. Consonants

Evidence for sonority distinctions among consonants comes from two sources: inventories of allowed onsets and codas, and the behavior of peak assignment. The onset and coda evidence is significantly simpler to gather and evaluate, so I will concentrate on it here.

Phonologists commonly assume that licit onsets and codas cross-linguistically are subject to the Sonority Sequencing Principle (SSP), which states that onsets must be of rising sonority and codas must be of falling sonority. Assuming that Armenian obeys the SSP, which I believe to be true[5], we can use the inventory of onsets and codas allowed in the language as a diagnostic for sonority distinctions, since syllable margins are not allowed to have consecutive elements of equal sonority. By this measure, we can establish the sonority distinctions in (10).

(10)

a. liquids are more sonorous than nasals (*ǰerm* 'warm', *buṙn* 'fist')
b. liquids are more sonorous than fricatives (*hars* 'bride')
c. liquids are more sonorous than stops (*lirb* 'insolent')
d. nasals are more sonorous than stops (*gund* 'sphere')
e. fricatives are more sonorous than stops (*mišt* 'always')

The one distinction in sonority that we cannot establish on the basis of licit codas is nasal vs. fricative, since codas of this type are not attested (except in unassimilated borrowings such as *ṙevanš* and in cases where the fricative is an appendix such as *toms* 'ticket'). There is evidence that nasals are more sonorous than fricatives in the behavior of sibilant + consonant sequences, however. Underlying sibilant + stop + vowel sequences surface with an epenthetic vowel before the sibilant in SWA and without an epenthetic vowel in SEA, as in *st-a-na-l* 'receive' [(*ə*)*stanal*], whereas sibilant + liquid or nasal sequences epenthesize between the two segments in both dialects, as in *slak^h* 'arrow' [*səlak^h*], *šnorh* 'grace' [*šənor*]. I believe that this difference

[5]The one possible exception is the sibilant + non-sibilant fricative coda type discussed in section 3.1.5. One could say either that the second element of these clusters belongs to an appendix, or that sibilants are more sonorous than other fricatives.

in syllabification results from the sonority relationships involved: sibilants are more sonorous than stops but less sonorous than liquids and nasals. If this analysis is correct, we can deduce that nasals are in fact more sonorous than fricatives.

Since we have already established that Armenian distinguishes the full complement of sonority levels proposed in (1) and there is evidence for this hierarchy outside of Armenian, there is no need to search for further confirmation in the behavior of peak assignment. Nevertheless, for the sake of completeness I present a few examples here. Consider the word *spltr-ik* 'feeble' [*sə.pəlt.rik*]. If stops were more sonorous than liquids, we would expect the syllabification **sP.lT.rik*[6], which would yield the surface form [*səplətrik*]. Thus, we can assume that liquids are in fact more sonorous than stops. Now consider the word *slnbun* 'slippery' [*sələmbun*]. If fricatives were more sonorous than liquids, we would expect the syllabification **Sl.N.bUn*, which would give *[*səlnəbun*]. So far, then, we have the hierarchy liquid >> {fricative, stop}. Now consider the word *plst^{h}r-plst^{h}r* 'brilliant' [*pə.ləs.t^{h}ər.pə.ləs.t^{h}ər*]. If stops were more sonorous than fricatives, we would expect the syllabification **pL.sT^{h}r.pL.sT^{h}r*, which would give *[*pəl.sə.t^{h}ər.pəl.sə.t^{h}ər*]. We can thus assume that fricatives are more sonorous than stops, which gives us the hierarchy liquid >> fricative >> stop. One could probably find words that would confirm the rest of the sonority hierarchy, but I will not do so here since my original proposal is clearly on the right track.

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[6]Throughout this chapter capital letters in representations denote syllabic peaks.

It should be noted that I have not distinguished voicing within obstruents, so that whereas in the Dell and Elmedlaoui model voiced fricatives are more sonorous than voiceless fricatives and voiced stops are more sonorous than voiceless stops, in my model all fricatives are considered to be of equal sonority and the same is true for stops. To the best of my knowledge there are no forms in Armenian which would allow us to distinguish the two possibilities, so I have opted for the more conservative position.

3.1.3. Nuclei

The heart of the syllabification procedure proposed in this chapter is the assignment of syllable nuclei in a series of passes according to the sonority hierarchy just discussed. By building the model of syllabification around this process, I intend to capture the cross-linguistic generalization that syllables center on peaks of sonority, and the fact that Armenian epenthetic schwas always appear adjacent to these sonority peaks. In the model of syllabification and epenthesis I propose here, the placement of schwas is controlled by procedure (iv) in (1), which places [-cons] root nodes adjacent to [+cons] nuclei. This procedure accounts for the placement of epenthetic schwas in an elegant way: epenthetic vowels are predicted to occur only adjacent to original syllable nuclei, whereas competing models which do not syllabify consonants as nuclei have difficulty explaining why a form such as *prngt-a-l* 'sneeze (v)' is pronounced [*pʰə.ṙəŋg.tal*] rather than *[*pʰəṙ.nəg.tal*]. In my model this outcome makes sense, because the epenthetic schwas are both adjacent to the underlying nucleus *ṙ*.

Nevertheless, given that all surface syllables must have vocalic nuclei, one might ask why I am supposing that consonants can be assigned to syllable nuclei at an earlier stage of the derivation. Consider a word such as *glnt*^{h}*or* 'fat', which surfaces as [*gə.lən.t*^{h}*or*]. In my model, this word is initially parsed as *gLn.t*^{h}*O*<*r*>, where capital letters denote syllable peaks and brackets enclose unparsed material. The epenthesis procedure in (1.iv-v) subsequently produces *gl□nt*^{h}*o*<*r*>, where □ represents an empty [-cons] root node; the cyclic pass which scans for voiced stops produces *G.l□n.t*^{h}*o*<*r*>, which becomes *g□.l□n.t*^{h}*o*<*r*> after epenthesis. Post-cyclic syllabification followed by melodic specification of empty vowel positions then gives the correct surface form *gə.lən.t*^{h}*or*. Notice that both epenthetic schwas occur directly adjacent to the original nucleus *L*, and we do not get the perfectly possible surface form **gəl.nə.t*^{h}*or*.

Let us consider briefly how such a word might be parsed in other models of syllabification. I discuss here two prevalent models, a traditional rule-driven approach (Kenstowicz 1994:270, based on Kahn 1976) and a templatic approach (Itô 1986, Dell and Tangi 1993). The rule-driven approach mentioned by Kenstowicz first assigns vowels as syllable nuclei then attaches eligible preceding consonants as onsets, and finally attaches eligible following consonants as codas. Such a model would produce an initial parse <*gln*>*t*^{h}*or* for the form under discussion. The unparsed consonants would then be syllabified with the assistance of an epenthesis rule of the form Ø → *ə* /_<C>, in other words 'insert a schwa before an unsyllabified consonant.' If this rule applied iteratively from right to left, we would first obtain <*glən*>*t*^{h}*or*, which would then syllabify as <*g*>*lən.t*^{h}*or*. A second iteration of the epenthesis rule would then produce **əg.lən.t*^{h}*or*, unless we subjected the procedure to additional constraints (for example one prohibiting epenthesis at word boundaries) and added a right-epenthesis rule. This procedure fails to account for forms such as *k*^{h}*rt*^{h}*munɟal* 'complain', which surfaces as [*kʰərtʰ.mən.ǰal*]. The procedure just described should produce an initial parse *<kʰrtʰ>mUn.ǰAl*; the epenthesis rule would then produce the incorrect forms *[*kʰə.rətʰ.mən.ǰal*] or *[*əkʰ.rətʰ.mən.ǰal*].

Alternately we could formulate an epenthesis rule of the form Ø → ə /<C>_, which would insert a schwa to the right of an unparsed consonant and apply from left to right. This rule would produce **gəl.nə.tʰor*, unless we added a look-ahead constraint which could block coda assignment to a consonant that could serve as an onset for a following consonant (cf. Kenstowicz 1994:272). The theory of phonology I am espousing in this thesis holds that look-ahead rules do not exist, though, so this analysis is untenable. In addition the look-ahead approach crucially requires the consideration of consonantal nuclei in order to derive the correct outcome for *glntʰor*; by making this concession, however, the look-ahead analysis concedes the main point of my analysis.

The template approach supported by Itô 1986 and Dell and Tangi 1993 would also start from the initial parse *<gln>tʰor*. At this point Dell and Tangi's procedure groups unparsed consonants into pairs from right to left, which in this case yields *(g)(ln)tʰor*; these groupings are matched to CVC templates, giving **əg.lən.tʰor* (Dell and Tangi actually assume that unary constituents at word boundaries attach to an adjacent syllable without epenthesis, but in the case of Armenian this would also produce an unacceptable form, **glən.tʰor*). Altering the procedure to apply from left to right would produce the incorrect form **gəl.nə.tʰor*.

In summary, traditional theories of syllabification and epenthesis which do not allow consonantal nuclei fail to account for the Armenian facts in a satisfactory manner. Such approaches could be improved by allowing consonantal nuclei, but this concession would entail the addition of rules which would in effect mimic the procedure outlined in (1).

The concepts of nucleus assignment to consonants and epenthesis of consonantal nuclei are not new or unprecedented. We know, for example, that languages such as English, German (Rubach 1990), and Bella Coola (Bagemihl 1991) allow sonorant consonants to serve as syllable nuclei, and languages such as Imdlawn Tashlhiyt Berber (Dell and Elmedaloui 1985) can assign all consonants to nuclei. Processes of epenthesis of the type proposed in this thesis are found in the history of Proto-Indo-European (Halle and Calabrese 1993) and in Berber (Dell and Elmedlaoui 1985), which allows syllabic voiced consonants at one stage in the derivation, but expels them from the nucleus at a later stage. Dell and Elmedlaoui avoid the problem of epenthesis by claiming that the vowels it produces play no role in the phonology. In Armenian, however, we know that the schwas produced by epenthesis play a role in phonological processes such as vowel harmony (cf. chapter 2), and thus cannot be ignored.

Let us now examine how the peak assignment procedure operates in a typical Armenian word such as *bldrʁan* 'heracleum villosum' (cf. (2)), which enters the syllabification procedure containing no prespecified syllabic structure. Peak assignment proceeds iteratively through the sonority hierarchy in (9); thus, the procedure first scans the word from right to left for non-high vowels. This first pass identifies the unsyllabified low vowel *a* as an eligible target and assigns it to the nucleus of a new syllable. At this point the preceding *ʁ* is immediately syllabified as an onset to the new syllable (the specifics of onset assignment are considered in the next subsection). The fact that onset assignment directly follows peak assignment is intended to capture the cross-linguistic generalization that syllabification prefers to create CV syllables whenever possible.

After the core syllable *ʁa* has been assigned, the procedure looks for a coda for the *a*. Though the following *n* is a possible coda, it is not considered during the cycle because it is in morpheme-final position. Borowsky 1986 and Itô 1986 have suggested that UG syllabification does not syllabify a morpheme-final consonant in order to avoid resyllabification in consonant-final morphemes followed by vowel-initial morphemes. In a word such as Armenian *kov-i* 'cow-gen.' [*kovi*], for example, we do not want cyclic syllabification to produce the closed syllable *kov* and then have to resyllabify the *v* as the onset of the *i* in the next morpheme. By assuming that the morpheme-final *v* is left unsyllabified in its cycle, we leave it available to be assigned as the onset for the *i* in the next cycle, without resyllabification. This principle actually does a significant amount of work in Armenian[7], as we shall see in the discussion of plurals in section 3.2.4.

Returning to *bldrʁan*, we now know that the final *n* is not syllabified in the cycle. The assignment procedure then moves on to the next level in the sonority hierarchy, high vowels, and finds no eligible candidates. The next pass then considers liquids, and moving from right to left first comes across the *r*. This *r* is assigned to the nucleus of a new syllable, and the *d* attaches as its onset. No segments are available to serve as a coda, so the procedure moves on to the left. The next eligible candidate is the *l*, which is assigned to the nucleus of a new syllable, and the *b* attaches as its onset.

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[7]As well as in other languages; cf. the analysis of Arabic stress in Kenstowicz 1994:274 and English length contrasts of the deep : depth type.

At this point the procedure has parsed all of the eligible segments in the word, producing the form *bL.dR.ʁA<n>*; all other passes of sonority then apply vacuously. Since the pass considering liquids has produced two [+cons] nuclei, the epenthesis process comes into play, inserting empty [-cons] root nodes to the left of the two offending nuclei. The syllable structures dominating these nuclei are then deleted (the mechanisms of epenthesis are discussed in more detail in section 3.1.6). The application of epenthesis reactivates the syllabification procedure, which first assigns the empty vocalic root nodes to syllable nuclei and adjacent segments as their onsets and codas, giving *b□l.d□r.ʁa<n>*. The form *b□l.d□r.ʁa<n>* then feeds into the post-cyclic syllabification component, where the *n* becomes available to serve as a coda for the *ʁa* syllable (cf. section 3.2.3), and a schwa melody is filled in for the vocalic root nodes.

Following Dell and Elmedlaoui 1985 I assume that nucleus assignment is subject to a hiatus constraint that prohibits the creation of directly adjacent syllable peaks; in Armenian, however, this constraint does not hold for non-high vowel sequences. The activity of this constraint can be seen in forms such as *χos-e-*c^h*-n-e-l* 'make speak', the causative of *χos-e-l* 'speak'. The first two cycles of syllabification produce the parse *χO.sE.* When the c^h becomes available in the fourth cycle, it is first considered as a syllable nucleus; if this were to occur, we would derive the incorrect surface form *[*χo.se.*c^h*ə.nel*]. The hiatus constraint blocks peak assignment to the c^h, however, and it subsequently attaches as a coda to the preceding syllable, resulting in the correct surface form [*χo.se*c^h*.nel*].

The hiatus constraint also plays an interesting role in the treatment of vowel sequences, as I discuss in section 3.2.1.

3.1.4. Onsets

In the preceding subsection we saw that the syllabification procedure attaches an onset as soon as a nucleus is created. In this section I consider the constraints governing the assignment of onsets. Calabrese 1994 proposes that onset assignment creates only sequences of rising sonority, which he builds into his syllabification algorithm in the following manner (1994:10).

(11) incorporate X into the onset of a nucleus if X is left-adjacent AND:

a. an unsyllabified segment s

OR:

b. a sequence of unsyllabified segments $\{s_n, s_{n+1}\}$ *iff* s_{n+1} *is more sonorous than* s_n

I have italicized the portion of Calabrese's procedure that limits onsets to sequences of rising sonority. My procedure abandons this particular constraint, based on the fact that some languages allow onsets that do not rise in sonority. Instead, I assume that UG provides a hierarchy of marking statements concerning possible onsets. The least complex onsets are those of increasing and maximally dispersed sonority according to the principles established by Clements 1988, illustrated in (12) (O = obstruent, N = nasal, L = liquid, G = glide).

(12) O least complex

N

L

G

OL

ON, OG

NL, NG

LG most complex

Onsets of level or falling sonority are marked by UG as more complex than those in (12). In this way I incorporate the Sonority Sequencing Principle (SSP) within a broader scheme of margin possibilities. The SSP states that onsets must rise in sonority and codas must fall in sonority; as stated above, this condition holds for Armenian margins but not for all languages (classical Greek and Polish come to mind). My model crucially differs from Calabrese's in assuming that onset types which do not obey the SSP are characterized by marking statements rather than prohibitions (on this terminology cf. chapter 1). Thus, we expect to find languages where onsets of level or falling sonority are allowed, whereas Calabrese's model requires additional machinery to account for such cases.

I suggest that speakers set a pointer in the hierarchy of marking statements converning onsets: all onsets characterized by a level of complexity greater than that marked by the pointer are disallowed, and onsets of lesser complexity are allowed (for the concept of the pointer in markedness hierarchies cf. chapter 1). The onset assignment procedure (ii) in (1) is then subject to the constraint that it can only create onsets of a complexity level below that marked by the pointer in a given language. I now consider where this pointer is placed in Armenian.

As we already saw in chapter 2, all simplex consonantal onsets are allowed. These cases are relatively trivial, and will not be considered here. Among the inventory of complex onsets, Armenian allows only consonant + *y* sequences, as shown by forms such as *kiank*^{h} 'life' [*kyaŋk*^{h}]; all other possible complex onset sequences trigger epenthesis, as for example in *dram* 'money' [*də.ram*]. Since consonant + *y* sequences are not the simplest complex onsets, as one can see in (12), we must account for this distribution. In the case of Japanese, which also allows only simple and consonant + *y* onsets, it has been suggested that consonant + *y* onsets be treated as monosegmental palatalized consonants (Vance 1987:29). I adopt this proposal for Armenian. This assumption allows us to say that Armenian allows only simple onsets and is compatible with the rest of my analysis.

3.1.5. Codas and appendices

Coda assignment works in essentially the same manner as onset assignment, being limited to sequences below the level of complexity established by a pointer in a hierarchy of marking statements concerning codas. Armenian coda assignment crucially differs from the system Dell and Elmedlaoui propose for Berber, however, in assigning codas within each pass of syllable attachment.

Armenian allows all consonants to serve as simple codas in surface representations (though I argue in section 3.2 that *m* is not allowed in codas during cyclic syllabification). As for complex codas, Armenian allows the following types:

(13) glide + consonant
nasal + homorganic stop or affricate
liquid + less sonorous consonant
fricative + stop (and perhaps fricative)

The only position in which we can be sure that we are dealing with complex codas rather than simple coda + appendix sequences is in morpheme-internal position, since as I argue below Armenian allows a single appendix position in morpheme-final position. I have found examples of morpheme-internal sequences illustrating the following complex codas (S = fricative, T = stop).

(14)	underlying form	surface form	gloss
ST	*hast-l-ik*	*hast.lik*	moderately firm
NT	*anjreu*	*anj.rev*	rain
*r*T	*hrč-u-e-l*	*hərč.vel*	be glad
*r*N	*karmir-a-na-l*	*karm.ra.nal*	blush

The following additional postvocalic clusters are found in surface syllables in morpheme-final position.

(15)	underlying form	surface form	gloss
LS	*durs*	*durs*	outside
GN	*goin*	*guyn*	color
GL	*k^h^oir*	*k^h^uyr*	sister
GT	*zoig*	*zuyg*	pair
GS	*ais*	*ays*	this
NS	*toms*	*toms*	ticket
TT	*cack*^{h}	*cack*^{h}	roof
SS	*χorisχ*	*χorisχ*	honeycomb
TS	*mak*^{h}*s*	*mak*^{h}*s*	tax
GNT	*erkain-k*^{h}	*yerk*^{h}*ayŋk*^{h}	long things
LTT	*part-k*^{h}	*partk*^{h}	debt
NTT	*bṙunc*^{h}*k*^{h}*-ner*	*bə.ṙunc*^{h}*k*^{h}*.ner*	fists
TST	*tek*^{h}*st*	*tek*^{h}*st*	text

Many of the more complex cluster types in (15) (NS, TT, TS, GNT, LTT, NTT) only occur when the final member is *s* or k^h. This striking distribution suggests that Armenian allows a single appendix position at the end of morphemes, and that this position may be occupied by *s* or k^h, and perhaps *χ*. The stipulation that appendices can occur at morpheme boundaries rather than at word boundaries alone weakens the general notion of what an appendix is, but I see no way around this fact in Armenian.

There are several reasons to suppose that k^h can occupy an appendix. First of all, -k^h can freely appear after all other codas allowed in the language, whereas sequences such as *-*tp* and *-*rtk* are not allowed. Secondly, -k^h can occur after *v* (cf. *gov-k*^{h} 'praise', *nzov-k*^{h} 'curse', *xəṙov-k*^{h} 'agitated'), whereas other stops cannot (cf. the discussions of vowel sequences in 3.2.1 and labial codas in 3.2.3). Finally, k^h can follow *m*, unlike other consonants (except *s*; cf. discussion of *m* in 3.2.3).

(16)	underlying form	surface form	gloss
	*χnam-k^h^*	*χənamk^h^*	care
	*dem-k^h^*	*demk^h^*	face

There are also good reasons to suspect that *s* can serve as an appendix. In words such as *mak^h^s* 'tax', *s* must be an appendix because it is more sonorous than k^h and therefore violates the sonority sequencing principle, which is generally believed to hold for codas cross-linguistically. Like k^h, *s* is also able to occur after a coda *m*, which otherwise cannot occur in complex codas except with homorganic stops (17).

(17) *toms* 'ticket'
amb 'cloud'
**tomt*

Interestingly, the k^h that occurs in Armenian appendices seems to have developed from an original (probably labialized) *s*; it is thus possible that at some point in its history Armenian allowed only *s* in appendices.

The forms *bdešχ* 'consul' [*bədešχ*] and *χorisχ* 'honeycomb' [*χorisχ*] are the only examples I have been able to find of a possible appendix other than k^h or *s*. In the absence of other examples, however, I cannot rule out the possibility that these clusters are actually complex codas. By the same token, I cannot completely rule out the possibility that all of the clusters in (15) involve coda + appendix sequences rather than complex codas without proper morpheme-internal evidence. The cluster type TST only occurs in the English loanword *tek^{h}st*; for the purposes of this paper I assume that it is an unassimilated loan and therefore has not undergone the rules of Armenian phonology.

Let us now consider how the coda assignment procedure (iii) in (1) accounts for the inventory of possible codas just presented. According to Clements' 1988 dispersion principle, codas have the complexity ranking in (18).

(18)	G	less complex
	L	
	N	
	O	
	GL	
	LN, GN	
	NO, GO	
	LO	more complex

As we can see in (15), Armenian allows all of the coda types in (18), though a subset of the two most complex codas, NS and LS, do not appear to be allowed.

Based on these facts I assume that Armenian sets a pointer above the level LO; all sequences below this level of complexity are allowed as codas, and those above are not. The marking statement $*\{NS\}_{coda}$ which disallows nasal + fricative coda sequences is exceptionally not deactivated. The coda assignment procedure in (1.iii) is then only allowed to syllabify sequences whose marking statement is deactivated.

Now let us return to the question of where in the derivation coda assignment occurs. If coda assignment applied at the end of the derivation as proposed for Berber, we would be unable to explain how complex codas such as we find in *anjrev* 'rain' are created. The Dell and Elmedlaoui model assigns syllable codas after the cycle of core syllabification has incorporated all possible CV syllables within a word, predicting that this form should initially be syllabified as **a.nJ.rev*, which would surface as *[*anəjrev*]. In order to explain why words of this type actually surface with complex codas, we must assume that coda and appendix incorporation applies within each pass of peak assignment rather than at the end of the syllabification procedure.

The assumption that coda assignment applies in each pass creates a problem, however. If coda assignment applied blindly, we would expect a word such as *aṙu* 'stream' to syllabify as **aṙ.u* rather than the attested form *a.ṙu*, assuming that non-high vowels are syllabified before high vowels. One could of course resort to resyllabification in such cases, but I would prefer to avoid this when possible.

Calabrese (personal communication) suggests that this problem can be avoided by allowing the rule of coda attachment to assess the relative sonority of a segment following a coda candidate: if an unsyllabified segment immediately following the coda candidate is more sonorous, that candidate is not syllabified as a coda. Let us consider how this requirement would affect *aṙu*, for example: peak assignment would first assign *a* to a syllable nucleus, then look for an onset and find none. Subsequently, the procedure would consider the *ṙ* as a possible coda for the *a*. Since the following *u* is more sonorous, coda assignment is blocked. A subsequent pass would then assign the *u* to a syllable peak and attach the *ṙ* as its onset.

The case of *aṙu* is relatively straightforward within Calabrese's model. Let us now consider how it would deal with a simple coda, as in the word *ardi* 'modern' [*ar.t^h^i*]. Peak assignment would first assign the *a* to a syllable nucleus, then look for an onset and find none. Subsequently, the procedure would consider the *r* as a possible coda for the *a*; since the following t^h is less sonorous, coda assignment is allowed. The procedure then considers the t^h as a possible second member of the coda; rt^h is in fact a possible coda (cf. *liard* 'liver' [$liyart^h$]), but the t^h is not allowed to attach because the following *i* is more sonorous. A subsequent pass then assigns the *i* to a syllable peak, and attaches the t^h as its onset.

The principle of sonority sensitivity crucially must be sensitive to morpheme-final consonants, even though these are not syllabified in the cycle. Consider for example the verb *grgž-e-l* 'be very sour', which is syllabified as [*gər.gə.žel*]. The first cycle considers the morpheme *grgž*, but leaves the final *ž* unsyllabified. The attachment procedure first targets the *r*, and assigns the preceding *g* as its onset. At this point the procedure becomes interesting: if the *ž* were not visible at all, the following *g* should be able to attach as a coda for the *r* since it would not be followed by a more sonorous consonant. If this were the case we would derive the syllabification **gRg.žel*, which would yield the incorrect surface form *[*gərg.žel*]. Consequently, we must assume that morpheme-final consonants are visible to the cyclic syllabification procedure for the purposes of coda formation but are simply not syllabified. Dell and Tangi 1991 propose a similar analysis for Ath-Sidar Riffian Berber, which possesses rules sensitive to unparsed consonants (cf. Kenstowicz 1994:275).

The same analysis applies in the case of $dnt^h\dot{r}$-*e-l* 'be astonished', which is pronounced [$dən.t^hə.\dot{r}el$]: if the *ṙ* were not visible, we should expect *[*dənt^h.ṙel*]. Note the contrast between this form and *anjrev* 'rain' [*anj.rev*], where no schwa appears within the NTL sequence. This disparity confirms that the sonority sensitivity principle proposed by Calabrese is only sensitive to unsyllabified segments. In the case of *dnt^hṙ-e-l*, the t^h is not assigned to the coda because of the following unsyllabified *ṙ*; in the case of *anjrev*, however, the following *r* does not prevent the *j* from attaching to the preceding coda, because the *r* is already syllabified as the onset of the *e* nucleus. Note that these facts also proviced support for Armenian syllabification being cyclic (cf. 3.1.7).

3.1.6. Epenthesis

The workings of epenthesis in Armenian are somewhat complicated, though the end results are straightforward: an empty [-consonantal] root node is placed to the left or right of a nuclear consonant, and the host syllable is then deleted. In (19) I recapitulate the conditions under which epenthesis occurs to the left or the right.

(19) place a [-cons] root node to the right or left of nuclear [+cons] segments, according to the following principles:

a. to the left in open syllable with onset or closed syllable with stop coda

b. elsewhere to the right

The elsewhere principle in (19b) accounts for epenthesis in the following cases:

(20)

a. syllables which lack an onset

b. syllables which end in two or more [+cons] segments that cannot form a complex coda

In this subsection I present the motivations for each of the stipulations in (19) and (20).

Let us first consider the cases in (19a). A typical example of an open syllable containing a consonantal nucleus and an onset is the form *bldrʁan* considered above. Recall that this form is initially syllabified as *bL.dR.ʁA<n>*, with two syllables matching the description in (19a). According to the principle in (19a), an empty vocalic root node is inserted to the left of the nucleus in these two syllables and their syllabic structure is then deleted, yielding *b□ld□rʁan*. Melodic fill-in in the post-cyclic component then gives the correct surface form *bəldərʁan*. Moving on to the second condition in (19a), consider the example of *k^{h}rt^{h}munǰ-a-l* 'complain' [*k^{h}ərt^{h}mənǰal*]. The first morpheme in this verb is initially parsed as *k^{h}Rt^h.mUn<J̌>*. After all levels of sonority have been considered for syllable peaks, the epenthesis procedure kicks in to deal with the nuclear *r*. According to the principle in (19a), an empty vocalic root node is placed to the left of the *r* and the host syllable is deleted, giving *k^h□Rt^{h}mUn<J̌>*. The cycle of peak assignment then applies again and assigns the *k^h□Rt^h* sequence to a single syllable, and the post-cyclic component fills in the schwa melody.

Now consider the cases in (20) beginning with (20a), where the syllable lacks an onset, as in the form *dram* 'money' [*dəram*]. This word is initially syllabified as *D.rA<m>*, with the first syllable containing only a consonantal nucleus. According to principle (19b), an empty vocalic root node is inserted to the right of the nuclear *d*, and the syllable to which it had been attached is deleted. The post-cyclic component then assigns the empty vocalic position to a syllable nucleus and attaches the *d* as its onset, and attaches the *m* as a coda for the following syllable.

Condition (20b) governs the behavior of closed syllables with consonantal nuclei. The relevant cases we want to account for are given in (21).

(21)

underlying form	surface form	gloss
blntor-e-l	*bələntorel*	sew hastily
p^h*ṙngt-a-l*	*p*^{h}*ərəŋgtal*	sneeze
plst^h*r+plst*^{h}*r*	*pələst*^{h}*ər-pələst*^{h}*ər*	brilliant
t^h*rnp*^{h}	*t*^{h}*ərəmp*^{h}	noise made by heavy but soft object hitting the ground

All of the cases in (21) involve initial syllables which are first syllabified with consonantal nuclei and one or more coda consonants (*bLn*, *p*^{h}*Ṙng*, *pLs*, *t*^{h}*Rn*). The curious fact is that the forms in (21) insert two schwas within these syllables. When one examines the consonant sequences involved, the reason for this asymmetry becomes clear: the nucleus + coda sequences in (21) are not possible complex codas. We can capture this generalization by stating that epenthesis applies to the right of the nucleus in these cases.

Let us now consider the results of epenthesizing to the right in such cases, taking *blntorel* as an example. The first cycle produces the parse *bLn.tO<r>*. At this point the epenthesis procedure kicks in and inserts an empty vocalic root node to the right of the *l* nucleus, which is then desyllabified, giving *bl□ntO<r>*. The next pass scans for nasals and more sonorous segments, and first assigns the empty root node to a nucleus, the *l* to its onset, and the *n* to its coda. Subsequently the stop pass assigns the *b* to a nucleus, which then receives an epenthetic position to the right according to (19b), giving *b□.l□n.tO<r>*. Subsequent cycles and the post-cyclic component then produce the correct surface form *bəlantorel.*

Epenthesis seems to be the lynchpin of Armenian syllabification, as one can gather from the preceding discussion. In addition to the interesting issues involved in determining its internal workings, the epenthesis procedure itself interacts in significant ways with other aspects of the Armenian syllabification algorithm, as I demonstrate in the next section.

3.1.7. The Cycle

There are several reasons to believe that Armenian has two levels of syllabification, the first of which is cyclic and the second post-cyclic. We have already seen some evidence for this claim in the behavior of coda assignment (recall the discussion of *dnt*^{h}*ṙel* vs. *anjrev*). In this section I consider further evidence from the interaction of epenthesis and coda formation.

Given the root *t*^{h}*ṙ*- 'fly', there are two logical outcomes when one adds the causative -*c*^{h}*-n-e-l*. If coda attachment applies before epenthesis, the -*c*^{h}- should be blocked from forming a nucleus by the hiatus constraint and then attach as the coda of the *t*^{h}*Ṙ* syllable, which at the time has no coda. Alternately, if coda attachment applies after epenthesis we should expect the -*c*^{h}- to form the nucleus of a new syllable, since the preceding syllable will already have an *r* in its coda and the hiatus constraint will therefore not be invoked. The fact that we get *t*^{h}*əṙc*^{h}*ənel* 'make fly' rather than **t*^{h}*əṙc*^{h}*nel* indicates that epenthesis in fact applies before coda attachment. This form would then have the derivation in (22):

(22)

a. underlying form t^h ṙ - c^h - n - e - l

b. first cycle (t^h<ṙ>)

peak

t^h <ṙ>

epenthesis t^h □[8] <ṙ>

desyllabification t^h □ <ṙ>

c. second cycle (t^h□ṙ-<c^h>)

peak

t^h □ ṙ - <c^h>

onset

t^h □ ṙ - <c^h>

coda

t^h □ ṙ - <c^h>

[8]As mentioned earlier, the symbol □ represents a [-cons] root node with no melodic features. My analysis requires that it be considered in the same pass as the other [-cons] phonemes during peak assignment; there is no evidence that might allow us to determine whether it groups with high or non-high vowels. Note also that the syllable is deleted when the empty root node is inserted.

d. third cycle (*t^h□ṙ-c^h-<n>*)

peak	t^h □ ṙ - c^h - <*n*>
epenthesis	t^h □ ṙ - c^h □ - <*n*>
desyllabification	t^h □ ṙ - c^h □ - <*n*>

e. fourth cycle (*t^h□ṙ-c^h□-n-e*)

peak	t^h □ ṙ - c^h □ - *n* - *e*
onset	t^h □ ṙ - c^h □ - *n* - *e*

f. post-cyclic (*t^h□ṙ-c^h□-n-e-l*)

coda	t^h □ ṙ - c^h □ - *n* - *e* - *l*
melody	t^h ə ṙ - c^h ə - *n* - *e* - *l*

Note in (22b,c) that epenthesis, like high vowel deletion, deletes the syllable to which the target segment was attached. The primary evidence for this fact is the behavior of closed syllables with consonantal nuclei considered above, as in the word *p^hṙngt-a-l* 'sneeze' [*p^həṙəŋgtal*]. The first cycle of peak assignment produces the syllable *p^hṘŋg*, which according to the principles in (1) becomes *p^hṙ□ng* after epenthesis. If the syllable structure were not deleted at this point, we would require further mechanisms at later stage of the derivation to account for the p^h and ṙ becoming onsets of epenthetic syllables. Once the syllable is deleted, on the other hand, the ṙ is available to serve as the onset of the empty vowel and the p^h becomes a nucleus and subsequently the onset of an empty vowel.

Returning to (22), the *ṙ* crucially must already be attached to the coda before the c^h is dealt with, or we would expect a syllable *ṙ*C^h to be formed. The proper ordering is brought about by a combination of cyclicity and final consonant extrasyllabicity. During the first cycle, neither the *ṙ* nor the c^h is available for syllabification. The t^h is assigned to a syllable nucleus, and subsequently receives an epenthetic vocalic root node to its right according to the principles in (19). In the second cycle the *ṙ* is available for syllabification but the c^h is not, since it occupies final position in the rightmost morpheme under consideration. The syllabification algorithm first assigns the epenthetic vocalic root node to a nucleus and attaches the t^h as its onset and the *ṙ* as its coda. When the c^h subsequently becomes available in the next cycle, it is immediately assigned as a nucleus and subsequently triggers epenthesis, yielding the correct surface form [*t*^{h}*əṙ.c*^{h}*ə.nel*].

We can see here that the derivation in (22) crucially requires that the first level of syllabification be cyclic. If either extrasyllabicity or epenthesis did not apply in a cyclic fashion and the whole word were syllabified at once, as in Berber, we would expect the syllabification **t*^{h}*Ṙc*^{h}*.nEl*, which would surface as **t*^{h}*əṙc*^{h}*nel* (cf. *k*^{h}*rt*^{h}*munǰ-a-l* 'complain' → *k*^{h}*Rt*^{h}*.mUn.ǰAl* → [*k*^{h}*ərt*^{h}*mənǰal*]). If we proceed morpheme by morpheme, on the other hand, we obtain the correct results.

Two other phenomena related to syllabification are sensitive to morpheme boundaries, but do not necessarily require cyclic syllabification. The plural selection rule discussed in section 3.2.4, for example, indicates that morpheme-final consonants are left unsyllabified until the post-cyclic component. Though this indicates that the first level of syllabification is sensitive to morpheme boundaries, it does not necessarily entail that this level is cyclic. One could account for the plural alternations by simply requiring that the final consonant of a (pre-plural)*word* be left unsyllabified; word-internal morpheme boundaries never have any effect on the plural rule. The same is true of appendices (3.1.5), which can only occur at morpheme boundaries. For this reason the rule which assigns appendices obviously must have access to morpheme boundaries, but again it need not apply in a cyclic manner.

3.1.8. Directionality

The final aspect of UG syllabification to be considered is the direction in which the attachment procedure scans for nuclei. There is some evidence in Armenian indicating that the procedure applies from right to left.

Consider the form $t^ht^ht^hk$*-eni* 'type of tree', which surfaces as [t^h*ə.*t^h*ə*t^h*.ke.ni*]. If attachment proceeded from left to right, we would expect the first cycle to produce $T^ht^h.T^h.$<*k*>, which would yield the incorrect surface form *[t^h*ə*t^h*.*t^h*ə.ke.ni*]. If attachment proceeded from right to left, on the other hand, we would expect the first cycle to produce $t^h.t^hT^h.$<*k*>, which yields the correct surface form [t^h*ə.*t^h*ə*t^h*.ke.ni*].

One could argue in the case of $t^ht^ht^hk$*-eni* that the syllabification procedure avoids creating geminates and the form therefore does not support right to left syllabification. If one wishes to pursue this argument, though, it is necessary to explain forms such as *ar*t^h*un-n-a-l* 'awake' [*ar.*t^h*ən.nal*] where geminates are created.

3.2. Peculiarities of Armenian syllabification

The mechanisms discussed in the previous section account for the basic workings of syllabification in Armenian as well as all other languages. In this section I consider some modifications that must be made on a language-particular basis in order to account for some recalcitrant Armenian facts.

3.2.1. Nuclei

The universal procedures that deal with nuclei require certain additional stipulations in order to account for the syllabification of vowel sequences and epenthesis triggered by consonantal nuclei immediately preceding the intransitive morpheme *-u-*. In this subsection I consider both in turn.

3.2.1.1. Vowel sequences

We have already seen in chapter 2 that Armenian deals with underlying vowel sequences in a number of ways including glide insertion, hiatus, deletion, and coalescence. The possible outcomes are reviewed in (23), ignoring for the moment coalescence, which is rare and unproductive, and simple glide formation, which I return to in the discussion of high vowel sequences.

(23) underlying form	surface form	gloss
a. hiatus		
kaos	*ka.os*	chaos
boa	*bo.a*	boa constrictor
amena-azniu	*a.me.na.az.niv*	nicest
amena-□ntir	*a.me.na.ən.tir*	choicest

b. glide insertion

eu	*yev*	and
Maro-i	*Maroyi*	Maro (personal name)-gen.
gadu-ei-n	*gaduyen*	cat-abl.-def. (SWA)
mi-a-na-l	*mi.ya.nal*	unite
liard	*li.yard*	liver
ji-u	*ji.yu*	horse-gen.

c. deletion

bari-ut^{h}iun	*barut^{h}yun*	goodness
matani-u	*matanu*	ring-gen.
tʁai	*tə.ʁa*	boy

The forms in (23a) indicate that hiatus is the norm for sequences of non-high vowels, which is in fact what we predict on the basis of the model in (1). Take for example the word *kaos*: assuming that peak assignment applies from right to left, the first segment to be syllabified will be the *o*, which is assigned to a nucleus; the preceding *a* is not allowed to occupy syllable margins, and remains unsyllabified. The procedure then moves to the *a* and assigns it as a nucleus and the *k* as its onset; the hiatus constraint does not come into play here, since it is only sensitive to configurations involving high vowels. The *s* is later incorporated as a coda in the postcyclic component.

What is perhaps most interesting about (23a) is the form *amenaəntir*. Given our assumption that Armenian does not possess a schwa phoneme, it is not clear how the schwa comes to be in this form or in its source *əntir* 'choice', for that matter. I propose that the morpheme *ənt-* on which *əntir*, *ənker* 'friend' (/*ənd-ker*/ 'with-eater'), and a handful of other words are based contains an empty vocalic root node in its underlying representation. This is similar to the analysis of French vowel-initial words that do not undergo liaison which postulates underlying empty consonantal positions. Though the postulation of empty vocalic positions is undesirable in general terms, I believe it better to have a limited number of morphemes containing such segments than to add another phoneme to the inventory whose distribution is entirely predictable except in these few cases.

The glide insertion cases in (23b) appear to be a simple variant of the hiatus configuration in cases involving a vowel from which a glide can be formed. These vowels are blocked from becoming glides themselves by other constraints. In *liard* 'liver' [*liyard*], for example, the *i* is unable to form a complex onset with the preceding *l*. Given the procedure in (1) we should in fact expect [*ləyard*]; it is possible that this is in fact the form produced, and a subsequent rule raises schwa before *y*. This hypothesis receives indirect support from the fact that there are no *əy* sequences in Armenian. In forms such as *mi-a-na-l* [*miyanal*] and *ji-u* [*jiyu*] I assume that the *i* is prevented from occupying an onset because it is the only vowel in the root. The SWA form *gaduyen* is noteworthy because it inserts a *y* despite lacking an adjacent *i* (the corresponding SEA form is *katv-ic^h*). It seems to be the case that mid vowels are able to generate glides; compare the behavior of word-initial *e-* and *o-*, which become *ye-* and *vo-* respectively (cf. section 3.2.2.2).

Deletion generally involves *i* and occurs in two situations: adjacent to a *u* separated by a morpheme boundary, and in final position following a vowel in polysyllabic words. I have nothing special to say about the latter case; I consider the former case in the next subsection.

3.2.1.1.1. high vowel sequences

The behavior of high vowel sequences poses an interesting challenge to the analysis of extrasyllabicity and coda attachment presented above. The facts regarding syllabification of high vowel sequences are as follows: *-iu-* surfaces as *-yu-* morpheme-internally before a consonant (24a), as *-iv-* before vowels (24b) and morpheme boundaries (24c), and as *-u-* or *-iyu-* across morpheme boundaries, depending on whether the root is monosyllabic (24d) or polysyllabic (24e); *-ui-* surfaces as *-vy-* before vowels (24f) and *-vi-* in all other circumstances (24g-h).

(24)	underlying form	surface form	gloss
a.	*jiun*	*jyun*	snow
b.	*diuan*[9]	*divan*	archives
c.	*t^hiu*	*t^hiv*	number
d.	*ji-u*	*jiyu*	horse-gen.
e.	*matani-u*	*matanu*	ring-gen.
f.	*kauiai*	*kavya*	earthen
g.	*t-u-i*	*təvi*	I gave
h.	*katu-i*	*katvi*	cat-gen.

Based on the exceptional behavior of high vowel sequences in the genitive singular (24d,e,h), I assume that the genitive suffix comes out of the lexicon attached to a syllable nucleus (cf. the analysis of Berber high vowels in

[9]This form could have an underlying *-v-* rather than *-u-*; one cannot be certain in morpheme-internal environments. I assume that this word has a *-u-* merely on the basis of the orthography.

Guerssel 1986, Dell and Tangi 1991). This leads to the creation of hiatus configurations when the preceding stem ends in a vowel, which will also be assigned to a nucleus. At this point we need to postulate two additional rules, one stating that *u* is desyllabified when the first member of such a configuration, and another stating that *i* deletes when the first member of such a configuration, subject to the constraint on monosyllabic roots mentioned earlier. The workings of *i*-deletion are relatively straightforward; *u*-desyllabification is slightly more complicated. According to the principles I have outlined, a form such as *katu-i* would initially be syllabified as *ka.tu.i*; the hiatus configuration would trigger desyllabification, which deletes the syllable to which the *u* was attached. After this, the postcyclic syllabification procedure derives the proper surface form. We can apply the same analysis to *təvi* in (24g) by postulating that the first person singular aorist suffix also comes out of the lexicon attached to a syllable nucleus.

It is tempting to suggest on the basis of forms such as *katvi* and *təvi* that high vowels pattern with consonants with respect to extrasyllabicity, but if we say this we cannot account for the fact that bisyllabic nouns ending in high vowels take the polysyllabic plural (*kəʁzi-ner* 'islands', *katu-ner* 'cats'). If the final high vowel in these cases were extrasyllabic, we would expect them to take the monosyllabic plural and surface as **kəʁziyer* and **katver*.

At this point we have accounted for all of the forms except (24a,c). If we assume that *i* and *u* are equally sonorous, then (24a) shows the expected syllabification, but we need a special stipulation to account for (24c). By the same token, if we assume that *i* is more sonorous than *u* in order to account for (24c), we must explain the unexpected outcome of (24a). I propose that the two vowels are of equal sonority; consequently the rightmost member of high vowel sequences should always be assigned to a syllable nucleus since the syllabification procedure applies from right to left. This analysis gives us forms of type (24a) directly: in *jiun*, for example, the *u* is assigned to a nucleus and the *ji* sequence attaches as its onset; the post-cyclic component then attaches the *n* as a coda, giving the proper surface form *jyun*. Forms of the type in (24c) result from a constraint which blocks peak assignment to morpheme-final *u* when preceded by another high vowel. Once peak assignment to the *u* is blocked, the procedure moves on to the *i* and assigns it to a nucleus; in the case of t^hiu the t^h then attaches as its onset and the *u* subsequently becomes its coda. This analysis is highly ad hoc, but I have no better solution at the moment.

3.2.1.2. Intransitives

The behavior of epenthesis in verbs involving the intransitive/passive morpheme *-u-* is somewhat peculiar.

(25)	underlying form	surface form	gloss
a.	*varj-u-e-l*	*varjvel*	be hired
b.	*manr-u-el*	*manərvel*	grow smaller
c.	*matn-u-e-l*	*matnəvel*	be betrayed
	kočik-u-e-l	*kočkəvel*	be buttoned

The intransitive morpheme always surfaces as *-v-*, which could derive from either an underlying *-v-* or and underlying *-u-*. Forms of the type in (25a) suggest that the underlying form is *-u-*. If the morpheme were *-v-*, the verb *varjvel* would have the derivation in (26).

(26)

a. first cycle *v a r* <*j*>

b. second cycle *v a r j* - <*v*>

c. third cycle *v a r j* □ - *v* - *e*

d. fourth cycle --

e. post-cyclic *v a r j ə v e l*

The crucial step is (26b), where the *j* is assigned to a syllable nucleus and subsequently triggers epenthesis, leading to the incorrect surface form **varjəvel*. If on the other hand the intransitive morpheme is -*u*-, we have the derivation in (27).

(27)
CYCLIC

a. first cycle *v a r* <*j*>

b. second cycle *v a r j* - *u*

c. third cycle *v a r j* - *u* - *e*
(peak assignment to *e* blocked by hiatus constraint)

d. fourth cycle --

POST-CYCLIC

e. *e* assigned to nucleus, allowed to take onset from preceding syllable

v a r j v e l

f. once nucleus of syllable is removed, the rest of the syllable disappears

v a r j v e l

g. *j* attaches as coda of preceding syllable

v ar j v e l

The central feature distinguishing (27) from (26) is the fact that the intransitive morpheme initially syllabifies as a nucleus, with the *j* as its onset. This defers the important syllabification activities until the post-cyclic component, where nuclei are able to appropriate an onset from a preceding syllable (3.2.2.3) and stray segments are gathered up as codas if possible before being considered as nuclei (3.2.3.1).

Let us now consider how to account for the forms in (25b,c). The form in (25b) shows the outcome we expect: cyclic syllabification produces *mAn.rU<el>*; the post-cyclic component then assigns the *e* to a nucleus and approporiates the following *l* as its coda and the preceding *u* as its onset, at which point the syllable dominating the *r* is deleted. The r then tries to attach to the coda of the preceding syllable but cannot, and subsequently becomes a nucleus and appropriates the preceding *n* as its onset. This process yields *mA.nR.uEl*, which gives the correct surface form *ma.nər.vel.*

Given this analysis, we expect forms of type (25c) such as *matn-u-e-l* to surface as **ma.tən.vel* rather than the attested *mat.nə.vel.* In order to account for this disparity, I propose that the postcyclic rule of onset theft (3.2.2.3) only applies with nuclei more sonorous than nasals, i.e. liquids and vowels.

3.2.2. Onsets

Armenian possesses three interesting abnormalities involving onset assignment: the treatment of sibilant + stop sequences, initial prothesis, and onset theft. In this subsection I examine each of these problems in turn.

3.2.2.1. Sibilants

Sibilant + consonant sequences show the following outcomes.

(28)	underlying form	surface form	gloss
a.[10]	*st-a-na-l*	*əs.ta.nal*	receive
	zg-a-l	*əz.gal*	feel
	štap-e-l	*əš.ta.pel*	hurry
b.	*šnorh*	*šə.nor*	grace
c.	*slak^h*	*sə.lak^h*	arrow
	zroic^h	*zə.ruyc^h*	narrative

The problematic case is (28a), where the first principle in (19) would predict *[*sə.ta.nal*], *[*zəgal*], and *[*šətapel*]. This peculiar behavior of sibilant + consonant clusters is paralleled in the development of Pāli from Sanskrit as well as a number of languages surveyed by Broselow 1980.

(29)	Sanskrit	Pāli
(a)	*stána-* 'breast'	*t^{h}ana-*

---

[10]SEA does not epenthesize in words of type (9a), but rather attaches the *s* as an appendix to the following syllable.

(b) *snātá-* 'bathed' *sinātá-*

At the moment, I am unable to explain why sibilant + stop sequences behave in this peculiar manner before vowels. Broselow 1980 has proposed that sibilant + stop clusters in languages of this type behave like monosegmental affricates, and therefore behave differently than sibilant + sonorant sequences. This assertion leaves us with the problem of account for initial sibilant + stop clusters which epenthesize *after* the sibilant, as in (30).

(30)	underlying form	surface form	gloss
	sp^hṙ-oc^h	*səp^hṙoc^h*	tablecloth
	s$k^h$$t^h$-e-l	*sə$k^h$$t^h$el*	shrink from the cold
	skrt^h-e-l	*səkərt^hel*	scratch (v)
	splχ-e-l	*səpəlχel*	slip (v)
	sp^hrt^hn-e-l	*səp^hərt^hnel*	blanch, go white
	spltr-ik	*səpəltrik*	feeble
	spl-c^h-n-e-l	*səpəlc^hənel*	polish (v)

I suggest that sibilant + stop sequences behave abnormally only when followed by a vowel. This being the case, we have to account for forms such as in (31) (again, SEA does not have the initial schwa in these words).

(31)	underlying form	surface form	gloss
	struk	*əstruk*	slave
	strǰ-a-l	*əstərǰal*	regret (v)
	stng-a-l	*əstəngal*	have convulsions

Obviously any theory of syllabification will require some stipulation to account for the minimally different forms *səp*^{h}*ṙoc*^{h} and *əstruk* 'slave'. I suggest that *əstruk* is derived from *stor* 'inferior', in which case the underlying form of 'slave' is *stor-uk* (*-uk* is a common suffix), which is lexically specified as undergoing unstressed vowel deletion. If this is correct, we then expect the surface form *əstruk*. At the moment I have no explanation for *əstərǰal* and *əstəngal*.

Notice that the post-cyclic level of syllabification treats *s* no differently than other consonants. Thus a form such as *sut-e-l* 'lie', which is syllabified in the cycle as *sU.tE<l>*, subsequently undergoes high vowel deletion and feeds into the postcyclic component as *<s>tE<l>*. At this point *s* is syllabified as a nucleus and undergoes right epenthesis according to the first principle in (19). This assumption neatly gives us the distinction between *stanal* 'receive' [*(ə)stanal*], where the sibilant + stop sequence is syllabified in the cyclic component, and *sutel* 'lie' [*sətel*], where the sibilant + stop sequence is syllabified in the postcyclic component.

3.2.2.2. Prothesis

Armenian also has a constraint requiring that all initial syllables have an onset, which produces forms of the type in (32):

(32)	underlying form	surface form	gloss
	ert^h-a-l	*yert^hal*	go
	osp	*vosp*	lentil

Similar processes are found in Chuvash, Telugu, Romanian, Russian, Marshallese, Gagauz, and many other languages. Interestingly, the *y*- produced by the onset constraint does not undergo the general Armenian rule of *y*-strengthening in word-initial onsets (cf. *ietoi* 'afterwards' [*heto*]). The onset constraint does not apply to initial {*i u a*}, as shown in (33).

(33)	underlying form	surface form	gloss
a.	*inn*	*inə* (*[*yinə*])	nine
	ut^hn	*ut^hə* (*[*vut^hə*])	eight
b.	*anj*	*anj* (*[*vanj*], *[*yanj*])	person

Presumably in the case of high vowels this is because Armenian absolutely prohibits the sequences *-yi-* and *-vu-*, but the reasons for the behavior of *a* are less clear. It may be because no appropriate glide can be created from a low vowel; another possibility is that initial low vowels are actually preceded by a glottal stop which is not phonemic in Armenian. The problem of initial onsetless syllables is addressed in more detail by McCarthy and Prince 1993.

3.2.2.3. Post-cyclic onset theft

We have already seen some of the workings of onset theft in the discussion of intransitive verbs, where the thematic vowel is able to appropriate the preceding intransitive morpheme *-u-* as its onset, despite the fact that the *u* has already been syllabified as a nucleus. We also require a rule of this type to account for forms such as *tun-d* 'your house', which surfaces as *tu.nəd.* In this case, the cycle produces *tUn<d>*; when the *d* becomes eligible for syllabification in the post-cyclic component, it first tries to attach as a coda (cf. 3.2.3.1) and fails, and then becomes a nucleus. At this point we must explain why the form *tUn.D* produced in this way does not give **tun.də*, which we should expect according to (19). I propose that the principle in (19) is prevented from epenthesizing at word margins; thus, the expected epenthesis site is passed over in favor of the opposite option when it would produce a violation of this constraint. According to this analysis, epenthesis produces *tUn.□d*, which then feeds the onset theft procedure, giving *tU.n□d.* This form then surfaces as the attested *tunəd.*

3.2.3. Codas

There are three interesting constraints on coda assignment in Armenian. First of all, it appears to be the case that m cannot be assigned to a coda in the cycle, but can in the postcyclic component. Secondly, the postcyclic component seems to consider unsyllabified segments as possible codas before it assigns them as nuclei. Finally, this procedure apparently avoids creating complex codas across morpheme boundaries.

3.2.3.1. M

Given the inventory of coda types discussed in section 3.1.5, the following forms are problematic.

(34)	underlying form	surface form	gloss
	hrmšt-k-e-l	*hər.məšt.kel*	push
	amč^h-n-a-l	*a.məč^h.nal*	be ashamed

Since *r* + nasal and nasal + stop clusters are allowed in Armenian, we should expect the forms in (34) to surface as **hərm.šət.kel* and **am.č^hə.nal* respectively. These unexpected outcomes appear to result from the way in which the syllabification algorithm treats *m*. An inspection of surface forms reveals that *m* occurs in syllable codas in the following circumstances:

(35)

a. word-final (*ham* 'flavor', *ǰerm* 'warm')

b. word-final cluster with *s* (*toms* 'ticket') or k^h (*kamk^h* 'will')

c. before labials (*ambar* 'granary')

If we accept the idea that *s* and k^h can be assigned to a syllable appendix in morpheme-final position, the three positions in (35) collapse into two: word-final and pre-labial. Our task then is to explain why *m* cannot occur in a morpheme-internal coda before a non-labial consonant. I suggest that this gap results from the fact that the cyclic level of syllabification in Armenian does not allow *m* in syllable codas. The intuition here is that as in many languages including English, nasals are not allowed to have a distinctive place of articulation in coda position. According to this analysis, forms of the type in (35c) involve underlying *n*'s which undergo place assimilation to a following labial consonant, thereby merging with underlying *m*.

At this point we must explain why *m* is allowed in morpheme-final clusters and in morpheme-internal clusters produced by high vowel deletion such as *karmir-a-na-l* 'blush' [*karm.ra.nal*]. I suggest that the post-cyclic level of syllabification applies after high vowel deletion and allows *m* to be syllabified in codas. This being the case, *karmir-a-na-l* would initially be syllabified as *kar.mi.ra.nal*; stress assignment would subsequently produce *kar.mi.ra.nál*, triggering high vowel deletion, which would give *kar<m>ra.nál* (I assume that high vowel deletion also deletes the syllable to which the high vowel is attached). At this point the post-cyclic syllabification component assigns the *m* to the coda of the preceding syllable. This analysis crucially requires that the second level of syllabification try to attach an unsyllabified segment to the coda of a preceding syllable before it tries to attach it to a syllable nucleus. Though applying coda attachment before peak assignment may seem counterintuitive in general terms, I believe that it makes sense in the context of of the second cycle of syllabification, whose basic function is to deal with leftover consonants rather than to create new syllables. The idea is that the post-cyclic component prefers to avoid creating new syllables if possible; thus, *karm.ra.nal* is preferable to **kar.mə.ra.nal* because it does not require the creation of a new syllable.

The next case to account for is morpheme-final clusters containing *m*, as in *ʃerm* 'warm' [*ʃerm*] and *toms* 'ticket'. In the first form, cyclic syllabification produces *ʃEr<m>*; the post-cyclic component then treats the *m* in exactly the same manner as in the case of *karmranal*. The form *toms* is slightly more interesting. The cycle produces *tO<ms>*, because the *m* cannot attach as a coda or become a nucleus (due to the hiatus constraint), and the *s* is not syllabified because it is morpheme-final. The post-cyclic component first deals with the *m*, which becomes a coda; the *s* then becomes a coda as well by the same principle. Note how the syllabification of *toms* differs from that of *mom-s* 'my candle' [*mo.məs*]; I consider this disparity in 3.2.3.1.2.

3.2.3.1. post-cyclic assignment

As I have already mentioned, the post-cyclic component of syllabification differs from the cyclic component in several interesting ways. Two of the more problematic differences involve the treatment of codas, which I consider now.

3.2.3.1.1. Ordering

I have already suggested above that coda attachment must be ordered before nucleus assignment in the post-cyclic component. The primary evidence for this assertion comes from the behavior of m. Consider again the forms *jerm* 'warm' and *toms* 'ticket'. The cyclic level of syllabification produces *jer<m>*; the post-cyclic level then must attach the stray *m* to the preceding coda, as in the case of *karmranal*. If nucleus assignment were to apply first, we would expect **karmərანal* and **jerəm*. In the case of *toms*, the cyclic level of syllabification ignores the final *s*, but is also forced to leave the preceding *m* unsyllabified, since it cannot attach to the preceding coda and is not allowed to create a hiatus configuration by syllabifying as a nucleus. Thus the output of the first level is *to<ms>*; the post-cyclic level then syllabifies the *m* as a coda and the *s* as an appendix. Note again that the second level of syllabification does not create a new syllable *mS*, which would produce **to.məs*. This demonstrates that coda formation absolutely must precede peak assignment in the post-cyclic level. One could argue in the case of *karmranal* discussed earlier that peak assignment to *m* is blocked by the principle 'once a consonant, always a consonant'; in other words, the *m* prefers to remain a consonant once it has been syllabified as an onset in the first level. This idea is spurious in many regards, particularly because the idea of being consonantal in a syllabic sense (*m* is of course always [+consonantal] in the strict sense) is lost when the host syllable is deleted by the rule of high vowel deletion. Regardless of its general spuriousness, the maxim 'once a consonant, always a consonant' cannot apply to *toms*, since the first level of syllabification never assigns 'consonantal' positions to either the *m* or the *s*.

3.2.3.1.2. Constraints on attachment

Now let us return to the case of *toms* versus *mom-s*. We have seen that *toms* is syllabified [*toms*]; we must now explain why the minimally different form *mom-s* 'my candle' is syllabified [*mo.məs*]. This discrepancy in fact characterizes the behavior of all trans-morphemic clusters, as illustrated in (36).

(36)	underlying form	surface form	gloss
a.	*gund*	*gund*	globe
	tun-d	*tunəd*	your house
b.	*durs*	*durs*	outside
	duṙ-s	*duṙəs*	my door
c.	*χos-e-c^h-n-e-l*	*χosec^{h}nel*	make talk
	ver-c^h-n-e-l	*verc^{h}ənel*	raise

I see two possible ways of accounting for these facts: either the suffixes in (36) contain an underlying schwa or empty vowel position that is deleted under certain conditions, or the suffixes contain only consonants, and the difference in syllabification results from some constraint on syllabification across morpheme boundaries. I have already discussed why we do not want to postulate underlying schwas in such cases; it is more difficult to rule out the empty vowel hypothesis. I believe that it is better to postulate a single constraint on syllabification than to suppose that all suffixes consisting of a single consonant actually include an abstract vowel segment, especially when the behavior of such suffixes is completely consistent. If these suffixes in fact contained empty vowel positions, we would expect to find suffixes without these abstract segments which behaved differently; this is not the case. Consequently, I assume that the relevant suffixes in (36) consist of single consonants. I then postulate a constraint on coda attachment which states that complex codas cannot be formed across morpheme boundaries.

The idea that morpheme boundaries can block formation of complex syllabic constituents is paralleled in Latin, where stop + liquid clusters are syllabified as complex onsets morpheme-internally, but as coda + onset sequences across morpheme boundaries (Steriade 1986:13).

(37)	underlying form	surface form	gloss
a.	*labr-u-m*	*la.brum*	lip
b.	*ab-rog-ō*	*ab.ro.gō*	I ask

The Latin case is in fact the mirror image of what I have proposed for Armenian. Steriade suggests that the difference between (37a) and (37b) results from the fact that the cluster in (37a) is homomorphemic whereas the cluster in (37b) is heteromorphemic, which I believe to be correct. She implies that (37a) is actually monomorphemic, however, which is not correct. In order to preserve her analysis while recognizing that (37a) actually involves three morphemes, we end up paralleling my analysis of Armenian. Let us assume that Latin follows the universal principle of leaving a morpheme-final consonant unsyllabified. This being so, we should expect the surface forms **la.brum* and **a.bro.gō* in default of any other constraints; the second of these does not match the attested form. Consequently, I assume that an additional constraint is at work. In order to account for *ab.rogō* I propose that Latin onset maximization is subject to the same constraint as Armenian coda incorporation, namely that complex margins cannot be created across a morpheme boundary. The motivation for this type of constraint remains unclear, but the Armenian and Latin evidence indicate that it may well be a legitimate phonological phenomenon.

Note that the post-cyclic level of syllabification crucially requires access to morpheme structure. The forms in (36a), *gund* and *tun-d*, for example, emerge from the cycle as *gUn<d>* and *tUn-<d>* respectively. If morpheme boundaries were erased or ignored at this point, we would expect the two forms to undergo the same treatment of the final unsyllabified *d*. If on the other hand morpheme boundaries are still visible in the post-cyclic component, we can invoke the complex coda constraint discussed in the previous section to derive the different outcomes of the two words.

3.2.4. Related rules

Several rules of Armenian phonology intervene between the cyclic and post-cyclic components of syllabification. The most important of these are plural selection, stress assignment, and unstressed vowel deletion, which occur in the derivation in that order. I have already discussed stress assignment and vowel deletion in some detail in chapter 2; in this subsection I return to the topic of plural selection.

Recall from chapter 2 that the productive rule of plural formation in Armenian selects between two allomorphs: monosyllabic nouns take the suffix *-er* (38a), and polysyllabic nouns take the suffix *-ner* (38b).

(38)	singular	plural	gloss
a.	*čaš*	*čašer*	meal
b.	*dodoš*	*dodošner*	toad

As a general rule, epenthetic syllables count for plural formation, so that underlying monosyllabic nouns which surface with one or more epenthetic syllables take the polysyllabic plural, as in (39):

(39)	singular	plural	gloss
	ṙus	*əṙusner*	Russian
	gluχ	*gəluχner*	head

The facts in (39) indicate that plural formation applies after the cyclic syllabification procedure. The behavior of monosyllabic nouns with final consonant clusters indicates that it applies before post-cyclic syllabification, however. Consider the alternations in (40).

(40)	singular	surface form	plural	surface form	gloss
	arkʁ	*arkəʁ*	*arkʁ-er*	*arkʁer*	box
	astʁ	*astəʁ*	*astʁ-er*	*astʁer*	star
	vagr	*vagər*	*vagr-er*	*vagrer*	tiger

Given the above assumption that syllabification applies before plural formation, we might expect the forms in (40) to take the polysyllabic plural *-ner*, since at the time plural selection applies the form of 'tiger' for example should be *va.gR* (or *va.g□r* if epenthesis has already applied as well). Instead we obtain the forms with the monosyllabic plural morpheme in (40). This unexpected state of affairs receives an elegant explanation in light of our assumption that morpheme-final consonants are not syllabified during their cycle. Though this idea was originally intended to capture the intuition that morpheme-final consonants prefer to attach as the onset of a following vowel rather than the coda of a preceding syllable, it does a great deal more work in Armenian.

First of all, it allows us to account for the alternations in (40). Consider the case of *vagr* 'tiger': if morpheme-final consonants are not syllabified in the first level of syllabification, the form which feeds into plural selection will be *va<gr>*[11], which contains only one syllable and therefore selects the monosyllabic plural *-er*. By the same token, the unsyllabified *r* is available to serve as the onset for the following suffixal *e*

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[11]The *g* is left unsyllabified because the following segment is more sonorous (cf. (11)).

when the second level of syllabification applies. If the *r* were syllabified in the first level, we would have to postulate a rule of resyllabification that delinked a consonant preceding an onsetless vowel from its syllable and attached it as the onset of the onsetless syllable.

The plural selection rule raises another thorny problem, however. On one hand, the facts just discussed suggest that the plural rule applies after cyclic syllabification and before post-cyclic syllabification; on the other hand, word-building morphemic rules are generally considered to apply before all phonological rules. If we wish to maintain this theory, we are forced to stipulate that at least some rudimentary syllabification applies in the morphemic level of rules (cf. Sloan 1991). Essentially the same proposal has been made to account for the behavior of the Polish comparative formation, a morphological rule that applies early in the derivation yet requires some amount of pre-existing syllabification (Kenstowicz 1994:263). I will not go into this issue further here, but refer the reader to the discussion in Kenstowicz 1994 and references cited there.

3.2.5. Geminates

Armenian allows adjacent identical segments in underlying representations, but does not generally syllabify these as geminate structures in surface representations. Consider for example the forms in (41).

(41)	underlying form	surface form	gloss
a.	*$t^ht^ht^hk$-eni*	*$t^hə.t^hət^h$.ke.ni*	type of tree
b.	*t^hṙṙ*	*t^həṙ*	sound made when flying
c.	*gz-z-u-ac*	*gəz.vac*	torn

In each of the forms in (41) the syllabification algorithm I have proposed is not expected to produce surface geminates. Nevertheless, the forms in (41b-c) delete one of the underlying identical segments[12]. The same happens in some clusters produced by vowel deletion, for example *uʁiʁ-aki* 'correct' loses its medial unstressed *i* and is subsequently pronounced [*uʁaki*] rather than the expected *[*uʁʁaki*]. One could say that the deletions in (41b-c) result from enforcement of the OCP on underlying representations, but this hypothesis fails to account for the non-deletion in cases such as (41a). Forms of the *uʁaki* type could simply result from a surface constraint disallowing certain types of geminates. This constraint cannot hold for all consonants, as shown by forms such as *artʰun-n-a-l* 'awake' [*artʰənnal*], nor does it trigger the same repair strategy in all cases, as shown by forms such as *ptoit-i-l* 'stroll' [*pətətil*]. In the latter case cyclic syllabification produces *P.tUY.til*, which exceptionally undergoes vowel deletion giving *pə<t>til*, which we should expect to surface as **pət.til*. If we accept the idea that Armenian does not allow certain geminate consonants, we might expect this form to be repaired by deletion, as in *uʁaki*. The fact that epenthesis is opted for in this case but deletion is employed in *uʁaki* remains unexplained in my model.

3.2.6. Variation

We have already seen that my SEA informant (I) differed from Malχasyancʰ 1944 (M) in his pronunciation of seven forms, repeated in (42).

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[12]This is only true of my SEA informant's pronunciation; Malχasyancʰ has *tʰəṙəṙ* and *gəzəzvac*.

(42)

	orthography	underlying form	surface form	gloss
a.	*slkvel*[13]	*sl-k-u-e-l*	I *səlkvel*	slip
			M *səlkəvel*	
b.	*slχkvel*	*sl-χ-k-u-e-l*	I *səlaχkvel*	slip
			M *səlaχkəvel*	
c.	*sləpzt*	*sl□pzt*	I *səlpazt*	suddenly
			M *səlapazt*	
d.	*brštkel*	*bršt-k-e-l*	I *bəraštkel*	waft
			M *bəraštakel*	
e.	*gřštkal*	*gřšt-k-a-l*	I *gəřaštkal*	burp
			M *gəřaštakal*	
f.	*hrmštkel*	*hrmšt-k-e-l*	I *hərmaštkel*	push
			M *hərmaštakel*	
g.	*bzktel*	*bz-ik-t-e-l*	I *bəskatel*	pluck
			M *bəzaktel*	

In addition, Malχasyanc^{h} lists the following variants for 'grow drowsy':

(43)	underlying form	surface form
	t^{h}nbrt-e-l	*t^{h}əmbərtel* OR *t^{h}əmbrətel*

In this subsection I attempt to account for the variations in (42) and (43); I suggest that the primary cause is my informant's lack of knowledge of the internal morphemic structure of words he had not seen before.

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[13]In SWA orthography the intransitive morpheme is represented as <*u*>.

Consider for example the first form in (42), *slkvel* 'slip'. This verb has the morphemic structure *sl-k-u-e-l*: *sl-* has the meaning 'slip', and is attested in a number of words; *-k-* is a common verbal suffix of unclear function; *-u-* is the intransitive morpheme; *-e-* is the thematic vowel; and *-l* is the infinitive suffix. Given this morphemic structure, the syllabification algorithm I have presented in this chapter produces the correct surface form *səlkəvel*: the cycle produces *s□l.ku.<el>*, after which the post-cyclic component makes the *e* a nucleus and appropriates the *u* as its onset. The *k* is then left unsyllabified and first attempts to attach as the coda of the preceding syllable, but is prevented from doing so by the complex coda constraint discussed above, at which point it becomes a nucleus. My informant did not recognize this word, though he could tell it was a verb; thus, I assume that he parsed its morphemic structure as *slk-u-e-l*. Verbs ending in *-vel* are extremely common in SEA, so it is reasonable to suppose that my informant was able to parse the verb to this extent. Given the morphemic structure *slk-u-e-l*, then, we expect the syllabification *səlkvel*; the derivation is the same as for *sl-k-u-e-l* with the exception that the complex coda constraint does not prevent the *k* from attaching to the preceding syllable. This syllabification is precisely what was produced by my informant.

The same analysis can be applied to *sl-χ-k-u-e-l*, which is clearly a variant of *slkvel* with the addition of an *-χ-* morpheme of unclear significance. This form should undergo the derivation in (44).

(44)

a. UR *s l - χ - k - u - e - l*

CYCLE

b. cycle 1 — *s* □ <*l*>

c. cycle 2 — *s* □ *l* <*χ*>
(peak assignment to *l* blocked by hiatus constraint)

d. cycle 3 — *s* □ *l* □ *χ* <*k*>

e. cycle 4 — *s* □ *l* □ *χ* *k* *u*

f. cycle 5 — *s* □ *l* □ *χ* *k* *u* *e*
(peak assignment to *e* blocked by hiatus constraint)

g. cycle 6 — *s* □ *l* □ *χ* *k* *u* *e* <*l*>

POST-CYCLE

h. peak assgt — *s* □ *l* □ *χ* *k* *u* *e* *l*

i. onset theft — *s* □ *l* □ *χ* *k* *u* *e* *l*

j. coda assgt. — *s* □ *l* □ *χ* *k* *u* *e* *l*

k. *k* fails to attach to preceding coda because of complex coda constraint

l. peak assgt. — *s* □ *l* □ *χ* *k* *u* *e* *l*

m. epenthesis — *s□.l□χ.k□.vel*
n. melody — *sə.ləχ.kə.vel*

My informant must have parsed this verb as *slχk-u-e-l*, using the same reasoning as in the case of *slkvel.* This morphemic structure should give *sələχkvel*, which is exactly what my informant produced. The same analysis holds for the variations in (42d-f), in which my informant failed to parse the -*k*- as a separate morpheme.

In *slpzt*, my informant's pronunciation *səlpəzt* shows the syllabification predicted by my algorithm. I am forced to assume that the form *sələpəzt* cited by Malχasyanc^h contains an underlying empty vowel position between the *l* and the *p*; thus, the orthographic form <*sləpzt*> corresponds to a phonemic form /*slVpzt*/. This stipulation is highly undesirable, but at the moment I have no better analysis.

I also have no satisfying explanation for the variant *t^həmbrətel* in (43).

3.3. Conclusions

In this chapter I have argued that the Armenian syllabification system is driven by an algorithm provided by Universal Grammar which assigns syllable peaks and attaches margins in a series of passes based on the sonority hierarchy. Though this basic idea is taken from Dell and Elmedlaoui 1985, I have proposed a number of modifications of their proposal that are required to account for the Armenian data. The most notable of these modifications are the inclusion of cyclic and postcyclic levels of syllabification, the extrasyllabicity of morpheme-final consonants, the inclusion of coda incorporation in the cycle of peak assignment, and the mechanism of epenthesis that applies within the cycle. Other modifications proposed here are of great theoretical interest as well, but appear to be language-specific innovations.

3.4. Appendix

As an aid to those interested in conducting further work on Armenian syllabification, I present below a list of interesting forms upon which I based my own work (cf. also chapter 2). All words and their pronunciations are taken from Malχasyanc^{h} 1944 (M); when the pronunciation of my SEA informant differs, I notate his form with an 'I'. I employ the following symbols: . = syllable boundary, - = morpheme boundary, + = reduplicant boundary.

(37)	underlying form	surface form	gloss
	art^{h}un-n-a-l	*ar.t^{h}ən.nal*	wake up
	buk-lik-e-l	*bə.kəl.kel*	strangle
	bldrʁan	*bəl.dər.ʁan*	a plant (heracleum villosum)
	blntor-e-l	*bə.lən.to.rel*	sew hastily
	burd-gz-e-l	*bərd.gə.zel*	rip (v)
	burd-gz-n-uk	*bərd.gəz.nuk*	torn
	bršt-k-e-l	*bə.rəš.tə.kel*	spread a scent
		I *bə.rəšt.kel*	
	bšk-u-e-l	*bəš.kə.vel*	be buried
	bz+bz-n-e-l	*bəz.bəz.nel*	be destroyed
	bz-ik-t-e-l	*bə.zək.tel*	rip (v)
		I *bəs.kə.tel*	
	bzlt-a-l	*bə.zəl.tal*	buzz
	bz-nk^{h}-t-u-e-l	*bəzəŋk^{h}ətvel*	rip (intransitive v)
	bt^{h}ṙk-e-l	*bə.t^{h}əṙ.kel*	swell (v)
	buž-išk-e-l	*bə.žəš.kel*	heal
	čklt^{h}	*čə.kəlt^{h}*	slap (n)
	čnkl+mnkl	*čəŋ.kəl.məŋ.kəl*	decorations worn on woman's head
	čnkṙ	*čəŋ.kəṙ*	small
	čvl+čvl	*čə.vəl.čə.vəl*	chirpingly

čvtk-e-l	*čəf.tə.kel*	prune (v)
čṙ+čṙ	*čəṙ.čəṙ*	pulley-like device used in cleaning cotton
čṙvṙ	*čəṙ.vəṙ*	to and fro
dnt^hṙ-e-l	*dən.t^hə.ṙel*	be astonished
drχk-drχk-a-l	*də.rəχk.də.rəχ.kal*	crash
glčʁ-uk	*gəl.čə.ʁuk*	type of plant
glmlk-e-l	*gəl.məl.kel*	stagger
glnt^hor	*gə.lən.t^hor*	fat
gltor-čan	*gəl.tər.čan*	wheel
gmχlai	*gə.məχ.la*	type of vegetable
gmṙt-a-l	*gə.məṙ.tal*	shout
grgṙ-mun-k^h	*gər.gəṙ.muŋk^h*	vexation
grgž-e-l	*gər.gə.žel*	be very sour
grkžn-a-l	*gər.kəž.nal*	shake one's hair
gz-z-u-ac	*gə.zəz.vac*	torn
	I *gəz.vac*	
gṙst-k-a-l	*gə.ṙəs.tə.kal*	burp (v)
	I *gə.ṙəst.kal*	
gṙuz-n-ot	*gə.ṙəz.not*	frizzled
gždm-n-e-l	*gəž.dəm.nel*	scowl (v)
gɟl-t-e-l	*gə.ɟəl.tel*	destroy
ʁnt^h	*ʁənt^h*	(a) little
ʁṙ	*ʁəṙ*	dry
ʁṙvṙ	*ʁəṙ.vəṙ*	noise
ʁinɟ+ʁinɟ-a-l	*ʁənɟ.ʁən.ɟal*	cry

ʁnǰʁ-n-e-l	*ʁən.ǰəʁ.nel*	contort the mouth to kill (said of dogs)
hrmšt-k-e-l	*hər.məš.tə.kel* I *hər.məšt.kel*	push
ǰʁb+ǰʁb-n-ot-a-l	*ǰəʁbǰəʁbnotal*	be soaking wet
k^{h}rt^{h}munǰ-a-l	*k^{h}ərt^{h}mənǰal*	complain
k^{h}rk^{h}meʁ	*k^{h}ərk^{h}meʁ*	Arabian bean
lmn-c^h-n-e-l	*lə.mən.c^{h}ə.nel*	complete
plʁrtk-e-l	*pəl.ʁər.tə.kel*	not see well
plpst-a-l	*pəl.pəs.tal*	flash (v)
plst^{h}r+plst^{h}r	*pə.ləs.t^{h}ər.pə.ləs.t^{h}ər*	brilliant
ppz	*pə.pəz*	fire, light
pχ+pχk-a-l	*pəχ.pəχ.kal*	spurt out
p^{h}ṙngt-a-l	*p^{h}ə.ṙəŋg.tal*	sneeze (v)
sl	*səl*	surprising
sl-k-u-e-l	*səl.kə.vel* I *səlk.vel*	slip (v)
slnk^h+slnk^h	*sə.ləŋk^h.sə.ləŋk^h*	wander aimlessly
slpzt	*sə.lə.pəzt* I *səl.pəzt*	suddenly
sl-χ-k-u-e-l	*sə.ləχ.kə.vel*	be unstable
slχtr-ik	*sə.ləχt.rik*	lewd
štap	*štap*	haste
st-a-na-l	*sta.nal*	receive
sut-e-l	*sə.tel*	lie
t^{h}rnp^h	*t^{h}ə.rəmp^h*	noise made by heavy but soft object hitting the ground

t^{h}t^{h}t^{h}k-eni	*t^{h}ə.t^{h}ət^h.ke.ni*	type of tree
t^{h}nbr-t-e-l	*t^{h}əmbərtel,* *t^{h}əmbrətel*	grow drowsy
t^{h}t^{h}χk-ič^h	*t^{h}ə.t^{h}əχ.kič^h*	piece of wood used in mill
t^{h}ṙ-c^h-n-e-l	*t^{h}əṙ.c^{h}ə.nel*	make fly
zgoiš	*zguš*	careful
zrnp^h+zrnp^h-a-l	*zə.rəmp^h.zə.rəm.p^{h}al*	make walking noises
zχk	*zəχk*	sound made when heaving a heavy object
žpit-e-l	*žəp.tel*	smile (v)

4
Feature Geometry

In this chapter I consider evidence for the inventory and organization of features, based on universal properties of segmental inventories, phonetic properties and phonological behavior of features and segments, and interactions between consonants and vowels. In particular, I am concerned with features produced in the lower vocal tract, such as [ATR] (advanced tongue root), [RTR] (retracted tongue root), and [spread glottis], which often are referred to collectively as guttural features. The discussion of lower vocal tract features takes a set of Armenian data as its starting point, but focuses primarily on Altaic, Semitic, Caucasian, and Amerindian facts.

This chapter builds on the seminal investigations of the behavior and organization of features and segments produced in the lower vocal tract by Halle 1989 and McCarthy 1991. The central claims I make are that [ATR] is not an ersatz feature employed to encode height distinctions, as has been claimed by Clements 1991, but rather plays an important role in both consonants and vowels; that the distribution of uvulars, both in terms of alternations with velars and the general lack of the voiced uvular stop *G*, are motivated by the nature of the feature [ATR]; that all properties of guttural segments observed by McCarthy 1991, Goad 1992, Bessell 1993, and subsequent research can be captured by the feature geometry proposed in chapter 1; and finally, that the tongue root features [ATR] and [RTR] are analogous to tongue height features in producing a three-way contrast in possible segments.

Most of the topics discussed in this chapter revolve around the radical features [ATR] and [RTR] and segments which involve these features.

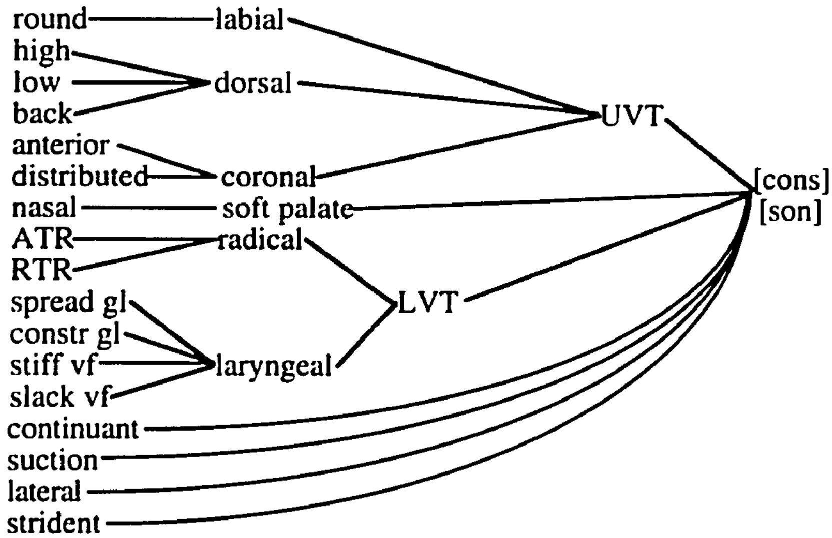
Thus, I consider it appropriate at this point to present briefly the assumptions I make concerning these elements. I assume that the lower vocal tract (= LVT in (1)) contains two articulators, the tongue root and the larynx, referred to in (1) as the radical and laryngeal nodes respectively. The structure of the laryngeal node is based on work by Halle 1989, and is relatively uncontroversial. I suggest that the radical node dominates two features, [ATR] and [RTR]. The feature [RTR] differs from [ATR] in involving the pharyngeal constrictors and perhaps the posterior wall of the pharynx (cf. McCarthy (forthcoming)) in addition to the tongue root. The possible values for these features have the following interpretation: [+ATR] = advancement of the tongue root, [-ATR] = retraction of the tongue root, [+RTR] = constriction of the pharynx, involving retraction of the tongue root and activation of the pharyngeal constrictor muscles, and [-RTR] = the neutral position of the tongue root. The features [ATR] and [RTR] freely combine, subject to the constraint that [+ATR, +RTR] is physically impossible, like [+high, +low].

I argue in this chapter that the various combinations of [ATR] and [RTR] values produce the following segment types: [+ATR, -RTR] (as a secondary articulation) = voiced stops, [-ATR, -RTR] = epiglottals (as a primary articulation) and uvulars (as a secondary articulation), and [-ATR, +RTR] = pharyngeals. I know of no [+ATR, -RTR] segments with the tongue root as their primary articulator. Voiced stops have as their primary articulator whatever has been assumed in the past; thus, for example, both *t* and *d* have coronal as their primary articulator, but *d* also has a radical secondary articulation containing the features [+ATR, -RTR]. Uvulars have a dorsal primary articulation which may be either [-back, +high] in the case of palatalized uvulars, or [+back, -high] in the case of regular uvulars. My motivations for making these assumptions are justified in the rest of this chapter.

4.1. ATR-voice interactions

Many languages show interactions between consonant voicing and vocalic [ATR] values; for example, vowels may become [+ATR] adjacent to voiced obstruents, or conversely (and less commonly) consonants may become voiced adjacent to [+ATR] vowels. These interactions have not yet received a satisfactory explanation within phonological theory. In the first part of this section I present evidence from Armenian, Babine, and the Southwest Turkic languages supporting Trigo 1991's proposal that voiced stops are [+ATR], and show that this assumption allows us to account for a number of previously unmotivated phenomena, including the aforementioned voice-ATR interactions, asymmetries among uvular consonants, and velar-uvular alternations in the Turkic and Tungusic languages. In section 4.2 I examine the behavior of the features [ATR] and [RTR], and consider their role in the feature geometry, specifically with respect to McCarthy 1991's pharyngeal node. I support a representational structure which incorporates the findings of McCarthy 1991 within the general proposal of Halle 1989, as in (1) (UVT = upper vocal tract, LVT = lower vocal tract):

(1)



I adopt Halle 1989's glottal node (equivalent to my laryngeal node) and McCarthy 1991's pharyngeal node (the radical node in (1)). My UVT node is isofunctional with the standard place node; I have eschewed the term 'place' because the laryngeal and radical articulators are technically places of articulation as well.

In this section I concentrate on the lower vocal tract (LVT) node, and particularly the radical node. The LVT structure in (1) essentially combines the proposals of Halle 1989 and McCarthy 1991, though the node labels are slightly different, and ATR (glossed over in McCarthy's work) is explicitly placed under the radical node.

Phoneticians have long known that advancement of the tongue root is necessary to produce voicing in stop consonants (for a review of the literature see Vaux 1992). In order to produce voicing, there must be a pressure differential of at least 2 cm H_2O across the glottis, with the subglottal pressure being higher, so that air may flow up freely through the vibrating vocal folds (Catford 1977:74). This is straightforward for sonorants, where the vocal tract is relatively unconstricted. Stops, however, require a complete closure at some point in the vocal tract, which quickly neutralizes any pressure differential across the glottis. Consequently, other articulatory mechanisms must be employed in order to produce voiced stops. What tends to occur is an expansion of the pharyngeal cavity, implemented primarily by lowering of the larynx and advancing of the tongue root, which lowers the supra-glottal pressure sufficiently to allow voicing. Several works in the past two decades (Halle and Stevens 1971, Gregerson 1976, Calabrese 1987, Trigo 1987, 1991, Vaux 1992) has suggested that this process may play a role in the phonology as well; one may consult Trigo 1991:128-131 and Vaux 1992 for a survey of the data and arguments which have been presented. In this section I briefly review the evidence from Madurese, Buchan Scots English, the Mon Khmer languages, and Akan, and present new data from a number of Armenian dialects, Babine, and the Southwest Turkic languages supporting the hypothesis that voiced stops have a phonological [+ATR] specification.

4.1.1. Voice → ATR

There is ample evidence for ATR values of consonants spreading to following vowels. Let us consider first the case of the Austronesian language Madurese, discussed in Trigo 1987, 1991:128-131. In Madurese, vowels surface as [+ATR] after voiced and heavy aspirated consonants, and [-ATR] word-initially and after all other consonants, as in (2) [where *U* represents a high round vowel and *I* a non-round high vowel[1]]:

---

[1] I assume that Madurese has the phonemic vowel inventory {*i a u ə*}, and that the rule of [ATR] spreading discussed here is feature-changing. The

(2) *bUdI* 'back' → *budi*

k^hUsI 'gums' → *k^husɛ*

bAtU 'stone' → *bətɔ*

According to Trigo, both voiced stops and heavy aspirated stops are [+ATR] (note that the heavy aspirated stops develop from historical voiced stops[2]), and all other consonants are [-ATR]; consonants then spread their ATR values to following vowels, as in (3):

(3)

b *O*	*d* *E*
[+ATR]	[+ATR]
k^h *O*	*s* *E*
[+ATR]	[-ATR]

---

rule takes the following form: associate [+ATR] to vowels from preceding consonants, and elsewhere associate [-ATR]. This type of rule where the elsewhere case inserts the opposite feature value is discussed by Kiparsky (1981).

[2]Trigo does not consider the question of how voiced stops developed into heavy aspirated stops, which is not easily explained within current theory.

b *A* *t* *U*

[+ATR] [-ATR]

I propose a slightly different interpretation of the facts in (2). I assume that Madurese has the phonemic vowel inventory {*i a u ə*}, and that the rule of [ATR] spreading discussed here is feature-changing. The rule takes the following form: associate [+ATR] to vowels from preceding consonants, and elsewhere associate [-ATR]. This type of rule where the elsewhere case inserts the opposite feature value is discussed by Kiparsky (xx); similar cases are found in the Buchan Scots English and Babine cases discussed below..

Note that underlying high vowels become mid vowels when associated with a [-ATR] feature, so that *I* → *ε*, *U* → *ɔ*; similarly, the underlying low vowel *A* is raised to *ə* when [+ATR]. I assume that the marking statements *[+high, -ATR] and *[+low, +ATR] are active in Madurese, and the [ATR] spreading rule in (3) creates violations of these marking statements. Madurese chooses to repair these violations by means of delinking, and delinks [+high] in [+high, -ATR] configurations and [+low] in [+low, +ATR] configurations. I use the lowering of high vowels as a diagnostic for the presence of [-ATR] throughout this chapter.

Now consider the case of Buchan Scots English (Kohler 1984, Trigo 1987). In Buchan, the surface form of the underlying high front vowel *i* (Trigo's /E/) is determined by the following consonant, surfacing as *i* before voiced obstruents and *ε* before single sonorants and voiceless obstruents, as in (4):

(4) *bId* 'bid' → *bid* *lIv* 'live' → *liv*

bIt 'bit' → *bɛt* *lIft* 'lift' → *lɛft*

Following Trigo 1987's analysis, it appears that ATR values are spreading to the *i* from the following consonant, if we assume that voiced stops are [+ATR] and voiceless stops are [-ATR]:

(5) *b I d* *b I t*

[+ATR] [-ATR]

As in Madurese, when [ATR] spreading creates the illicit configuration [+high, -ATR], Buchan delinks [+high], yielding *ɛ*.

Perhaps the best-known case of consonant voicing affecting following vowels occurs in the Mon Khmer languages (Haudricourt 1946, Gregerson 1976). As is clear from the acoustic information collected in Gregerson 1976, voiced obstruents in the Mon languages are characteristically followed by [+ATR] vowels, and voiceless obstruents by [-ATR] vowels. Consider the case of Rengao (Gregerson 1976:333):

(6)

a. after original voiced obstruents	*i*	*e*	*ə*	*o*	*u*
b. after original voiceless obstruents	*ᵋi*	*ɛ*	*a*	*ɔ*	*ᵓu*

Though these sets are normally distinguished in terms of tone (set (a) is associated with low tone, and set (b) with high tone), they differ with respect to [ATR] as well: set (a) is [+ATR], and set (b) is [-ATR]. Note that the [-ATR] high vowels appear to have undergone fission, splitting into diphthongs containing [-ATR] in the first element and [+high] in the second[3]. As in Madurese, the [+ATR] counterpart of *a* is raised to *ə*.

According to Stewart 1967, some dialects of Akan also show interactions between voiced obstruents and [+ATR] vowels; [+ATR] vowels occur after voiced obstruents, and [-ATR] vowels occur elsewhere. Unfortunately, I have been unable to procure this article, so I cannot discuss it further here.

In addition to the cases described above, which have led Trigo 1991 to propose that voiced obstruents are [+ATR], I would like to add evidence from Armenian and Babine. In several Armenian dialects, vowels surface as [-back] after voiced stops. In Vaux 1992, I showed that this seemingly unmotivated development can be accounted for if we assume that voiced stops are [+ATR], and spread this feature to following vowels. All [+ATR] vowels subsequently become [-back], producing historical alternations of the type in (7)[4]:

(7)	classical	Van	Kirzan	gloss
a.	*bah*	*päχ*	*bäh*	spade
	bołk	*pöχk*	*böχk*	radish
	burd	*pürt^h*	*bürd*	snowstorm
	gaṙn	*k^{y}är*	*g^{y}är*	sheep
	goł	*k^{y}öʁ*	*g^{y}öʁ*	thief

[3]I assume that these diphthongs are *$^{\varepsilon}i$* and *^{ɔ}u* rather than *^{e}i* and *^{o}u* (i.e. [+ATR] diphthongs), but I have no evidence for this assumption other than the prediction of fission.

[4]Data from Baʁramyan 1961 (Kirzan), Adjarian 1952 (Van).

	gund	*k^{y}ünd*	*g^{y}ünd*	heap
	danak	*tänäk*	*dänag*	knife
	dołal	*töʁal*	*döʁdöʁal*	tremble
	durs	*tüs*	*düs*	outside
	jag	*cäk^{hy}*	*jäk^{h}*	cub
	joʁ	*cüöʁ*	*jöʁi*	bar
	ju	*cü*	*jü*	egg
	ǰardel	*čärtel*	*ǰärdel*	cut
	ǰok	*čök*	*ǰök*	distinction
	ǰur	*čür*	*ǰür*	water
b.	*paṙaw*	*paṙav*	*paṙav*	old woman
	port	*puoṙt*	*port*	navel
	putuk	*putuk*	-----	pot
	puk	-----	*puk*	throat
	kanač^{h}	*kanač^{h}*	*kananč^{h}*	green
	kov	*kov*	*kov*	cow
	kušt	*kušt*	*kušt-ə* ‘nearby’	side
	tak^{h}	*tak^{hy}*	*tak^{h}*	hot
	tokank^{h}	*tuokank^{h}*	-----	punishment
	toron	*turun*	*toron*	madder (plant)
	tun	*tun*	*tun*	house
	cak	*cak*	*cak*	hole
	cov	*cov*	*cov*	sea
	cunr	*cundər*	*cundər*	knee
	čakat	*čakat*	*čakat*	forehead
	čort	-----	*čort*	servant boy

If we did not assume that voiced stops were [+ATR], we would have to postulate an ad hoc rule in these cases stating that voiced stops spread [-back] to following vowels. Since we cannot say that voiced stops are [-back] and voiceless stops are [+back], we must assume that the data in (6) and (7) result from ATR spreading, exactly as in (3) (for further discussion of the relationship between [+ATR] and [-back] cf. Vaux (forthcoming)).

The Athabaskan language Babine also provides strong evidence that voiced stops are [+ATR]. According to Cook 1989, Babine has six underlying vowels, each of which may surface as [+ATR] or [-ATR], depending on the preceding consonant, as in (8)[5]:

(8)	after:		vowels surface as:
a.	*t t' tł tł' ł c c' s k k' x q q' χ qʷ q'ʷ χʷ ʔ h*	b.	*ɛ₁ ɛ₂ a ɔ₁ ɔ₂ ʌ*
c.	*b d dl j g G Gʷ m n l z y γ w*	d.	*i e æ o u ə*

After voiceless consonants the vowels surface as in (8b), and after voiced stops and sonorants they surface as in (8d). I assume that the first vowel set is [-ATR] and that the second set, voiced stops, and sonorants are [+ATR][6]. As Madurese and the other languages discussed above, Babine has a rule

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[5]ε_1 is described as a front mid unrounded vowel slightly higher than ε_2; similarly, $ɔ_1$ is slightly higher than $ɔ_2$.

[6]Though *y* and *w* are generally assumed to be [+ATR], it is not clear why the other sonorants should have a [+ATR] specification. Perhaps Babine has extended the [+ATR] feature of voiced stops, so that all voiced segments are phonologically [+ATR], whether or not they require tongue root advancement in order to be voiced.

that associates [ATR] values to vowels: they receive [+ATR] from a preceding [+ATR] consonant, and [-ATR] elsewhere. These consonantal [ATR] values then spread to following vowels, producing the attested vowel alternations. The Babine facts are thus quite similar to the Armenian case just discussed, but importantly they preserve the [ATR] alternations intact, whereas Armenian has undergone a subsequent process of fronting.

Finally, I would like to mention the Chinese languages Wa and Yunnanese Jingpho (belonging to the Mon Khmer and Tibeto-Burman families respectively), wherein according to Maddieson and Ladefoged 1985 lax (i.e. [-ATR]) vowels occur with voiceless consonants and tense (i.e. [+ATR]) vowels with voiced consonants. I have not had the opportunity to study these languages further.

4.1.2. ATR → Voice

If voiced stops are indeed [+ATR], one might suggest that we should also expect to find cases where [+ATR] vowels cause adjacent consonants to become voiced. I do not believe that this should necessarily be so. The [+ATR] element of voiced stops is a secondary by-product of voicing, which is implemented by the feature [-stiff vocal folds][7]. When [+ATR] spreads to a voiceless stop we should not necessarily expect these stops to become voiced, because the [-stiff] feature required to produce voicing is not

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[7]In fact, as I mentioned above, the production of voicing in obstruents is brought about with the aid of both tongue root advancement and lowering of the larynx. I suggest later in this chapter that some languages may employ lowering of the larynx without tongue root advancement, though this possibility is highly marked.

already present in the stop. Nevertheless, there appear to be at least two cases in which vocalic ATR values spread to adjacent consonants and subsequently induce voicing. I survey each of these phenomena in turn.

In the Southwest Turkic languages (Turkish, Azeri, Gagauz, Turkmen), historically voiceless obstruents are voiced before [+ATR] vowels. Consider the proto-Turkic forms and their outcomes in modern Turkish in (9):

(9)	Proto-Turkic	Turkish	Proto-Turkic	Turkish
	**kara* 'black'	*kara*	**taŋ* 'dawn'	*tan*
	**käl-* 'come'	*gel-*	**täniz* 'sea'	*deniz*
	**kɨl* 'hair'	*kɨl*	**tɨg* 'sharp object'	*tɨğ* 'needle'
	**kit-* 'depart'	*git-*	**til* 'tongue'	*dil*
	**kol* 'hand'	*kol*	**toq* 'satiated'	*tok*
	**köz* 'eye'	*göz*	**tön-* 'turn'	*dön-*
	**kuš* 'bird'	*kuš*	**tut-* 'hold'	*tut-*
	**kül-* 'laugh'	*gül-*	**tüš-* 'fall'	*düš-*

In Vaux (forthcoming) I argue that we must assume a system characterized by two series of ATR vowels for proto-Turkic, wherein, as in the Armenian dialects described above, all [+ATR] vowels become [-back] and all [-ATR] vowels become [+back], as in (10):

(10)	[+ATR] ([-back])		[-ATR] ([+back])	
[+high]	*i*	*ü*	*ɨ*	*ʋ*
[-high, -low]	*ä*	*ö*		*ɔ*
[+low]			*a*	

In modern Turkish the old ATR oppositions are lost, and with them the velar-uvular alternations found in the other Turkic languages (which will be discussed in section 4.2.2). Though I have stated that the configuration [+ATR, +stiff] should not necessarily produce voicing, the Turkic case seems to indicate that tongue root advancement can in fact induce voicing. In these circumstances I assume a readjustment rule of the following nature:

(11) [+ATR] → [-stiff]

It is not clear to me whether this rule has a phonetic motivation, or results from a phonological reanalysis, something like 'all voiced stops are [+ATR], therefore all [+ATR] stops must be voiced'.

The second case of [+ATR] vowels voicing consonants appears in the Armenian dialect of Aresh, spoken in northeast Azerbaijan. Aresh generally preserves the classical Armenian consonants intact.

(12)	classical	Aresh	gloss
	bah	*bäh*	spade
	pah	*pah*	guard
	p^{h}*ak*	*p*^{h}*ak*	closed

Aresh has also developed an extensive system of [ATR] harmony, which produces [+ATR] vowels in many positions where they did not exist in classical Armenian[8]. Original voiceless consonants adjacent to vowels which have undergone this change become voiced in medial and final position in a number of words (Lusenc^{h} 1982:75).

(13)	classical	Aresh	gloss
	habet^{h}	*häbed*	tinder
	gitanal	*gidänäl*	know
	daganak	*dägänäg*	rod
	dastak	*dästäg*	wrist
	xorakn	*xöräg*	sunken-eyed
	orjak	*örjäg*	male
	t^{h}*ikunk*^{h}	*t*^{h}*ügüŋk*^{h}	back (anatomical)

One can see in forms such as *krak* > *kərak* 'fire', *hakaṙak* > *hakaṙak* 'contrary', *anyišatak* > *anhišatak* 'forgotten' that the *k* in word-final *-ak*

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[8]As I mentioned in chapter 2, it is difficult to determine whether vowel harmony in Aresh and other dialects involves [ATR] or [back], since there is no information on these dialects, where [ATR] and [back] values are generally predictable from each other.

sequences, for example, normally does not become voiced. Though the process of voicing adjacent to [+ATR] vowels does not appear to be productive and has many exceptions, I believe that it is best understood as the result of a rule spreading [+ATR] to consonants, followed by a rule like the one in (11).

We have seen in this section that there is considerable evidence supporting the hypothesis that voiced obstruents are specified [+ATR]. It does not appear to be true, however, that voiceless obstruents are necessarily [-ATR]; in most of the Armenian dialects mentioned above, for example, voiceless obstruents have no effect on vowels. This distribution follows naturally from the phonetic facts: production of voicing in obstruents requires pharyngeal expansion, but production of voiceless obstruents requires no special pharyngeal gesture.

It was pointed out to me when I presented an earlier version of this paper at the 1993 LSA conference that we might expect the [+ATR] element of voiced stops to play a role in [ATR] harmony systems. Within the theory of phonology I am proposing in this thesis, this expectation should be realized only in systems that spread all [ATR] values, since the [+ATR] element of voiced stops is neither marked nor contrastive. To the best of my knowledge [ATR] systems generally spread contrastive [ATR] values and therefore should ignore voiced consonants.

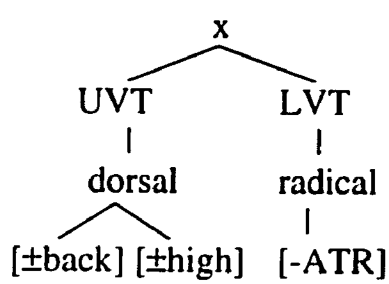
4.2. Uvulars

Further support for the theory that voiced stops are [+ATR] comes from the cross-linguistic distribution of uvular consonants. Many phonologists now assume that uvulars are characterized by a primary dorsal articulation and a secondary [-ATR] articulation (see Elorrieta 1992). If this is true, we should expect voiced uvular stops to be rare, because the tongue root cannot be simultaneously advanced and retracted. This distribution is strikingly confirmed in the world's languages. Furthermore, many languages with ATR harmony show synchronic alternations between *k* and *q* and between *g* and the voiced uvular fricative *ʁ*, which I demonstrate in this section to be easily accounted for if we assume that voiced stops are [+ATR] and uvulars are [-ATR]. In this section I consider the arguments presented in the literature for a [-ATR] element in uvulars, and survey the evidence of uvular asymmetry and velar-uvular alternations.

4.2.1. [-ATR] component of uvulars

The first generative treatment of uvulars was Chomsky and Halle 1968, where it was proposed that uvulars are [-high, +back]. Recent work by Elorrieta 1992 and others has shown that uvulars must have a [-ATR] component, as in (14) (N.B. Elorrieta, following Trigo 1991, assumes that there is a second type of uvular which has no [-ATR] element; I believe that this type is simply a back velar, and should not be called a uvular. I consider back velars later in this chapter):

(14)



The primary piece of evidence adduced in support of uvulars having a [-ATR] element comes from Coeur d'Alene, where ATR harmony is blocked by uvular consonants (Cole 1987, Elorrieta 1992)[9]. Uvulars also commonly lower adjacent high vowels (e.g. in Greenlandic (Elorrieta 1992:144) and Yakut (Wetzels 1986)), which as we have seen above is a characteristic side-product of [-ATR]. This process is traditionally explained (and still accepted by Elorrieta 1992) by assuming that uvulars have a [-high] specification under the dorsal node. I propose that [-high] is present but non-contrastive in uvulars, which are distinguished from velars by their [-ATR, -RTR] secondary articulation.

The assumption that uvulars have a [-ATR] specification also enables us to account for the alternations between velars and uvulars produced by ATR harmony in the Turkic and Tungusic languages (and perhaps Coeur d'Alene--see Elorrieta 1992:148). In both of these language families, roots are associated with floating [+ATR] or [-ATR] features (q.v. Vaux (forthcoming)), which then spread to all eligible segments in the root and suffixes; underlying dorsal consonants surface as dorsals in [+ATR] words, but as uvulars in [-ATR] words. Consider the alternations in (15) and (16):

---

[9]Doak 1992 suggests that uvulars do not block ATR harmony in Coeur d'Alene, but her argument crucially depends on the assumption of radical underspecification, which has been convincingly argued by Calabrese (forthcoming) to be incorrect.

(15) Turkic (examples from Uyghur (Hahn 1991); NB *i* is neutral)

(a) dative /-GA/

bala 'child'	→	*bali-ʁa*
hädä 'elder sister'	→	*hädi-gä*
waqit 'time'	→	*waqit-qa*
küč 'power'	→	*küč-kä*

(b) past /-GAn/

käl- 'come'	→	*käl-gän*
bar- 'go'	→	*bar-ʁan*
kir-mä- 'enter (neg.)'	→	*kir-mi-gän*
oqu- 'read'	→	*oqu-ʁan*

(c) imperative 3d person /-GIn/

käl- 'come'	→	*käl-gin*
bar- 'go'	→	*bar-ʁin*
išli- 'work'	→	*išli-gin*
oqu- 'read'	→	*oqu-ʁin*

(d) 1st plural present-future conditional /-K/

oqu- 'read'	→	*oqu-saq*
käl- 'come'	→	*käl-säk*

(16) Tungusic

(a) Even (Ard 1980:28, Comrie 1981:70)

K, G → *k, g* /_{*i e u o ə*}

q, ʁ /_{*ɪ a ʊ ɔ ɘ*}

(b) Bikin Nanay (Sem 1976:36-7)

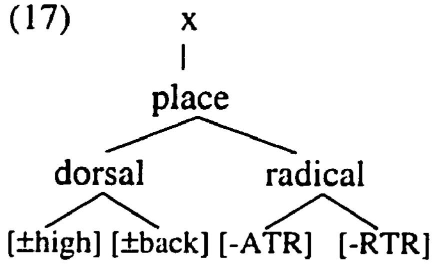
-ksa '-skin':	*giu* 'wild deer'	→	*giu-ksə* 'wild deer skin'
	mafa 'bear'	→	*mafa-qsa* 'bear skin'
-md'uga 'agent suffix':	*dala-* 'lead'	→	*dalamd'vʁa* 'leader'
	ulfi- 'sew'	→	*ulfimd'ugə* 'seamstress'

Traditional accounts for these alternations state that the feature spreading is [back], and [+back] dorsal consonants become uvular as a result of some unspecified phonetic implementation rule. This account suffers from two problems: the harmony feature is actually [ATR] (see Vaux (forthcoming)), and it is not clear why [+back] dorsals should become uvulars; note that in the Tungusic languages both front and back [-ATR] vowels change velars into uvulars, and [+back, +ATR] vowels do not. If we assume that uvulars are dorsals with a [-ATR] secondary articulation, however, the Turkic and Tungusic facts fall in line: when harmonic [-ATR] spreads to a dorsal consonant, a [dorsal, -ATR] segment is produced, which is a uvular. I consider this phenomenon further in the next section. One might suggest that the Tungusic facts indicate that uvulars are not crucially [+back], since they are produced from underlying velars regardless of the [back] values of neighboring vowels. This is not necessarily true, because we could postulate that dorsals with a secondary [-ATR] articulation automatically become [+back, -high] as well. There is evidence that uvulars can be [-back], however: according to Colarusso 1975, several Northwest Caucasian languages have [-back] uvulars opposed to a set of [+back] uvulars; this is notably the case in Abkhaz, which I have been able to confirm in work with a native informant (see discussion below). It is also interesting to note that the one Turkic language (Turkish) and several Tungusic languages (standard Evenki, Oroč, Sibe, Manchu) which have lost ATR harmony have also lost this velar ~ uvular alternation; Turkish, for example, now employs [back] harmony, and has replaced the old velar-uvular alternation with a front velar-back velar alternation.

Trigo 1991:124-5 presents further historical evidence from the Kedah dialect of Malay, where a process of oral depletion changes the voiced uvular fricative ʁ into the voiced pharyngeal fricative ʕ, and Nootka, where uvulars become pharyngeals after a historical process of oral depletion has applied. Colarusso 1985:367 mentions similar developments in Nitinat, Columbian, Abkhaz, Abaza, and Northwest Semitic, whereby historical uvulars become pharyngeals. Both Trigo and McCarthy 1991 assume that the secondary articulation of uvulars is pharyngeal, not [-ATR], so that the above processes simply result from delinking of the dorsal element. Remember that for the reasons outlined above we must assume that uvulars are actually [-ATR]; we can still maintain Trigo and McCarthy's analysis, however, if we assume that pharyngeals are actually [-ATR, +RTR], as has been proposed by McCarthy 1991:53. I consider this issue further in section 4.3.3.

We have seen in this section that there is ample evidence for uvulars containing a [-ATR] specification. Importantly, though, the existence of palatalized uvulars in Abkhaz and other Northwest Caucasian languages suggests that uvulars need not be [+back], as is currently assumed. Moreover, given the constraint that [+consonantal] segments cannot be [-high, -back] (cf. chapter 1), these palatalized uvulars must be [+high]. In other words, a palatalized glottalized[10] uvular differs from a [-back] *k*'´ (both of which exist in Abkhaz) solely with respect to the feature [ATR]: *k*'´ is [+high, -back] and unspecified for [ATR], whereas *q*'´ is [+high, -back, -ATR]. The same analysis must be made for the Northwest Caucasian language Ubykh (Colarusso 1988:438). In light of these facts, I propose that uvulars are represented as follows:

(17)



In this representation uvulars still have a primary dorsal articulation, but the values for the features [high] and [back] vary, as discussed above: palatalized uvulars are [+high, -back, -ATR, -RTR], and regular uvulars are [-high, +back, -ATR, -RTR]. I assume that uvulars are [-RTR] based on the fact that they do not show the apparent spreading of [+low] characteristic of [+RTR] segments. I assume that the production of uvulars from the pharyngealization (i.e. spreading of [-ATR, +RTR]) of dorsals in Semitic languages results from the activity of a marking statement *[-ATR, +RTR]/_[+cons], which delinks the feature [+RTR] in [-ATR] consonants.

[10]By historical chance, Abkhaz has glottalized but not plain uvular stops (though it does possess a plain *k*').

4.2.2. Uvular asymmetry

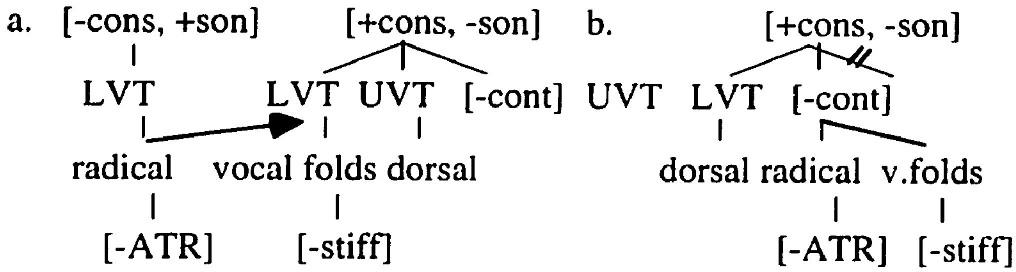
In the preceding sections I presented evidence that voiced stops have a [+ATR] specification and that uvulars are dorsals with a [-ATR] specification. If these hypotheses are correct, we should expect that voiced uvular stops should be highly complex and rare, because it is not physically possible to simultaneously advance the tongue root to produce voicing and retract the tongue root to produce a uvular articulation. This prediction is born out in the languages of the world, notably in the Northwest Caucasian, Dagestanian, Semitic, and Turkic families, which generally have rich systems of uvular and pharyngeal consonants, but not uvular *ɢ*. The most striking illustration comes from the Turkic languages, which have extensive synchronic alternations between *k* ~ *q* and *g* ~ *ʁ*, as we have already seen in (15). I propose that in these cases spreading of [-ATR] to an underlying *g* produces the configuration [-stiff, -ATR], which violates an active marking statement *[-stiff, -ATR]/_[-cont] (cf. Calabrese (forthcoming)). In other words, the retraction of the tongue root spread from the preceding vowel prevents the creation of a sufficient pressure differential to produce the voicing targeted by [-stiff]. In order to produce voicing while preserving the [-ATR] feature, the illicit segment is then repaired by delinking [-cont], thereby becoming the uvular fricative *ʁ*[11], which does not require [+ATR] in

---

[11]I assume following Calabrese 1988 that delinking of a binary feature entails insertion of its inverse, so that delinking of [-cont] produces a [+cont] segment. Note in this case that delinking does not apply to either of the features in the marking statement ([-stiff] or [-ATR]), but rather to the feature specified in the environment ([-cont]).

order to be voiced. This process would be represented as follows (intermediate nodes omitted):

(18)



It appears that the [-ATR] feature of the uvular articulation is more important than the [+ATR] feature required for voicing (i.e. [-ATR] *G* becomes *ʁ* and not *g*), and similarly the voice feature is more important, so we do not get *g* ~ *q*; this makes sense, considering that [+ATR] is merely a side-product of stop voicing, and not an independent feature.

It is important to note that some languages do have *G*, however. One might suggest that these must all be languages with uvulars of the [dorsal, +back] type (i.e. without a [-ATR] element) assumed by Trigo 1991, Elorrieta 1992, and others. We should expect, then, that uvulars in these languages will not block ATR harmony, develop into pharyngeals, or show any of the other characteristics associated with the [-ATR] element of uvulars discussed in section 4.2.1. I would like to claim, however, that *all* uvulars have a [-ATR] element, and that the dorsal, [+back] segments are simply back velars such as we find in modern Turkish. Voiced stops of this type seem to be just as acceptable as *g*'s without a [back] specification; consequently, if these were actually uvulars we would not expect to find the widespread absence of uvular *G* among the world's languages. My theory predicts that the languages where *G* exists are able to manipulate other mechanism(s) typically involved in the facilitation of voicing, such as the lowering of the larynx mentioned above, in order to produce voicing in uvular voiced stops. This alternative strategy is highly marked and complex, presumably because of the difficulty involved in manipulating these structures independently of the pharynx. The status of non-ATR uvulars and alternative voicing strategies are empirical questions which I will not consider in this chapter.

Interestingly, many of the languages with *G* have no voiceless counterpart *q* (Maddieson 1984 lists Persian, Klamath, Somali, Kunimaipa, Kwakw'ala, and Lak; Kibrik and Kodzasov 1990 also include the Dagestanian language Andi). It is possible that these languages actually have a conventional unaspirated voiceless uvular *q*, and the investigators of these languages mistook the absence of aspiration for voicing, as is common for speakers of English. This may well be the case in Lak, for example, which according to a different analysis (Murkelinskij 1967) possesses an unaspirated *q*, but no *G*. In the case of Persian, however, we have reasonably reliable evidence from phoneticians (Majidi and Ternes 1991) that Persian velar *ʁ* is pronounced [*G*] initially, after nasals, and when geminated. Further study of the articulatory mechanisms involved in this case would be useful.

There are also languages with both *G* and *q*: Awiya (cited in Maddieson 1984), Haida, Tsimshian, and Kwakiutl (Boaz 1911), Chilcotin (Cook 1986), and the Dagestanian languages Tabasaran (Djubek dialect), Rutul, Tsaxur, Kryz, Budux, and Xinalug (Kibrik and Kodzasov 1990). Unfortunately these languages (mainly American Indian languages of the Pacific Northwest and Dagestanian languages of the Caucasus) have not been properly studied to date, and we cannot be sure what the actual phonetic status of *G* is in each case. Note that Swanton 1911:211 says Haida *G* is pronounced 'feebly', which may mean that it is actually a lenis stop or a fricative, and Boaz 1911:293 observes that Tsimshian *G* is pronounced as *ʁ* except in slow speech, and Kwakiutl *G* is 'so strong that it is very easily mistaken for a surd' (1911:429); in each of these cases there appears to be trouble producing the *G*, and fricativization or devoicing is employed to make it more pronounceable. If any of these languages actually possesses both [*G*] and [*q*], however, we cannot appeal to the aspiration argument just mentioned, but must assume their voiced uvular stops are of the [dorsal, +back] type, or that some mechanism other than tongue root advancement is being employed to expand the supraglottal cavity.

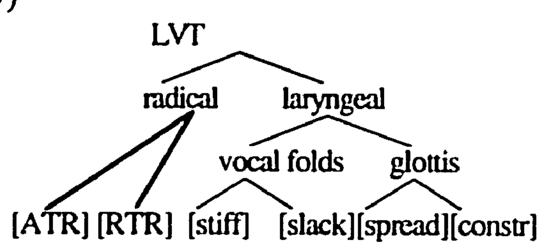
It has been suggested by an anonymous reviewer that the *G* gap does not involve ATR clash, as I am proposing, but is rather an extreme case of the so-called '*p*/*g* gap', whereby according to traditional linguists languages tend to have *b* more often than *p*, and *k* more often than *g*. Under this interpretation, the lack of uvular *G* is merely an extension of the *k*-*g* distribution. I do not find the two analyses to be incompatible. Though Maddiesson 1984:36 has shown that the *p*/*g* gap is not statistically significant among the world's languages, I believe that the basic insight of this reviewer is correct, namely that constraints on the articulatory apparatus underlie the absence of *p*, *g*, and *G* cross-linguistically. In the case of *g* and *G*, the relevant constraint is the difficulty involved in producing a sufficiently large cavity between the dorsal constriction and the vocal folds to allow voicing; in this much I agree with the reviewer. The analysis I am proposing here goes beyond this general statement, however, in attributing the significantly greater rarity of voiced uvular stops to the fact that tongue root retraction required by uvulars makes it even more difficult to produce a sufficiently large supralaryngeal cavity.

In this section I have provided several new arguments for Trigo 1991's theory of [+ATR] in voiced stops and a revised version of the proposal that uvulars have a [-ATR] specification (Cole 1987, Trigo 1991, Elorrieta 1992), and shown that the combination of these two ideas correctly predicts the peculiar distribution of voiced uvulars in the world's languages. In the next section I consider what these facts might suggest about the structure of the laryngeal and pharyngeal nodes.

4.3. The Position of ATR in Feature Geometry

ATR has received three basic interpretations in the literature: Cole 1987 and Halle 1987 classify ATR as an oral place node, together with labial, coronal, and dorsal; Halle 1989 places it under the laryngeal node; and McCarthy 1991 (implicitly) places it under the pharyngeal node. In this section I argue that ATR belongs under the radical node and support the configuration in (19):

(19)

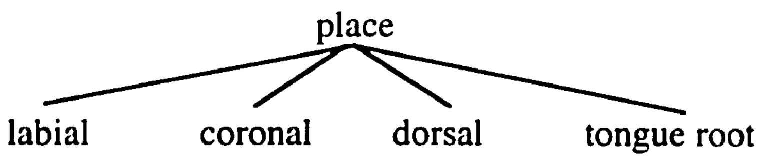


This structure is essentially a combination of McCarthy and Halle's proposals; though formally almost identical to Halle 1989's system, it also allows us to account for the generalizations about guttural segments described in McCarthy 1991, and the patterning of pharyngeal versus laryngeal segments discussed in Elorrieta 1992.

4.3.1. ATR as an independent articulator

Early works on feature geometry (Halle 1987, Cole 1987) assumed that the tongue root was an independent articulator dominated by the place node, as in (20):

(20)

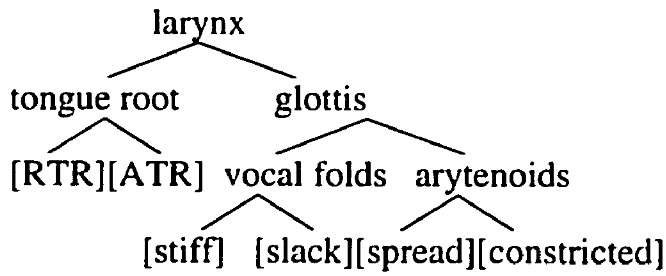


I will not consider this proposal in detail here, because it is not directly relevant to my theory, but merely point out some basic problems it encounters. First of all, it does not capture the common patterning of uvular, pharyngeal, and laryngeal segments established by McCarthy 1991. Second, it cannot account for the fairly common development of pharyngeals from uvulars, which I consider in more detail in section 4.3.3. Finally, the structure in (20) implies that there will exist segments defined solely by a [+ATR] or [-ATR] articulation, which is incorrect if we accept McCarthy's proposal that uvulars are [+back, -ATR] and pharyngeals are [+RTR, -ATR]. Clearly advancement of the tongue root will not produce any type of constriction; it appears that retraction of the tongue root also cannot produce consonantal constriction. Consequently, ATR must be subordinate to some other primary articulator (though not in the strict geometric sense).

4.3.2. ATR and the Laryngeal Node

The extensive interactions between voicing and ATR described in section 4.1 might lead us to look favorably upon Halle 1989's proposal that (for independent reasons) places both [ATR] and [stiff vocal folds] under the laryngeal node, as in (21):

(21)



In this subsection I argue that Halle's model enables us to capture the generalizations considered in this chapter, but first requires some modifications of potentially confusing node labels.

Though in some respects, such as grouping [ATR] and [RTR] under a common node, the structure in (21) is similar to the one proposed in McCarthy 1991, it makes certain strong predictions about interactions between tongue root features and voicing which do not seem to be correct. It is true, as Halle has pointed out, that pharyngeal articulations are often associated with laryngeal gestures, such as the common production of creaky voice in pharyngeal ʕ and *ħ*, but these types of interaction do not necessarily imply affiliation under a common node. The main problem is that we do not want to implicate [ATR] and [RTR] in processes of voicing assimilation and final devoicing, which are generally taken to involve spreading and delinking of the laryngeal node respectively. For example, given that final devoicing in Sanskrit and other languages with distinctive aspiration delinks both voice and aspiration features, we may suppose (following McCarthy

1988) that the process traditionally labelled 'final devoicing' is actually deletion of the laryngeal node. If we take Halle's proposal at face value, we should expect that final uvulars become velars in languages with final devoicing; this is incorrect, as we can see in Turkic languages such as Tatar (Poppe (1968:18)):

(22)	*/ayag/* 'foot'	→	nom. sg.	*ayaq*
			poss. sg.	*ayaʁ-ɨ* 'his foot'

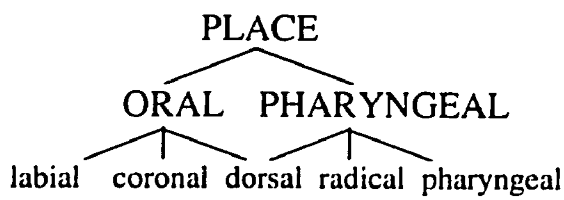
Similarly, we should expect that pharyngeal consonants would be deleted (or perhaps become *h*) by final devoicing; McCarthy 1991:35-6 has shown that pharyngeals are in fact unaffected by such processes.

The issues just mentioned do not actually pose more than a terminological problem for Halle's system, however: what is termed laryngeal assimilation and delinking in other theories would simply be operations on Halle's glottis node. If we say that final devoicing is actually delinking of his glottis node, tongue root and pharyngeal features remain unaffected, as desired. My revised geometry (19) is essentially identical to Halle's, but resolves the terminological confusion produced by his term 'glottis'. In my system final devoicing is still delinking of the laryngeal node, but the content and structure of the laryngeal node is identical to that of Halle's glottis node. In the next section I consider how this structure differs empirically from McCarthy's proposal.

4.3.3. ATR and the Pharyngeal Node

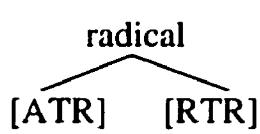
McCarthy 1991 provides convincing evidence for the existence of a pharyngeal node, dominated by the place node and dominating radical, pharyngeal, and dorsal articulators, as in (23):

(23)



The affiliation of the dorsal articulator to both the oral and pharyngeal nodes is problematic. Halle 1989 has demonstrated that the data which led McCarthy to postulate this structure can be accounted for by a model in which the dorsal articulator is dominated only by the Place node (= McCarthy's oral node). McCarthy also implies that [ATR] belongs under the radical articulator, though this is never explicitly stated. Given the evidence presented earlier for uvulars having a [-ATR] element, it is a simple matter to augment his representation of uvulars as [dorsal, radical] with an [ATR] node placed under the radical articulator. Since this addition does not interfere with his analysis in any way, and allows us to account for the [-ATR] element of uvulars and pharyngeals, I henceforth assume that McCarthy's radical articulator dominates [ATR]. Similarly, I assume that the radical articulator dominates [RTR], for reasons to be discussed in section 4.3.3.1. My modifications of McCarthy's tree are summarized in (24):

(24)



McCarthy (1991:53) proposes the representations of uvulars, pharyngeals, and laryngeals given in (25 a, f, h) (N.B. I have replaced his [radical] with [-ATR]):

(25)	(a)	[+back, -ATR]	uvulars
	(b)	[-ATR]	Ø
	(c)	[+ATR]	Ø
	(d)	[+ATR, +RTR]	Ø
	(e)	[+ATR, -RTR]	Ø
	(f)	[-ATR, +RTR]	pharyngeals
	(g)	[-ATR, -RTR]	Ø
	(h)	[+RTR]	laryngeals (maybe)
	(i)	[-RTR]	Ø

I have added the other possible permutations of McCarthy's pharyngeal features for the sake of completeness[12]. As Elorrieta 1992:145 has pointed out, the structure in (24) allows us to account for the patterning of uvulars and pharyngeals against laryngeals in Coeur d'Alene: uvulars and pharyngeals share the feature [-ATR], whereas laryngeals are only [+RTR].

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[12]I have included single feature possibilities such as [-ATR] (25b) because McCarthy assumes underspecification, and such combinations therefore are theoretically possible. In RRT, however, activation of one radical feature entails activation of the other, so only four combinations are possible, one of which ([+ATR, +RTR]) is ruled out by a marking prohibition. These possibilities are discussed below.

McCarthy seems to treat [RTR] as a privative feature, so that [-RTR] is the same as being unspecified for [RTR]; this assumption rules out (25 e, g, i). [ATR], on the other hand, is equipollent, and can be positive, in the case of voiced consonants and tense vowels, *or* negative, in the case of uvulars, pharyngeals, and lax vowels. [+ATR] and [-RTR] cannot form constrictions for the same reason that [-high] cannot, as discussed earlier, so consonants cannot be of the types (25 c, e, i). We might expect type (25b) to exist, but apparently it does not, so we must assume that retraction of the tongue root does not by itself form sufficient constriction to produce consonantal articulation. Presumably the reason that [+RTR] is sufficient constriction for a consonant but [-ATR] is not is that [+RTR] involves constriction of both walls of the pharynx, as well as the epiglottis, whereas [-ATR] only involves the front wall of the pharynx; in this sense, [+RTR] involves twice as much constriction as [-ATR]. I argue below, however, that laryngeals do not in fact possess radical features, and that neither [ATR] nor [RTR] is sufficient to produce a consonantal articulation.

McCarthy suggests (with some reservations) that laryngeal segments (*h* and ʔ) are [+RTR]. If this were the case, though, we should expect laryngeals to have the same effects that are associated with other segments containing a [+RTR] specification. McCarthy himself observes that pharyngeals make adjacent high vowels [+low] in Semitic languages; this must come from the [+RTR] feature, because as we have seen, [-ATR] only makes high vowels into mid vowels[13]. Consequently, if laryngeals are

[13]This fact is of course only significant in languages possessing mid vowels.

[+RTR], they should also make high vowels [+low], but they in fact have no effect on adjacent vowels, as McCarthy observes. Similarly, we should expect that laryngealized [+ATR] vowels would not exist, because of the incompatibility of tongue root retraction and pharyngeal constriction mentioned above; the fact that all vowels can be laryngealized in languages such as Sedang, an Austro-Asiatic language with a standard seven vowel system (Smith (1968)), again indicates that laryngeals cannot be [+RTR]. We should also expect if laryngeals are defined by a [+RTR] feature that *h* and ˀ would not be affected by rules deleting the laryngeal node; this does not appear to be the case in Sanskrit, which as mentioned above delinks laryngeal features in word-final position, and does not allow final *h*. Similarly, the Siouan language Dakota allows only plain voiceless stops, voiceless fricatives, and the coronal sonorants *l*, *n*, and *y* in word-final position, and disallows aspirated, ejective, and voiced consonants, voiced fricatives, *m*, *w*, *h*, and ˀ (Shaw (1989:5-6)). Dakota thus appears to have a constraint which disallows laryngeal features (voice, aspiration, ejection) in word-final codas; the fact that *h* and ˀ are disallowed in this environment strongly suggests that they are defined in terms of laryngeal features, and not pharyngeal features. Finally, if laryngeals were [+RTR] we would not be

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In RRT, as discussed in chapter 1, we assume a set of equivalencies between consonantal and vocalic features in order to capture common C-V interactions. Among these equivalencies are :

consonantal	vocalic
+RTR	[+low]
coronal, [-ant]	[-back]
labial	[+round]

able to describe the Northeast Caucasian epiglottals, which contrast with pharyngeals and laryngeals in Agul and Avar[14]. I propose that the epiglottals are actually [-RTR, -ATR], and (following Halle and Stevens (1971)) *h* and ʔ are actually [+spread] and [+constricted] respectively. My revised geometry still captures the generalizations about Semitic gutturals observed by McCarthy 1991: gutturals are the class of segments defined by the lower vocal tract node.

The final possibility predicted by McCarthy's system is (23d), which in my theory should describe pharyngealized and emphatic voiced stops; I consider these segments briefly now.

4.3.3.1. Pharyngeals and Pharyngealized and Emphatic Consonants

I assume that pharyngeals are [-ATR, +RTR], and that pharyngealization and emphasis are phonologically identical, both being characterized by a [+RTR] specification. In addition to the evidence for this classification adduced by McCarthy 1991, Hoberman 1988, Czaykowska-Higgins 1987, Halle 1989, and others, I would add the empirical observation that there do not appear to be any languages which employ both pharyngealization and emphasis.

As I mentioned above, pharyngealized and emphatic voiced consonants are perfectly plausible given the structure in (21)--[ATR] and [RTR] are distinct features, and therefore should be able to act separately.

---

[14]My information on Agul and Avar comes from the UCLA phonetic database, which illustrates contrasts in these two languages between pharyngeals, epiglottals, and laryngeals. According to Kibrik and Kodzasov 1990:320-46, epiglottals are quite common in the Dagestanian languages, though earlier grammars as a rule do not mention these segments.

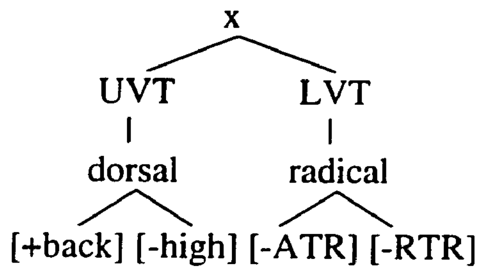
Phonetically speaking, however, we might expect emphatic/pharyngealized voiced stops to be rare, because the pharyngeal constriction produced by [+RTR] could interfere with the expansion of the pharyngeal cavity carried out by the tongue root in order to produce voicing in stops. Pharyngealized and emphatic voiced stops do in fact appear to be quite rare: the Northwest Caucasian languages, for example, have rich inventories of pharyngealized consonants, but these are normally not formed from voiced stops (Colarusso 1988:421-54). Arabic is unique among the Semitic languages in having an emphatic *D*, which seems to have developed from a lateral fricative (McCarthy 1991:3). Note, however, that none of the Semitic languages form an emphatic from *g*, though many have an emphatic *q* from *k*. Maddieson (1984) lists a 'pharyngealized voiced dental/alveolar stop' *D* in the Berber language Shilha, and a 'pharyngealized voiced dental plosive' *D* in the Berber language Tuareg; other than these cases, which may be borrowed from Arabic, I have found no emphatic or pharyngealized voiced stops in the languages of the world.

I attribute the limited presence of pharyngealized/emphatic voiced stops to variation in the techniques used to produce [+RTR]: in addition to activating the pharyngeal constrictors, it sometimes involves pulling the epiglottis back toward the back wall of the pharynx (Ladefoged 1982:149), but sometimes involves both epiglottal retraction *and* tongue root retraction (McCarthy 1991:5). The independence of the epiglottis from the rest of the pharynx is shown by the presence of both epiglottal and pharyngeal fricatives in Caucasian languages such as Avar and Agul; the epiglottis and pharyngeal walls normally seem to work in tandem, however. In the cases where [+RTR] is produced solely by retraction of the epiglottis, voiced emphatics should be possible, because movement of the epiglottis does not alter the volume of the supraglottal cavity. The rarity of pharyngealized/ emphatic voiced stops seems to indicate that production of [+RTR] normally involves tongue root retraction as well, just as it normally but not always involves laryngeal activity (Ladefoged 1982:149).

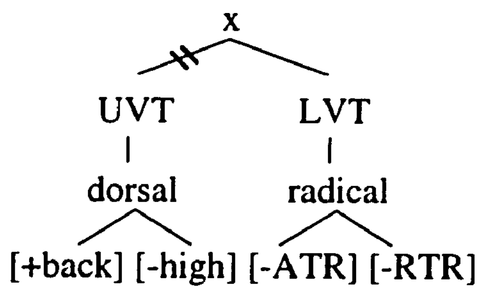
I believe that this type of articulatory implication within the pharynx can also account for the development of pharyngeals from uvulars in Nootka, Nitinat, Columbian, Abkhaz, Abaza, and Northwest Semitic. McCarthy 1991 suggests that these developments result from a process which deletes oral place features, but does not explain how we get the [+RTR] element of the pharyngeals, since according to my analysis uvulars are [-ATR, -RTR]. Delinking of the uvular's primary dorsal articulator should produce pure [-ATR, -RTR] segments; as we have already seen, though, this feature configuration is not sufficient to produce [+consonantal] constriction. I propose that this fact is reflected in a UG marking statement of the form *[-ATR, -RTR]/_[-cons], which is active in all languages except those possessing epiglottals. The debuccalization process mentioned above produces violations of this marking statement, which are repaired by delinking [-RTR]. The stages of development from uvulars to pharyngeals would then be represented as follows:

(26)

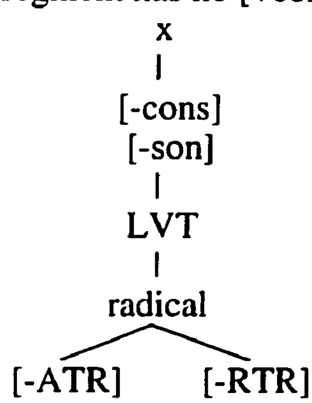
a. stage 1: uvular consonant



b. stage 2: debuccalization



c. stage 3: segment has no [+cons] constriction; becomes [-cons]



d. stage 4: *[-ATR, -RTR]/_[-cons] marking statement violated

e. stage 5: violation repaired by delinking [-RTR]

x
|
[-cons]
[-son]
|
LVT
|
radical
/ \\
[-ATR] [-RTR]

f. stage 6: final form: pharyngeal glide

x
|
[-cons]
[-son]
|
LVT
|
radical
/ \\
[-ATR] [-RTR]

Another interesting manifestation of pharyngeal coarticulation is the production of uvular *q* from emphatic *k* in the Semitic languages. This phenomenon has led some researchers to postulate that emphasis is actually [-ATR], not [+RTR], which is supported to some extent by the fact that uvulars and emphatics sometimes pattern together in phonological rules (McCarthy 1991:57-8). Within RRT, however, emphasis must involve either both radical features or neither, given the requirement of full specification. I assume that emphasis involves a secondary articulation containing the radical features [-ATR, +RTR]. It is then a simple matter to say that the cases where emphatics cause vowels to become [+low] involve spreading of [+RTR], whereas cases where they pattern with uvulars involve [-ATR].

An interesting case study for the analysis presented here is Ubykh, which according to Colarusso 1988:438 possesses a plain *q*, a palatalized *q*´, and a pharyngeal $q^ʕ$. My proposal distinguishes these three uvulars in the following manner: *q* = [dorsal, -ATR, -RTR]; *q*´ = [dorsal, +high, -back, -ATR, -RTR]; $q^ʕ$ = [dorsal, -RTR, +RTR].

4.3.3.2. Pharyngealized vowels

Given the relationship between tongue root and pharyngeal activity that we have established in this chapter, we should expect that pharyngealized [+ATR] vowels should not exist, as expressed by the prohibition *[+ATR, +RTR]. This prediction appears to be born out in the languages I have examined. The standard five vowel system {*i ɛ a ɔ u*} of the Afro-Asiatic language Hamer, for example, surfaces as {$ɪ^ʕ$ $ɛ^ʕ$ $a^ʕ$ $ɔ^ʕ$ $ʊ^ʕ$} when pharyngealized (Lydall 1976), indicating that [+ATR] vowels become [-ATR] when pharyngealized. Given the common lowering effect of [+RTR] on vowels, one might wonder why the Hamer vowels do not all become [+low]. I suggest that UG provides a marking statement *[+RTR, -low] which is deactivated in Hamer but active in languages where [+RTR] vowels become [+low].

Apparent cases of pharyngealized [+ATR] vowels in systems of five vowels or fewer should not necessarily bother us, because of the tendency to transcribe vowels as <*i e a o u*>, regardless of their actual [ATR] values. What is really needed is a seven vowel system (i.e. {*i e ɛ a ɔ o u*}) with pharyngealized counterparts, where we can be sure that there are actually [ATR] oppositions; such systems apparently do not exist.

4.3.4. *The Lower Vocal Tract Node*

In the preceding sections I provided evidence for a revised version of Halle and McCarthy's proposed feature geometries, represented in (1). This new theory differs from McCarthy's in grouping pharyngeal and laryngeal features under a common node, explicitly placing [ATR] under the radical articulator, and describing laryngeals with laryngeal rather than pharyngeal features. It allows us to capture the fact that gutturals (uvulars, pharyngeals, and laryngeals, the class defined by our lower vocal tract node) pattern together in Semitic, and describe the patterning of uvulars and pharyngeals against laryngeals in terms of a common node (our radical node) instead of a common feature ([-ATR]). Thus, in our theory the groupings {uvular, pharyngeal} and {uvular, pharyngeal, laryngeal} are exactly parallel, being defined by affiliation to a common node, whereas McCarthy's theory must appeal to two different types of determinant. Note that our theory predicts uvulars and pharyngeals will pattern together with epiglottals against laryngeals: I have not yet pursued this possibility.

I have also shown that we should revise McCarthy's analysis of the segments produced by combining the pharyngeal features [ATR] and [RTR], given in (25). In my revised system, these features produce the following alternatives:

(27)	(a)	[+ATR, +RTR]	(impossible)
	(b)	[+ATR, -RTR]	voiced stops (2^{o} articulation)
	(c)	[-ATR, +RTR]	pharyngeals, pharyngealized consonants (2^{o} articulation)
	(d)	[-ATR, -RTR]	epiglottals, uvulars (2^{o} articulation)

In this system, laryngeals have only laryngeal features: *h* is [+spread, -constricted, +stiff, -slack], and ʔ is [+constricted, -spread, +stiff, -slack] (cf. Halle and Stevens 1971:209).

My proposal is thus essentially a combination of Halle and McCarthy's structures, though in many respects it is more similar to Halle's.

4.4. Conclusions

The combination of Trigo 1991's theory of consonantal [ATR] with McCarthy 1991's theory of pharyngeal structure makes several strong predictions concerning the interaction of voicing with uvulars, pharyngeals, and pharyngealized consonants. I have examined a number of these predictions, and shown that many of them appear to be correct, particularly involving asymmetries among uvular and pharyngealized consonants and velar-uvular alternations. I have also argued that the interactions between consonant voicing and vocalic tenseness do not necessarily support Halle 1989's claim that [ATR] belongs to the laryngeal node, and proposed that [ATR] actually belongs under a modified version of McCarthy 1991's pharyngeal node.

Perhaps the most significant implication of the phenomena considered in this chapter is the idea that [ATR] and [RTR] are not 'ersatz' features, as has been claimed by Clements 1991. As we saw in chapter 1, Clements proposed a system of phonological representation wherein place of articulation for consonants and vowels are defined by a single set of features: labial consonants and round vowels are [labial], coronal consonants and front vowels are [coronal], velar consonants and back vowels are [dorsal], and so on. Clements furthermore claims that the features [ATR] and [RTR] are invalid, and attempts to absorb their functions within two new features, [open] and [pharyngeal]. In order to make this analysis work, however, Clements is forced to postulate three different features [open 1], [open 2], and [open 3]: [open 1] distinguishes [+ATR] and [-ATR] high vowels, [open 2] distinguishes [+ATR] and [-ATR] mid vowels, and [open 3] distinguishes [+ATR] and [-ATR] low vowels, as in (28):

(28)	lab	cor	dors	phar	open1	open2	open3
i	-	+	-	-	-	-	-
ü	+	+	-	-	-	-	-
ɪ	-	+	-	-	+	-	-
e	-	+	-	-	+	+	-
ö	+	+	-	-	+	+	-
ɛ	-	+	-	-	+	+	+
æ	-	+	-	+	+	+	+
a	-	-	+	+	+	+	+
ɔ	+	-	+	-	+	+	+
o	+	-	+	-	+	+	-
ʊ	+	-	+	-	+	-	-
u	+	-	+	-	-	-	-

Formally this system is inferior to the RRT model, because it replaces two features ([high] and [ATR]) with three features ([open 1, 2, 3]). The most significant flaw in Clements' model, though, is that it fails to capture the special behavior of [ATR], which as we have seen in this chapter plays a significant role in phonological interactions between consonants and vowels. These interactions make perfect sense when viewed as products of tongue root manipulations, but become completely arbitrary in terms of Clements' three [open] features, which have no phonetic connection to voicing, emphasis, uvularity, or any of the other features discussed in this chapter. I conclude that the feature [ATR] is a vital and integral part of the feature geometry provided by UG.

5
Laryngeal Features and Consonant Shifts

This chapter contributes to our knowledge of the laryngeal features involved in voicing and aspiration through an investigation of the phonological behavior of voiced and aspirated consonants in a number of languages. I pay particular attention to the voiced aspirates found in the Armenian dialect of New Julfa, a suburb of Isfahan, Iran. Some of the theoretical claims that emerge from my investigation include the idea that nasal voicing is constrained by a marking statement governing occurrences of the configuration [+nasal, +spread glottis]; that aspiration can induce voicing; that the reasons behind the development of the Armenian voiced aspirates may be related to the ones that give rise to the distribution of voicing and aspiration in English; and that the consonant shifts found in Armenian dialects and modern Indic languages are properly viewed as the results of the various repair strategies proposed by Calabrese 1988.

Throughout this chapter I rely on the description of the New Julfa dialect by Adjarian 1940[1] based on field notes from a month spent in Isfahan in 1919, when a handful of native speakers were still alive. Information from Allen 1950 is employed only secondarily, because it is not clear that his informant was a true native speaker of the dialect.

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[1] Adjarian's name is spelled <Adjarian> in French works and <Ačaŕyan> in Armenian works. In this chapter I consistently employ <Adjarian> to avoid confusion.

5.1. Basics

New Julfa has the phonemic inventory in (1).

(1)

b	b^h	*p*	p^h	*f*	*v*	*m*				
d	d^h	*t*	t^h	*s*	*z*	*n*				
j	j^h	*c*	c^h							
ǰ	$ǰ^h$	*č*	$č^h$	*š*	*ž*					
g	g^h	*k*	k^h							
				χ	*ʁ*					
				h	*ɦ*					
							ṙ	*r*	*l*	*l'*

i		*u*
e		*o*
ɛ		*ɔ*
	a	

As in standard Armenian, there is also a surface schwa created by epenthesis. The [+ATR] mid vowels are phonetically slightly diphthongized [^{i}e] and [^{u}o]. In this chapter I employ Adjarian's notation for the vowels: *<e o ē ō>* = */e o ɛ ɔ/* respectively. Among the consonants, New Julfa differs from standard Armenian in possessing a voiced *h* (*ɦ*) and a palatal *l'*, the latter of which is however quite rare. The most notable feature of the New Julfa consonant system is the existence of four stop series, plain voiced and voiceless and voiced and voiceless aspirated. This system is similar to what we find in many Indic languages, as well as a number of Armenian dialects (cf. chapter 1). In the following section I survey a number of interesting phenomena involving the laryngeal features which serve to distinguish the New Julfa consonant series.

5.2. Phonetic aspects of voiced aspirates

5.2.1. Phonetics of cross-linguistic laryngeal contrasts

In order to understand the phonological behavior of voiced aspirates, it is first necessary to understand the articulatory and acoustic mechanics of their production. According to Ladefoged 1982, it is in fact physically impossible to produce simultaneous voicing and aspiration: the rapid expulsion of breath involved in aspiration precludes the maintenance of a pressure differential between the subglottal and supraglottal cavities sufficient to enable periodic vibration of the vocal folds. In Ladefoged's view the perception of aspiration in stops actually depends more on the amount of time between release of a stop closure and the onset of voicing (V(oice) O(nset) T(ime)) than on degree of airflow through the vocal tract. Segments with a VOT greater than 40 milliseconds are generally perceived as voiceless and aspirated, independent of the amount of aspiration actually occurring during that interval. Given that the perception of aspiration is directly related to the period of voicelessness between the release of closure and the onset of voicing, aspiration and voicing are in fact in complementary distribution.

Perceptual studies have shown that humans are able to distinguish three categories of VOT: advanced, short lag, and long lag. Segments with advanced VOT, in which voicing begins before release of the closure, are perceived as voiced. Segments with short lag VOT, in which voicing begins within 30 milliseconds after release of the closure, are perceived as voiced or voiceless unaspirated, depending on the system of laryngeal oppositions in the language in question. Segments with long lag VOT, in which voicing begins 40 or more milliseconds after release of the closure, are perceived as voiceless plain or aspirated, again depending on the system of laryngeal oppositions in the language in question. In English, for example, short lag stops are perceived as voiced in word-initial position, but as plain voiceless after *s*. Long lag stops, on the other hand, are always perceived as plain voiceless by English speakers, but as voiceless aspirated by speakers of Thai, Hindi, and other languages with three-way laryngeal contrasts (Ladefoged 1982:132).

Given that humans are able to distinguish three degrees of VOT only, one might ask what phonetic factors enable speakers to systematically distinguish four-way laryngeal contrasts in languages such as Hindi. In addition to the three contrasts discussed above, which generally correspond to voiced, plain voiceless, and voiceless aspirated consonants respectively, Hindi and many Armenian dialects distinguish a fourth series, the voiced aspirates. Phonetic research has shown that the voiced aspirates in Hindi are in fact murmured, or characterized by intermittent voicing during the period following release of the consonantal closure and preceding the onset of periodic voicing (Ladefoged 1982:133), and that humans are able to distinguish this intermittent voicing from regular voicing. Halle and Stevens (1971:205) suggest that the intermittent voicing in voiced aspirates is a result of the large airflow involved in aspiration disrupting the maintenance of a transglottal pressure differential required to sustain vibration of the vocal folds. In other words, the phonetic manifestation of the phonological configuration [-stiff vocal folds, +spread glottis] is murmur or intermittent voicing. I follow Halle and Stevens in assuming that the VOT distinctions mentioned above are also phonetic realizations of phonological voice and aspiration contrasts.

In the discussion thus far I have focused on the phonetic aspects of VOT, which phoneticians such as Ladefoged have taken to be the primary correlate of voicing and aspiration. In an attempt to integrate these findings into a theory of universal features, Halle and Stevens (1971) proposed that the salient features involved in distinguishing voicing and aspiration are [stiff vocal folds] and [spread glottis] respectively. When the vocal folds are in a stiff configuration, adduction is not possible and voiceless segments are produced; when the vocal folds are slack, airflow across the glottis produces the Bernoulli effect, causing periodic adduction of the vocal folds and giving voiced segments. When the vocal folds are spread relatively far apart, turbulent airflow is allowed through the large glottal opening, producing aspiration; conversely, when the vocal folds are relatively close to each other, aspiration is not possible. In this view, then, plain voiced consonants are [-stiff, -spread], plain voiceless consonants are [+stiff, -spread], voiceless aspirates are [+stiff, +spread], and voiced aspirates are [-stiff, +spread]. The features [stiff] and [spread] are similar to the traditional notions of voice and aspiration, with the crucial distinction for the purposes of this chapter that voiceless fricatives are [+spread], though they are not aspirated in the traditional sense of the term. The feature configurations just proposed correspond to Ladefoged's VOT possibilities in the following manner:

advanced VOT	=	[-stiff, -spread]
short lag VOT	=	[+stiff, -spread]
long lag VOT	=	[+stiff, +spread]

5.2.2. Phonetics of Armenian voiced aspirates

The status of the voiced aspirates in modern Armenian dialects has challenged Armenologists and Indo-Europeanists from the time of Sievers, Adjarian, and Pedersen in the nineteenth century. The first phonetic study of

Armenian voiced aspirates was carried out by Adjarian 1898, who concluded on the basis of kymographic studies of a speaker of the Mush dialect that these sounds were in fact half-voiced, but in later work referred to them as voiced aspirates. Pedersen, Benveniste, and many Soviet Armenologists took these sounds to be direct descendants of the Indo-European voiced aspirates. Later phonetic work by Allen 1950 and Khachaturian 1973, 1984, 1992 returned to the half-voiced hypothesis. In this section, I summarize the phonetic information gathered on the Armenian voiced aspirates thus far, concentrating on the New Julfa dialect, and conclude that these segments are in fact voiced aspirates.

As mentioned above, Adjarian 1898 concluded that the Armenian voiced aspirates were phonetically half-voiced. Nevertheless, he distinguished these sounds from plain voiceless consonants, which are also half-voiced (i.e. short lag VOT in phonetic terms). According to Khachaturian, the distinction lies in the presence of intermittent voicing during the release phase of the voiced aspirates (1992:126), which as I argued above is characteristic of murmured stops.

Pisowicz (forthcoming) contends that Adjarian in his 1953 work on the Armenian dialect of Poland mechanically changed all of the plain voiceless segments in Hanusz 1886 to voiced aspirates in order to support his theory that this dialect employed voiced aspirates. Two factors militate against this claim. Firstly, if Adjarian had gone through Hanusz's corpus and systematically changed all plain voiceless stops and affricates into voiced aspirates, we would expect to find no exceptions or irregularities in the data. In fact, we find many such irregularities, indicating that Adjarian transcribed what he heard, rather than what he expected to hear. Some examples are given in (2).

(2)	classical	Poland	gloss
a. regular outcome	*ban*	*b^{h}an*	word, thing
	gazan	*g^{h}azan*	beast
	daṙnal	*d^{h}aṙnal*	turn
	jeṙn	*j^{h}ēṙk^{h}*	hand
b. exceptions	*baklay*	*bagla*	bean
	bašχel	*bašχel*	distribute
	gałap^{h}ar	*k^{h}aʁap^{h}ar*	idea
	gerezman	*k^{h}ērēzman*	tomb
	dipel	*t^{h}əbč^{h}el*	occur
	jew	*c^{h}ev*	form
	ji	*c^{h}i*	horse

Adjarian in fact goes to great pains to point out that not all of his words show the expected voiced aspirate outcomes.

The second indication that Adjarian was justified in distinguishing these sounds from plain voiced and voiceless consonants is provided by the phonetic studies of Armenian voiced aspirates by Allen and Khachaturian. Allen 1950 performed kymographic analyses on the voiced aspirates of an Armenian who spent his early childhood in New Julfa but later lived in Abadan. He concluded that like English voiced stops, these segments were voiceless in initial position and voiced in intervocalic position (cf. Ladefoged's 1982 description of English voiced stops). Unlike English, though, they caused following vowels to be articulated 'with markedly stronger breath-force and on a lower pitch' (1950:200). The lowered pitch in following vowels observed by Allen is also a characteristic effect of consonant voicing (House and Fairbanks 1953; attributed by Halle and Stevens 1971 to the feature [+slack]), indicating that these segments are voiced.

Allen's observations agree closely with Khachaturian's descriptions of voiced aspirates in other Armenian dialects. Khachaturian found that the voiced aspirates had a VOT ranging from 20 to 50 milliseconds, which by Allen's standards would qualify them as voiceless, though as in English they are perceived as voiced (Khachaturian 1983:61, 1992:123, 127; Ladefoged 1982). It is interesting to note that the VOT values for the voiced aspirates overlap with both plain voiced segments (20-30 ms) and with voiceless aspirates (40-100 ms; Khachaturian 1983:61). Clearly, then, some feature other than VOT serves to distinguish the voiced aspirates from the two voiceless series. As was mentioned above, the distinction appears to lie in the presence of intermittent voicing during the release phase of the voiced aspirates, which both Allen and Khachaturian noticed as noise in the following vowel. These facts correspond strikingly to the description of murmured stops in Hindi, summarized in section 5.2.1; thus, it seems safe to assume that the Armenian voiced aspirates are in fact phonetically murmured. In the rest of this chapter I argue that these murmured stops are best viewed as simple segments with [-stiff, +spread] laryngeal specifications.

5.3. Phonological behavior of voiced aspirates

In this section I survey the behavior of voiced aspirates with respect to phonological rules in the New Julfa dialect (many of the rules discussed here also apply in other group 1 and 2 dialects). The most striking fact to be noticed here is that the voiced aspirates appear to behave sometimes as voiced aspirated and sometimes as plain voiceless in processes involving assimilation of voicing and aspiration.

5.3.1. K-assimilation

As in SEA, the future tense in the New Julfa dialect is formed by adding the prefix *k-* to the present subjunctive; differently from SEA, however, this *k-* assimilates the laryngeal features of a following consonant, yielding *k(ə)-* before plain voiceless consonants and vowels (3a), *gə-* before plain voiced consonants (3b), *$k^hə$-* before voiceless aspirates and voiceless fricatives (3c), and *$g^hə$-* before voiced aspirates (3d)[2]. This *k-* merges with a following *h* or *ɦ*, becoming *$g^{hə}$-* (3e).

(3)	a.	*kə-tam*	'I will give'
		kə-kenam	'I will exist'
		k-ērt^{h}am	'I will go'
	b.	*gə-bəzzam*	'I will buzz'
		gə-lam	'I will cry'
		gə-zəṙam	'I will bray'
	c.	*k^hə-t^hoʁnem*	'I will allow'
		k^hə-$\check{c}^h$ap^{h}em	'I will measure'
		k^hə-χəndam	'I will laugh'
		k^hə-savorem	'I will grow accustomed to'
	d.	*g^hə-b^herem*	'I will carry'
		g^hə-g^hom	'I will come'
		g^hə-d^hənem	'I will put'
		g^hə-j^hevem	'I will form'

[2]The schwa which appears after the *k-* prefix is produced by a regular process of epenthesis discussed in chapter 3.

e. *k+havadam* → *g^havadam* 'I will believe'

k+ɦusadvel → *g^husadvem* 'I will get angry'

The process in (3) can be represented as spreading of the laryngeal node from the initial root consonant to the preceding *k*-, as shown in (4).

(4)

	k	(*ə*)	*C*	
	laryngeal		laryngeal	
[+stiff]	[-spread]	[αstiff]	[βspread]	

Since intervening -*ə*- but not full vowels are transparent to this spreading (*k*-*ērt^{h}am*, *k-asem* 'I will say'), we can say that the rule applies before epenthesis, which produces all schwas in the New Julfa dialect. Note that voiceless fricatives change the *k* to *k^h* (e.g. *k^hə-χəndam*), which I take to indicate that voiceless fricatives are [+spread] (following an earlier proposal by Halle (p.c.); cf. also Blevins 1993b). Adjarian 1940:§123 mentions that *k* also regularly becomes *k^h* before both *s* and *š*, e.g. *kušt* 'side', genitive *k^həštin*, *ɦetkus* 'behind', genitive *ɦetk^{h}əsin*. Interestingly, voiced fricatives do *not* trigger aspiration (e.g. *gə-zəṙam*), indicating that they are [-spread]. This finding makes sense in light of Catford's observation that voiced obstruents are accompanied by a narrowing of the glottis (1977:112).

The merger of *k* and the voiced laryngeal fricative *ɦ* in (3e) can be analyzed as spreading of the [-stiff] and [+spread] features of the *ɦ* to the *k*, followed by simplification of the cluster *g^hɦ*. The behavior of *h* is more problematic; it is not immediately clear why the combination of *k* + *h* should yield *g^h*. Since *h* is generally considered to be [+stiff, +spread], we might expect the combination to give *k^h. At the moment I have no explanation for this problem.

5.3.2. Nasal voicing

Another interesting phenomenon involving voiced aspirates is nasal voicing, which spreads the feature [-stiff][3] from nasals to following stops and affricates (5a), but not to fricatives (5b) or voiceless aspirates (5c) (Adjarian 1940:§118, 121, 151, 195).

(5)		classical	New Julfa	gloss
	a.	*əncay*	*ənja*	gift
		ankanel	*əŋganel*	fall
		čanč	*čanǰ*	fly
		ayntel	*əndeʁ*	there
	b.	-----	*insaf*	justice
		-----	*sunsunakvēl*	hunt around
		-----	*tʰanχel*	deceive
		-----	*sēmsuri*	type of melon
	c.	*tʰančʰel*	*tʰančʰin tal*	mutter
		šampʰur	*šampʰur*	spit
		yawnkʰ	*ɦuŋkʰ*	eyebrow

[3]We can tell that the whole laryngeal node is not spreading from the behavior of nasal voicing in Indic languages, where the [+spread] feature of voiced aspirates is not affected.

This process creates productive alternations in declension, where vowel syncope creates new environments for the rule, as shown in (6).

(6)	nominative	genitive	gloss
	kənik	*kəŋga*	wife
	g^{h}ort^{h}ənuk	*g^{h}ort^{h}əŋga*	frog

Nasal voicing in the Paleo-Siberian language Gilyak behaves in essentially the same way. According to Kenstowicz and Kisseberth 1979:436-7, this language possesses two phonemic stop series, plain voiceless and aspirated; after nasals, these surface as plain voiced and voiceless aspirated respectively.

(7)	nominative	1st pl. possessive	gloss
a.	*pəx*	*ñəŋ-bəx*	paint
	tux	*ñəŋ-dux*	axe
	ki	*ñəŋ-gi*	shoe
b.	*p^{h}uf*	*ñəŋ-p^{h}uf*	saw
	t^{h}u	*ñəŋ-t^{h}u*	sledge
	k^{h}u	*ñəŋ-k^{h}u*	bullet

Sagey 1986 describes a similar phenomenon in Zoque, an Amerindian language of Mexico. In this language, stops and affricates (8a) but not fricatives (8b) are voiced after nasal consonants.

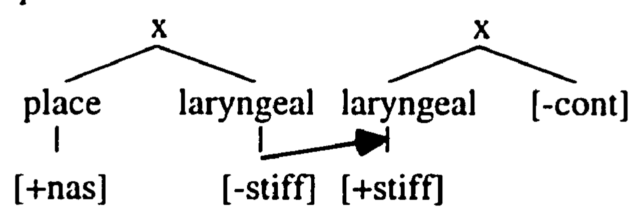
(8) Zoque (Kenstowicz 1994:500)

a.	*min-pa*	*minba*	he comes
	pʌn-t$^{\check{s}}$*ʌki*	*pʌnd*$^{\check{z}}$*ʌki*	figure of a man
b.	*winsaʔu*	*winsaʔu*	he received

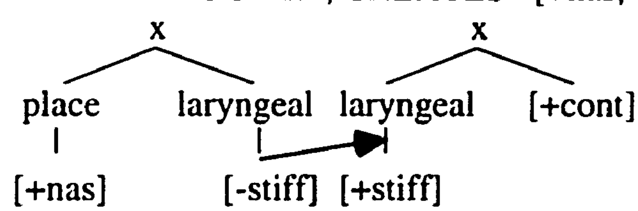
Sagey interprets this process as spreading of [-stiff] from a nasal to a following [-continuant] consonant, under the assumption that affricates are contour segments composed of a [-cont] followed by a [+cont] element. In this analysis, nasal voicing scans for only one immediately adjacent [cont] value, and since the [-cont] element of affricates is adjacent to the nasal, these segments undergo the rule. I schematize Sagey's analysis in (9), with irrelevant nodes omitted.

(9)

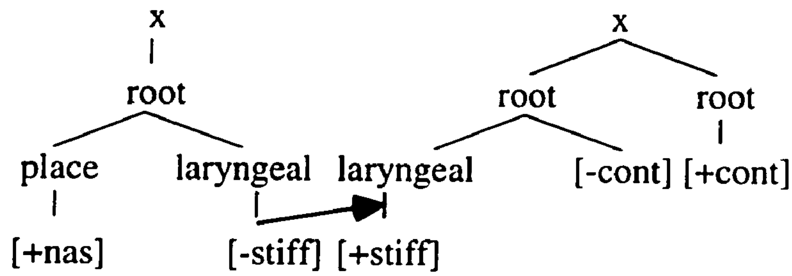
a. *np* → *nb*



b. *ns* → *ns* BLOCKED; CREATES *[+nas, +cont]



c. *nt*^{š} → *nd*^{ž}



Though the Armenian case in (5) appears to involve the same phenomenon, the analysis is more complicated. First of all, it is not immediately clear how to exclude the voiceless aspirates from undergoing nasal voicing (5c). Secondly, we must explain why only plain voiced consonants and not voiced aspirates appear after nasals. Thus, plain voiced forms where we might expect voiced aspirates are common (10a), but aspirated forms only occur in borrowings from the literary language (10b).

(10)

a.	*b*^{h}*ambak*	cotton
	g^h*angat*	complaint
	andam	limb
	b^h*rinj*	rice
	narinǰ	orange
b.	*hamb*^{h}*erel*	endure
		(in native lexicon we expect **xamberel*)
	žaṙang^h	heir
	hand^h*ipel*	meet
		(in native lexicon we expect **xandipel*)

Unfortunately, it cannot be determined whether the forms in (10a) have underlying voiced aspirates which lose their aspiration, or rather historically never became aspirated after nasals. In either case, the point of interest to us is the same, namely why voiced aspirates do not occur after nasals.

Nasal clusters possess special properties cross-linguistically: for example, many languages do not allow any consonant clusters except for homorganic nasal + consonant sequences (i.e. sequences which share the same place of articulation). Nasal clusters are commonly referred to a linked structures, because the nasal receives its place of articulation from the following consonant, thereby forming a closer bond within the cluster than in a cluster such as *-kt-*, which involves two distinct places of articulation. Crucially, however, nasals cannot form linked structures with fricatives. Consider for example the behavior of the English prefix *in-* in (11).

(11)	a.	*in-bue*	[*ɪmbyu*]
		im-possible	[*ɪmpasɪbəl*]
	b.	*in-finite*	[*ɪnfənɪt*]
		in-valid	[*ɪnvælɪd*]
	c.	*in-active*	[*ɪnæktɪv*]

The *-n-* of the prefix assimilates in place of articulation to a following labial stop or affricate (11a), but not to a following labial fricative (11b), in which case the default nasal *n* surfaces, as before vowels (11c). Previous analyses (e.g. Padgett 1991) have attributed this asymmetry to the [+continuant] feature of fricatives, arguing that nasal place assimilation produces a [+nasal] segment associated with a [+continuant] specification, a configuration disallowed by most languages (in the system presented in chapter 1, this configuration violates a marking statement *[+nasal, +cont]).

This type of analysis cannot work for the Armenian data, since the aspirates are [-continuant], and thus are incorrectly predicted to undergo nasal voicing. Let us assume instead that the relevant feature which blocks nasal voicing is [+spread], which distinguishes the aspirates and voiceless fricatives from plain consonants. Furthermore, let us assume that nasal place assimilation creates a structure similar (or perhaps identical) to prenasalized stops. I make this suggestion for three reasons: first, both prenasalized stops and nasal clusters possess a single place specification; second, though they are composed of two distinct articulations, both behave in a manner different from regular consonant clusters; third, prenasalized stops, like New Julfa nasal clusters, are always plain voiced (^{n}d, ^{m}b, ^{ŋ}g; *^{n}t, *^{m}p, *^{ŋ}k; cf. Maddieson 1984:67).

If we view New Julfa nasal clusters in this way, it makes sense that they always surface as sequences of nasal + homorganic voiced unaspirated [-continuant] consonant. What remains unexplained, though, is why plain voiceless consonants are voiced by preceding nasals in New Julfa and Gilyak, but voiceless aspirates are not. I propose that the answer parallels the reason why nasals do not assimilate to fricatives in English. Just as in English place assimilation is blocked from creating the disallowed configuration *[+nasal, +cont], so nasal voicing in both Zoque and New Julfa is blocked from applying to fricatives or aspirates, thereby preventing the creation of *[+nasal, +spread] configurations. Note that affricates, which contain a [+spread] component, do undergo the rule. We can deduce from this fact that the rule of nasal voicing is only sensitive to directly adjacent

[+spread] specifications, and therefore sees only the intervening [-spread] component of affricates. I return to this issue in section 5.4.

New Julfa therefore makes a valuable contribution to understanding of linkage in nasal clusters. In Zoque we can only see the restrictions on nasal clusters in the case of fricatives, which does not allow us to determine whether it is [+cont] or [+spread] which is incompatible with [+nasal]. The New Julfa and Gilyak facts, which group together aspirates and fricatives, show conclusively that the active marking statement in the case of nasal voicing must be *[+nasal, +spread].

The behavior of nasal voicing in the Indic language Sindhi provides an interesting test for this analysis. Sindhi possesses the consonant inventory in (12) (Bordie 1958; C = implosive, *ḍ* etc. = retroflex).

(12)

p	p^h	*b*	b^h	*B*	*m*	*ɸ*	*β*		
t	t^h	*d*	d^h	*D*	*n*	*s*	*z*	*l*	*r*
ṭ	*ṭ*^{h}	*ḍ*	*ḍ*^{h}	*D.*	*ṇ*				*R*
č	*č*^{h}	*ǰ*	*ǰ*^{h}	*J*	*ñ*	*š*		*y*	
k	k^h	*g*	g^h	*G*	*ŋ*	*x*	*γ*		
						h			

Sindhi possesses a historical[4] rule of nasal voicing basically identical to those described above (Turner 1966, Masica 1991). As in the other languages surveyed, plain voiceless stops and affricates are voiced by

[4]I have been unable to ascertain if the nasal voicing rule is still productive.

preceding nasals (13a-b)[5]. The forms in (13c) indicate that the feature [-stiff] alone is spreading, rather than the whole laryngeal node. The problem for the theory presented above is the data in (13d), which demonstrate that voiceless aspirates also undergo voicing (N = nasal glide).

(13)

a.	Sanskrit	Sindhi	gloss
	aŋka	*aŋgu*	mark
	kaṇṭā	*kaṇḍo*	thorn
	danta	*D.andu*	tooth
	čampa	*čambo*	type of tree
b.	*pañča*	*pañǰa*	five
	aNsa	*hañǰʰī*	shoulder
	haNsa	*hañǰu*	goose
c.	*ǰaŋgʰā*	*ǰāŋgʰa*	leg
	andʰa	*andʰo*	blind
	gambʰīra	*Gābʰīru*	deep
d.	*pantʰā*	*pandʰu*	path
	grantʰi	*gaṇḍʰi*	knot
	šuṇṭʰi	*suṇD.i*	ginger

---

[5]Note the peculiar behavior of original fricatives, which become [-anterior] affricates after nasals. It seems reasonable to assume that the nasal voicing rule applied after the fricatives became affricates, but I have no external evidence to support this idea.

In order to account for the Sindhi facts, we simply assume that the marking statement *[+nasal, +spread] is deactivated in this language. This would be a problem if *[+nasal, +spread] were a prohibition (i.e. physically impossible to produce) rather than a marking statement, in which case the Sindhi facts would require a different account. The fact that aspirated nasals exist in Indic languages such as Hindi-Urdu (Maddieson 1984; cf. *kvm^{h}ar* 'potter' vs. *kvmar* 'boy', *tvm^{h}e* 'to you', *vn^{h}e* 'to them') indicates that *[+nasal, +spread] is a marking statement that can be deactivated, however.

5.3.3. R-aspiration

Another process involving the voiced aspirates is aspiration after *r*, illustrated in (14).

(14)	classical	New Julfa	gloss
	orbewayri	*vorb^{h}avēri*	widow
	margarē	*marg^{h}arē*	prophet
	erdumn	*vord^{h}um*	oath
	arjakel	*ɦarj^{h}akel*	release

Both Adjarian 1940 and Allen 1950 agree that this process produces voiced aspirates from plain voiced stops and affricates, but does not affect plain voiceless consonants (15).

(15)	classical	New Julfa	gloss
	ašakert	*aškert*	pupil
	erkat^h	*arkat^h*	iron

Aspiration after *r* is common in Armenian dialects (q.v. J̌ahukyan 1972), but the restriction of application of this rule to voiced consonants is odd. At the moment I have no analysis for these facts.

5.3.4. Fricative assimilation

Perhaps the most interesting phenomenon involving voiced aspirates is their effect on preceding fricatives. In New Julfa and to a lesser extent in other dialects, fricatives were historically devoiced before voiced aspirates, as shown in (16).

(16) classical	New Julfa	gloss
anzgam	*anəsg^{h}am*	wicked
zgoyš	*əsg^{h}uš*	safe
xełdel[6]	*χeχd^{h}el*	strangle
ałbiwr	*aχb^{h}ur*	fountain
zgal	*əsg^{h}al*	feel
zbałum	*əsb^{h}aʁum*	business
złǰal	*zəχǰ^{h}al*	repent
ambołǰ	*amb^{h}oχǰ^h*	whole

We find similar developments in other dialects, e.g. classical *azg*, *xełdel*, *ałbiwr* > Akn *asg^h*, *χeχd^{h}il*, *aχb^{h}ir*; classical *zgest* 'clothing' > Sučava

[6] The symbol *ł* in Classical Armenian represents a dark ([+back]) *l*, which becomes *ʁ* in all of the modern dialects. The lateral value of this phoneme is postulated on the basis of etymologies (e.g. *ał* 'salt' : Latin *sal*) rather than phonetic evidence.

sg^hesd. I have been unable to find any productive alternations of this type in Adjarian 1940's description of the New Julfa dialect.

Obviously this phenomenon cannot involve spreading of the feature [+stiff], though one could suggest that it is a process of dissimilation rather than assimilation. If this process did in fact involve dissimilation of the feature [stiff vocal folds] in clusters, though, we might expect *s* to become *z* before voiceless stops, which is not the case:

(17)	classical	New Julfa	gloss
	hastat	*xastad*	firm
	nerskoys	*neskus*	India (literally 'interior')
	osp	*vosp*	lentil

One might also propose that fricatives devoice in syllable codas, but this is disproven by forms such as *maz* 'hair', *kuz* 'hunchback', *avaz* 'sand', *taʁ* 'song'. I propose that the changes in (16) result from a rule that spreads the feature [+spread glottis] from aspirates to preceding fricatives, with a subsequent repair rule delinking [-stiff] from all [+cont, +spread] segments. A similar proposal has been made for Icelandic by Thráinsson 1978. In some dialects of Icelandic voiced consonants are devoiced when they immediately precede aspirated stops, which lose their aspiration, as illustrated in (18) (here underscored letters represent voiceless consonants; data from Thráinsson 1978:39-41).

(18)	underlying form	surface form	gloss
	ulp^ha	*uḻpa*	coat
	heimt^ha	*heim̱ta*	demand
	vanta	*vaṉta*	lack
	vink^ha	*viŋ̱ka*	wave
	sār-t^h	*sauṟt*	painful-neut.
	maðkür	*maþkür*	worm

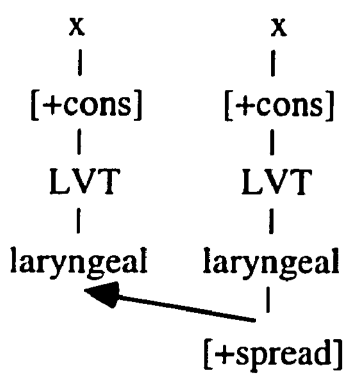
For reasons I will not go into here, Thráinsson interprets this process as a transferral of the feature [+spread] from the stop to a preceding sonorant or fricative, which is subsequently devoiced. There is some reason to believe that *ð* functions as a sonorant in Icelandic and other languages of Scandinavia. If this is the case, we could analyze the devoicing process as the result of delinking, activated by violations of a marking statement *[+son, +spread] that disallows aspirated sonorants.

If on the other hand *ð* is treated as an obstruent as in other languages, the preceding analysis requires further modification. Thráinsson observes that frivatives always surface as voiceless before underlying aspirated stops, which in turn surface as unaspirated. He interprets this distribution in conjunction with the facts in (18) as the result of a rule that transfers the feature [+spread] from a stop to a preceding consonant, as mentioned above. Let us now consider how the association of [+spread] to fricatives might lead to devoicing.

Suppose that UG contains a marking statement *[-stiff, +spread] which prevents the occurrence of voiced aspirated segments when active. This marking statement is active in Icelandic, which has no *[-stiff, +spread] segments. The rule which transfers [+spread] creates just such configurations, however. I suggest that when this happens, a repair rule applies and delinks the feature [-stiff].

In New Julfa the situation is slightly more complicated, since the marking statement *[-stiff, +spread] is deactivated (i.e. voiced aspirates are allowed). In this case we must invoke a related marking statement provided by UG which prevents the same configuration in fricatives: *[-stiff, +spread]/_[+cont]. This marking statement is not mentioned by Calabrese (forthcoming), but it seems to be quite a plausible addition to his system, reflecting the intuition that voiced aspirated fricatives are more complex than voiced aspirated stops. With the machinery just discussed in hand, I suggest that the Armenian data in (16) involve propagation of the feature [+spread] from right to left within an obstruent cluster, as in (19).

(19)



When the rule in (19) targets a voiced fricative, as is the case in the forms in (16), the disallowed configuration *[-stiff, +spread, +cont] is produced. I assume that a repair rule then delinks the feature [-stiff], as in Icelandic. Notice that the effects of rule (19) will not be visible with voiceless aspirates because they are never preceded by voiced obstruents. Our rule also accounts for the phenomenon of *s*-aspiration, which aspirates consonants before *s* (cf. *pstik* 'small' > *p*^{h}*əstik*, *gišer* 'evening' > *k*^{h}*əšer*)[7], provided of course that voiceless fricatives are [+spread]. Voiced fricatives, on the other hand, must be [-spread] for my analysis to make sense. This assumption is supported by the *k*-assimilation cases discussed above.

5.3.5. Aspiration delinking

The rule which spreads [+spread glottis] interacts with another important rule of New Julfa phonology that deletes the feature [+spread] in an obstruent directly following another obstruent (Adjarian 1940:§216)[8]. Most instances of this phenomenon involve final -*k*^{h} (20a), which can occur after all licit coda clusters in Armenian (cf. chapter 3); it is difficult to find cases involving the other voiceless aspirates, though some exist (20b).

---

[7]I assume that a similar process is responsible for classical Armenian *k*^{h}*san* '20' < IE **wik'ŋ̥t*- and *t*^{h}*šnami* < Persian *dušmān*. Note that *s*-aspiration appears to apply after vowel deletion but before epenthesis.

[8]I know of two counterexamples, *ɦaχt*^{h}*el* 'conquer' and *k*^{h}*oχc*^{h}*ər* 'sweet'. This process may be related to the Icelandic deaspiration rule discussed earlier as well as the famous case of Grimm's Law, which indicates that proto-Germanic obstruents were aspirated except after obstruents.

(20)	classical	New Julfa	gloss
a.	*džoχ-kʰ*	*dəžoχk*	hell
	kop-kʰ	*kopk*	eyelid
	tʰew-kʰ	*tʰefk*	wings
	mit-kʰ	*mitk*	mind
	aławtʰ-kʰ	*aʁōtʰk*	prayer
	anēc-kʰ	*anēck*	curse
	čawč-kʰ	*čōčk*	swing
	ačʰ-kʰ	*ačʰk*	eye
	varj-kʰ	*varcʰk*	wages
	χaws-kʰ	*χōsk*	speech
	həraš-kʰ	*hərašk*	miracle
b.	*eawtʰn*	*ōχtə*	seven
	nawtʰ	*naft*	oil
	kʰtʰ-u-e-l	*kʰəftel*	delouse

This process still appears to be productive, as shown by alternations such as *caʁikʰ* 'flower', genitive *caχki, šapikʰ* 'shirt', genitive *šapki.* Presumably this change occurred after the change of the dark lateral *ł* to the uvular fricative *ʁ*, since original *ł* triggers this process but *l* does not; cf. *ałkʰat* 'poor' > *aχkad*, but *χelkʰ* 'mind' > *χelkʰ* (in addition, of course, *ʁ* is an obstruent whereas *l* is not). The rule of aspiration delinking can be represented as in (21) (irrelevant nodes omitted).

(21)

$$\begin{array}{lcc} & \mathrm{x} & \mathrm{x} \\ & | & | \\ & [\text{-son}] & [\text{-son}] \\ & & | \\ & & \mathrm{LVT} \\ & & | \\ & & \text{laryngeal} \\ & & \not| \\ & & [\text{+spread}] \end{array}$$

The rule in (21) interacts with the spreading rule in (19) in interesting ways. First of all, consider a case of *s*-aspiration such as *ɦetkus* 'behind' → genitive *ɦetk*^{h}*əsin*, which I argued above to be a manifestation of rule (19). Given the representation of aspiration delinking, we might expect it to apply to the output of (19), giving **ɦetkəsin*. I see two possible explanations for why this is not the correct surface form: either (21) applies before (19), or (19) applies before (21) but the application of (21) is blocked by some constraint. If (21) were ordered before (19), we might expect the voiced aspirates in (16) to be deaspirated by the preceding fricatives and then be unable to trigger fricative assimilation. Since this is not the case, we must assume the opposite ordering. If (19) applies before (21), though, we still must explain why the voiced aspirates in (16) do not lose their [+spread] feature, and similarly why we do not get **ɦetkəsin*. I attribute these facts to a principle of inalterability (cf. Schein and Steriade's 1986 Uniform Applicability Condition) which can block rules that do not apply exhaustively to their target. In the case of fricative + voiced aspirate sequences, for example, rule (19) creates a linked [+spread] structure between the two segments. Rule (21) then fails to delink the [+spread] feature of the voiced aspirate, because if it were to do so it would affect the preceding fricative as well, which does not meet the structural description of the procedure. The same can be said for *ɦetkʰəsin*: delinking does not apply because it would affect the *s* as well, which does not match the environment for the rule.

In the following section I consider another possible account for the facts presented in this section which builds on the theory of contour segments developed by Steriade 1992.

5.4. A Contour-based analysis

The data presented in section 5.3 present interesting challenges for the traditional representation of voiced aspirates as single segments characterized by the features [+spread, -stiff]. I have already suggested a possible analysis for the phenomena considered there; in this section I compare a competing analysis which builds on Steriade's 1992 theory of contour segments. I demonstrate that this analysis, though at first blush appearing to offer a nice account for the New Julfa facts, creates too many additional problems to be upheld here.

5.4.1. Contour segments

The model of contour segments proposed by Steriade 1992 crucially differs from previous theories in supposing that released stops have internal contours. Let us assume that released consonants link a single timing unit to two root nodes, the first of which contains the features involved in the closure, and the second of which contains the features involved in the release of the segment. This being the case, we predict that released consonants which contain opposite feature specifications in their two root nodes should show edge effects, behaving differently with respect to segments on the left as opposed to the right. Clearly the assumption of such contours in released stops adds great power to the theory, leading one to wonder whether the theory is sufficiently constrained.

Our revised version of Steriade's model allows us to represent contour segments (represented here for the feature [nasal]) in the following manner.

(22)

a. nasal stop (*n*)

```
            x
         /     \
+cons         +cons
+son          +son
-cont         -cont
         \     /
       [+nasal]
```

b. prenasalized stop (^{n}d)

```
            x
         /     \
+cons         +cons
+son          -son
-cont         -cont
  |             |
[+nasal]      [-nasal]
```

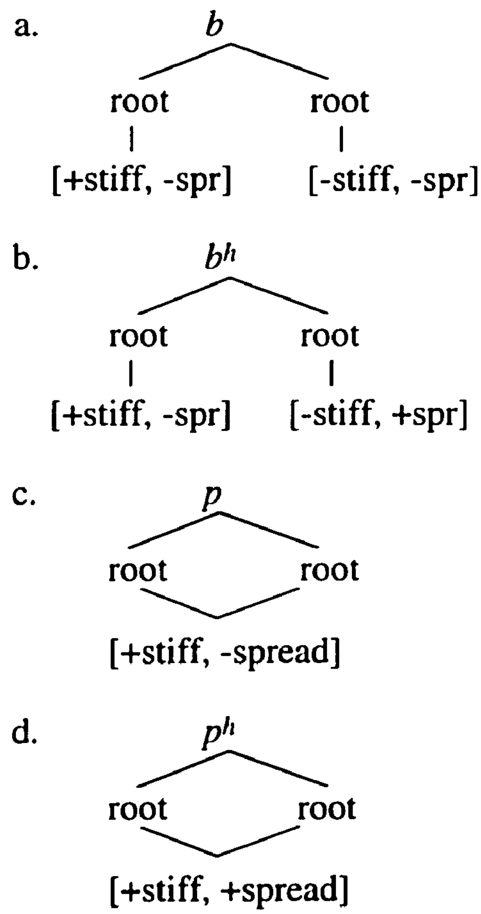
c. postnasalized stop (*d*ⁿ)

x	
+cons	+cons
-son	+son
-cont	-cont
[-nasal]	[+nasal]

Since in addition to contours involving nasality and continuancy we can have contour segments for the laryngeal features aspiration and glottalization (q.v. Steriade 1992), it is not implausible to expect that voicing contours should also be possible. It is certainly the case that in phonetic terms voicing can be associated with either the closure phase of a segment (advanced VOT) or the release phase (short and long lag VOT). Though Steriade maintains that voicing features must be associated with the closure phase in phonological representations, Blevins 1993a has suggested that the common phenomenon of laryngeal neutralization receives a straightforward account if we assume instead that all laryngeal features are normally associated with the release phase. In positions where consonants are unreleased (cf. Kenstowicz 1994:503), we should expect any features associated with the release phase of a segment to be lost. Consequently, by assuming that laryngeal features attach to the release node, we predict that voicing, aspiration, and glottalization should be neutralized in positions of unrelease. This is exactly what we find in syllable codas, the most common position in which consonants are unreleased.

Combining the phonetic aspects of voicing and aspiration discussed in section 5.2 with the phonological arguments just presented, one could propose the following representations for the basic stop varieties.

(23)



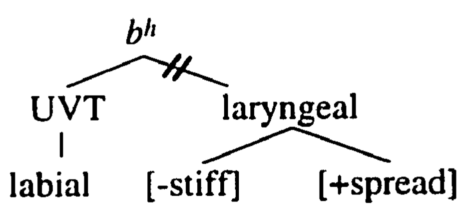
Note that the left edge of voiced segments (23a-b) is [+stiff]. As I understand Blevins' proposal, the closure position of released consonants *never* possesses laryngeal specifications; in Rules and Representations Theory, on the other hand, the closure position is a root node and is therefore required by full specification to have laryngeal features. The laryngeal features which attach to the closure node are always unmarked [+stiff, -spread], except in the case of voiceless aspirates, which must have [+spread] attached to the closure node for a number of reasons discussed below. The model presented in (23) crucially differs from Blevins' and other models in predicting that voiced stops should behave as voiceless with respect to rules sensitive to their left edge, which we want to capture the facts in (16).

Let us first consider how this model would deal with a typical case involving neutralization of laryngeal features, such as we find in Sanskrit. In this language, which like New Julfa contrasts four consonant series {*T D* T^h D^h}, all four series are neutralized in word-final position, surfacing as plain voiceless.

(24)	stem	nom.	acc.	gloss
a.	*marut-*	*marut*	*marutam*	wind (god)
b.	*su-hṛd-*	*suhṛt*	*suhṛdam*	friend
c.	*agni-math-*	*agnimat*	*agnimatham*	near the fire
d.	*su-yudh-*	*suyut*	*suyudham*	good warrior
	go-dhugh-	*godhuk*	*goduham*	cow milker
	kakubh-	*kakup*	*kakubham*	region

In a traditional model of phonology which views these four consonant series as simple segments, the process in (24) would be interpreted as a restriction disallowing marked laryngeal features in syllable codas. Any violations of this constraint would be delinked, as shown in (25).

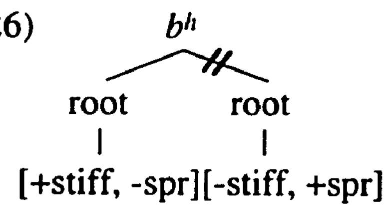
(25)



The delinking process in (25) produces a segment with no laryngeal specifications; at a later stage of the derivation, the default laryngeal features [+stiff, -spread] would be supplied.

Now consider how this phenomenon would be accounted for in our model. Let us assume that, as in English, word-final [-cont] obstruents are unreleased in Sanskrit. Consequently, all released consonants would lose their release node and any features attached thereto. By assuming that contrastive laryngeal features are associated with the release phase, we predict that these features will be lost in word-final position, and segments should surface with only the set of laryngeal features associated with their closure node. This process would affect voiced aspirates as in (26).

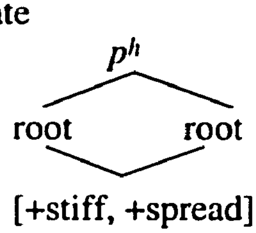
(26)



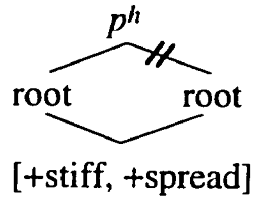
The behavior of voiceless aspirates with respect to laryngeal neutralization is a problem for this analysis. Given the structures in (23), delinking of the release node should have the following effect on voiceless aspirates.

(27)

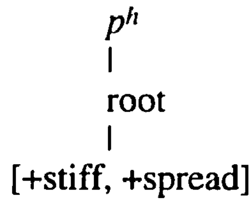
a. initial state



b. delinking



c. final form



We might expect the configuration in (27c) to be realized as a voiceless aspirate, but it in fact surfaces as plain voiceless (24c). This state of affairs could be attributed to the phonetic fact that aspiration is only realized during the release phase of consonants. In phonological terms, we might stipulate that the feature [+spread] cannot be realized unless it is attached to a release node. Alternately, we could say that [+spread] cannot associate to single [+cons] root nodes.

5.4.2. Edge effects

Now let us extend this theory beyond the realm of neutralization. By treating released consonants as contour segments, we predict the existence of rules sensitive to the left or the right edge of these consonants. This is a well-known property of contour segments, in particular affricates, which are generally thought to consist of a [-cont] element followed by a [+cont] element. The English plural rule in (28), for example, is sensitive to the right edge of stem-final affricates.

(28)	a.	cads	[*kæd-z*]
		knees	[*ni-z*]
	b.	cats	[*kæt-s*]
	c.	cuffs	[*kʌf-s*]
	d.	buses	[*bʌs-əz*]
		brushes	[*brʌš-əz*]
	e.	churches	[*čərč-əz*]
		judges	[*ǰʌǰ-əz*]

The underlying form of the plural morpheme is /*z*/, which surfaces after vowels and voiced stops (28a), and undergoes voicing assimilation after voiceless stops and non-coronal fricatives (28b-c). Because English does not allow sequences of coronals with identical continuancy values[9], addition of the plural to stems ending in *s* and *š* triggers epenthesis (28d). The fact that epenthesis also occurs after coronal affricates (28e), which contain both [+cont] and [-cont] components, indicates that the epenthesis rule is sensitive to the edge of the affricate adjacent to the triggering plural /*z*/.

Rules can also be sensitive to the opposite edge of affricates; such rules are traditionally called 'anti-edge effects'. Consider the case of Basque (Hualde 1987), which deletes the first of two successive [-cont] segments. This rule deletes a stop before another stop (29a), but crucially also deletes the [-cont] portion of affricates (29b).

---

[9]Note in this regard that the past tense suffix *-d* behaves in a parallel fashion: *prided* [*prayd-əd*], *played* [*ple-d*], *pitted* [*pɪt-əd*], *coughed* [*kɔf-t*], *missed* [*mɪs-t*], *brushed* [*brʌš-t*], *bleached* [*blič-t*], *judges* [*ǰʌǰ-d*].

(29)	a.	*bat paratu*	*ba paratu*	put one
		bat + naka	*banaka*	one by one
		guk + piztu	*gu-piztu*	we light
	b.	*haric-ki*	*haris-ki*	oak wood
		hoc bat	*hos bat*	a cold
		hic + tegi	*histegi*	dictionary

The rule seems to be able to 'look through' the intervening [+cont] portion of affricates. This is somewhat surprising, but has parallels in New Julfa discussed in the next section. I would like to claim that there are in fact no anti-edge effects, in the sense that rules cannot arbitrarily ignore salient adjacent feature specifications. Apparent cases of anti-edge behavior therefore must receive alternate explanations.

The Basque data in (29) appear to result from constraints on syllable structure rather than from a linear rule of consonant deletion. Consider the parallel case in the Armenian dialect of Aslanbeg (Vaux 1993b, Adjarian 1898):

(30)	underlying form	surface form	gloss
a.	*et-k*^{h}*-n*	*ye*ˀ*kə*	back
	šat	*ša*ˀ	much
	tʁa-k^{h}*-när-t*	*dəʁa*ˀ*närət*	your brothers
b.	*goǰig-e-l*	*gožgel*	wear shoes
	arǰ	*arš*	bear
	jej	*jez*	beating
	väc^{h}	*väs*	six

As in Basque, both stops and affricates lose their [-cont] component in syllable codas; unlike Basque, though, Aslanbeg leaves a glottal stop in place of deleted stops. The Aslanbeg rule is clearly syllable-based, because it applies to stops and affricates in word-final position as well as before consonants. Let us assume, then, that Aslanbeg possesses a constraint disallowing consonants less sonorous than fricatives in syllable codas, and that violations of this constraint are repaired by delinking the offending root node. This delinking leaves behind the [+cont] release node of affricates, resulting in a fricative; a special stipulation must be made to account for the appearance of a glottal stop rather than nothing in place of stops.

The Aslanbeg and Basque cases described above are similar enough to make us suspect that they result from the same process. If this is so, we must explain why word-final stops and affricates are not affected in Basque. The simplest solution is to assume that Basque allows a word-final appendix to which consonants may attach when not allowed in the coda[10].

The process of *k*-assimilation in New Julfa (3) also appears to show anti-edge effects if one assumes the model in (23). Recall that the future prefix surfaces as *k*- before vowels and plain voiceless consonants, *k^h*- before voiceless aspirates, *g*- before plain voiced consonants, and *g^h*- before voiced aspirates. If the rule were sensitive to directly adjacent laryngeal features, we should expect both plain and aspirated voiced consonants to select *k*-, since according to (23) their left edge is [+stiff, -spread]. One could suggest that the rule of *k*-assimilation should actually be formalized as in (31).

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[10]For more information on the status of syllable appendices cf. chapter 3.

(31) spread marked laryngeal features to the *k*- prefix from an immediately following consonant

In this interpretation, the future prefix is underlyingly specified as *k*, but can receive marked laryngeal features (i.e. [+spread] and [-stiff]) from an immediately following consonant. As I mentioned in the discussions of vowel harmony in chapters 1 and 2, adjacency has two possible interpretations in RRT: strict adjacency, limited to a single syllable; and regular adjacency, limited to visible features. The *k*-assimilation rule must involve regular adjacency. According to (31), the rule is sensitive to marked laryngeal features of triggers, and therefore will spread the marked [+spread] feature attached to the closure node of voiceless aspirates, yielding the correct output k^h-. The rule will not spread the unmarked laryngeal features attached to the closure node of the released consonants in (23a-c), however; instead, the first triggers it sees are the marked features attached to the release node of these consonants. In the case of plain voiced consonants (23a), the marked feature [-stiff] (but not unmarked [-spread]) spreads from the closure node, giving *g*-; similarly, [-stiff] and [+spread] spread from voiced aspirates. Plain voiceless consonants, which possess no marked laryngeal features, do not spread, and the prefix surfaces in its underlying form.

A similar phenomenon occurs in Sanskrit, the so-called Bartholomae's Law, which has the effects in (32).

(32)	root	past ppl.	gloss
a.	*i*	*itá-*	gone
b.	*āp*	*āptá-*	obtained
c.	*rip*^{h}	*rip*^{h}*itá-*	snarled
d.	*dad*	*dattá-*	given
e.	*id*^{h}	*idd*^{h}*á-*	kindled

Taking as an example the past participle suffix *-tá-*, we can see that it surfaces as such after vowels (32a), voiceless consonants (32b-c)[11], and plain voiced consonants (32d). The interesting case is (32e), where a voiced aspirate + voiceless aspirated (or unaspirated) consonant sequence becomes a plain voiced consonant followed by a voiced aspirate. Within the contour model, one could assume that (32d) and (32e) are controlled by two independent rules: (32d) involves standard voicing assimilation in coda position, whereas (32e) involves the rule in (33).

(33) in a cluster containing [+spread], spread marked laryngeal features to the release node of the rightmost member

The rule in (33) works in essentially the same manner as (31); in other words, it spreads the marked laryngeal features [-stiff] and [+spread], subject to regular adjacency. According to this principle, (33) will not see the closure node of the *d*^{h} or of the *t* in the *d*^{h}*-t* cluster in (32e), since neither contains marked laryngeal specifications. It will spread the marked [-stiff] and [+spread] specifications of the release node of the *d*^{h}, however. This

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[11]The *-i-* that appears before voiceless aspirates (27c) is epenthetic.

spreading is not blocked by the closure node of the following consonant, because it contains no marked laryngeal features[12].

One problem with this analysis is that the definitions of markedness and contrastiveness one is forced to assume in order for the analysis to work are positional rather than absolute. In other words, in a positional interpretation a certain feature may be marked or contrastive in one environment, but not in another. This runs counter to the system developed by Calabrese (forthcoming), where contrast and markedness are defined in absolute terms.

5.4.3. New Julfa edge effects

The proposal that released consonants are contour segments makes interesting empirical predictions concerning their behavior in rules sensitive to edges of contour segments. In a traditional model, where voiced and aspirated consonants are viewed as simple segments, we always expect rules sensitive to [-stiff] to target voiced consonants, and rules sensitive to [+spread] to target aspirates. In our model, on the other hand, we expect to find edge effects, with rules sensitive to the left edge of contour segments treating voiced aspirates as [+stiff, -spread], and rules sensitive to the right edge of contour segments treating voiced aspirates as [-stiff, +spread].

If we assume the modified form of Steriade's model proposed in this section, we can say that of the phenomena considered in section 5.3, two

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[12]Voiceless aspirates contain marked [+spread] in their closure node and thus are predicted to block spreading of aspiration from a preceding consonant. This prediction cannot be properly evaluated since the target consonant will surface as aspirated whether spreading applies or not.

(nasal voicing and fricative assimilation) involve conventional edge effects and one (*k*-assimilation) involves an edge effect sensitive to marked features. In the case of nasal voicing (section 5.3.2), we saw that the rule was blocked from applying to [+spread] segments. We must then ask whether or not nasal voicing is sensitive to [+spread] specifications associated only with the release phase of a segment, as is the case with voiced aspirates and affricates. It is of course impossible to determine whether or not the rule has applied to voiced aspirates, which are already voiced, but the fact that it does apply to affricates (5a) indicates that nasal voicing is sensitive only to directly adjacent [+spread] specifications[13].

Note that this analysis crucially forces us to assume that the closure phase of voiceless aspirates is [+spread]; otherwise, we would expect them to undergo the rule. This assumption is undesirable insofar as we would like the representation of voiced and voiceless aspirates to be parallel. However, in addition to accounting for the nasal voicing facts, this assumption is required to distinguish plain and aspirated voiceless affricates, such as we find in all Armenian dialects. If [+spread] attached only to the release node of voiceless aspirates, both plain and aspirated voiceless affricates would have a [-spread] closure node and a [+spread] release node, since (as we recall from the discussion of *k*-assimilation) the fricative component of

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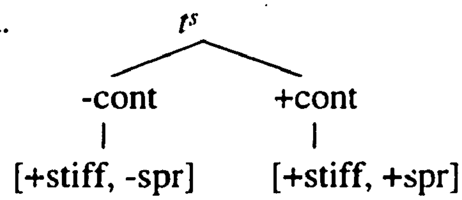
[13]Sindhi nasal voicing is somewhat different, since voiceless aspirates are affected. In this case, we must stipulate that the marking statement *[+nasal, +spread] is deactivated, as stated above. An additional stipulation is required to account for the fact that the spreading [-stiff] feature attaches to the release node rather than the closure node of the target segment, and the [+spread] feature of the closure node subsequently delinks.

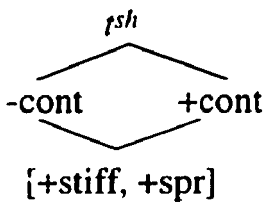
voiceless affricates is always [+spread]. In the contour model, on the other hand, aspirated affricates are distinguished from plain affricates by having [+spread] linked to both closure and release nodes, as in (34).

(34)

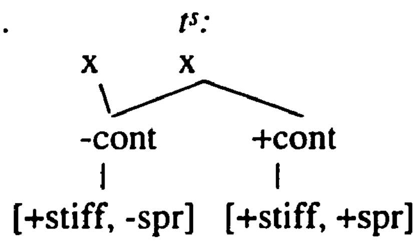
a.



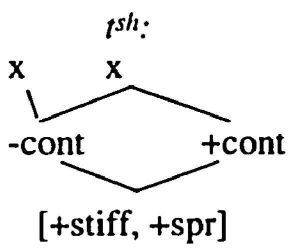
b.



c. (geminate voiceless affricate)



d. (geminate aspirated voiceless affricate)



The same problem does not arise for voiced aspirates, because voiced fricatives are [-spread]. Thus, plain and aspirated voiced affricates are represented as in (35).

(35)

a. d^z

-cont +cont

[+stiff, -spr] [-stiff, +spr]

b. d^{zh}

-cont +cont

[+stiff, -spr] [-stiff, +spr]

c. d^z: (geminate voiced affricate)

x x

-cont +cont

[+stiff, -spr] [-stiff, +spr]

d. d^{zh}: (geminate aspirated voiced affricate)

x x

-cont +cont

[+stiff, -spr] [-stiff, +spr]

The most important edge effect is fricative assimilation (section 5.3.4). Crucially, this rule must be sensitive only to adjacent [stiff] specifications. This being the case, voiced aspirates, whose left edge is [+stiff], will devoice preceding fricatives. The advantage of this model is that it predicts that voiced aspirates will behave as voiceless and unaspirated with respect to processes sensitive to their left edge, and will behave as voiced and aspirated with respect to processes sensitive to their right edge, whereas a traditional model predicts that they will always behave as voiced and aspirated. It also suffers from a number of disadvantages, however, including the problem of positional markedness mentioned earlier.

Even more problematic for this theory are cases of iterative voicing assimilation such as we find in Slavic languages. In these cases, the contour theory proposed here is forced to stipulate that assimilation only involves release nodes, which does not make much sense. Consider for example the case of Russian voicing assimilation, which has the effects in (36) (Mascaró 1987:33, from Halle and Vergnaud 1981).

(36)	underlying form	surface form	gloss
a.	*mcensk by*	*mcenzg by*	if Mcensk
b.	*ot mzdy*	*od mzdy*	from the recompense
c.	*bez mcenska*	*bes mcenska*	without Mcensk

As we can see in (36), Russian has a rule of regressive voicing assimilation which applies word-internally as well as to preceding prepositions. The rule only involves obstruents, however; sonorants neither trigger, block, nor undergo voicing assimilation. Within the contour model developed here, we must say that the rule spreads contrastive [stiff] specifications. If only marked [stiff] specifications were involved, we would be unable to explain the devoicing in (36c), which is triggered by an unmarked [+stiff] segment; similarly, if the rule involved all [stiff] specifications we would expect sonorants to participate. If the rule involves contrastive [stiff], though, we are hard-pressed to explain why the [stiff] specifications of intervening closure nodes do not block spreading. One possibility is to invoke the notion of positional contrast, according to which the [stiff] specifications of closure nodes are not contrastive because they always have the value [+stiff]. The idea that contrastiveness can be defined relative to a given environment represents a significant weakening of Calabrese's context-free definition of contrast, however, and should be treated with caution.

In addition, the positional contrast analysis is unable to account for the behavior of voicing assimilation in Cracow Polish (Mascaró 1987:31), which also involves sonorants (37).

(37)	underlying form	surface form	gloss
a.	*jak nigdy*	*jag nigdy*	as never
b.	*gwos narodu*	*gwoz narodu*	the voice of the nation
c.	*sãsiat radzi*	*sãsiad radzi*	neighbor advises

Since sonorants trigger voicing assimilation in this dialect we must assume that the rule involves all [stiff] specifications, the sonorants being neither marked nor contrastive for this feature. If the rule sees all [stiff] values, though, we can no longer employ the notion of positional contrast to explain the invisibility of closure nodes. As I suggested above, this problem forces us to make the unsatisfying stipulation that voicing assimilation only involves release nodes.

I conclude that a contour analysis is infeasible within the context of the theory of full specification adopted in this thesis. I do not rule out the possibility that it could be made to work in a system employing some form of underspecification, but such a system would abandon the advantages provided by full specification, as set out by Calabrese (forthcoming).

5.4.4. Word-final laryngeal features

In this subsection I consider some of the implications of extending the contour theory to the common process of laryngeal neutralization in word-final position. We have already touched on the topic of laryngeal neutralization in section 5.4.1, where it was proposed that this phenomenon results from the fact that word-final position commonly allows only unreleased segments, as is optionally the case under certain conditions in English. This theory also predicts that fricatives, which according to Steriade 1992 do not have a release node, should not be affected by laryngeal neutralization. Traditional doctrine, on the other hand, predicts that laryngeal neutralization should affect all segments with laryngeal specifications. In theory, then, we should be able to evaluate the two theories based on the actual behavior of fricatives: if they are unaffected by laryngeal neutralization, we should prefer Steriade's model; if they are affected, we should prefer the traditional model.

Let us first examine the behavior of final neutralization in New Julfa, where stops and affricates generally surface as voiceless in word-final position. The effect of this process is of course only noticeable in original plain voiced stops, which surface as voiceless aspirated (the other two consonant series are voiceless).

(38)	classical	New Julfa	gloss
	gub	*gup*^{h}	dark place
	jag	*j*^{h}*ak*^{h}	cub
	awd	*ɦōt*^{h}	air, weather
	yaṙaǰ	*ɦaṙēč*^{h}	front

The simplest account for the facts in (38) assumes that the plain voiced segments become aspirated according to the regular rule (i.e. classical plain voiced stops regularly become voiced aspirates in New Julfa), and then undergo final devoicing. This account is problematic for the contour model discussed above which treats final devoicing as deletion of the release node, which houses contrastive laryngeal specifications. When the release node is deleted we expect aspiration to disappear, which is not the case in New Julfa. Another possibility is that final devoicing preceded the historical rule which produced voiced aspirates from plain voiced stops, in which case we would have to postulate a rule of word-final aspiration. Such rules are not uncommon, being found in languages such as Kashmiri (Masica 1991:204), Klamath (Blevins 1993a), and Sierra Popoluca (Kenstowicz and Kisseberth 1979; this rule actually aspirates coda consonants).Fricatives are not affected by the rule of final devoicing: *cov* 'sea' > *cōv*, *maz* 'hair' > *maz*, *mał* 'sieve' > *maʁ*.

Based on the New Julfa facts and languages such as Turkish, which also does not devoice final fricatives (Underhill 1976:469), one might be inclined to support the model proposed here. One must notice, however, that final devoicing in Russian and many other languages does affect fricatives. Both theories are therefore forced to stipulate that the behavior of one or the other set of languages is exceptional; final devoicing is thus not a sufficient criterion to evaluate the two theories.

5.5. Consonant shifts

The facts presented in this chapter also suggest an explanation for an important element of the Armenian consonant shifts (Pisowicz 1994).

Recall from chapter 2 the consonant systems attested in the modern dialects, repeated below.

(39) correspondences in initial position

	d	*dh*	*t*	Indo-European
1	*d*	*dh*	*th*	Sebastia
2	*t*	*dh*	*th*	Erevan
3	*d*	*d*	*th*	Istanbul
4	*d*	*t*	*th*	Sasun, Middle Armenian
5	*d*	*th*	*th*	Malatia, SWA
6	*t*	*d*	*th*	Classical Armenian, Agulis, SEA
7	*t*	*t*	*th*	Van

In order to understand the consonant shifts, we must first determine the structure of the system to which they applied. There is good reason to assume that Common Armenian possessed a consonant system of the type found in classical Armenian, i.e. {$D\ T\ T^h$}. The most immediate confirmation of this fact is provided by a quick examination of the consonant-shift isoglosses: all consonant systems appear in continuous areas except for group 6 (cf. chapter 2), which occurs in classical Armenian and isolated areas throughout the Armenian dialect continuum, a telltale sign of archaism. In addition, historical developments such as Adjarian's Law and the change of IE **w* to CA **g* only make sense if Common Armenian had the same consonant system as group 6[14]. I assume that the dialect divisions

[14]For example, if we accept Pedersen's 1906 suggestion that the group 1 and 2 dialects are more archaic than the rest in terms of their consonant systems,

had begun to develop from Common Armenian at latest by the time Armenia reached its broadest physical expansion under Tigran II in the first century B.C.. As soon as isolated communities came into being as a result of this expansion, separate dialects must have developed. Therefore the consonant shifts must have taken place some time between this date and the ninth century A.D., the time of the Autun glossary, the first document showing significant divergence from classical Armenian.

The consonant shifts in (39) at first appear to be quite complicated. Closer inspection reveals however that they result from two basic innovations: the development of voiced aspirates and subsequent changes thereto, and the voicing of the original plain voiceless series in groups 1, 3, 4, and 5 (cf. figure (4-5), chapter 2). At the moment I have no special insights into the second development; I consider the first below.

Given an original system $\{D\ T\ T^h\}$, I propose that Common Armenian developed a rule associating the feature [+spread] with syllable-initial position. The same rule exists in English, causing underlying plain voiceless stops to become aspirated and plain voiced stops to become voiceless (the same proposal in essence was made by Catford 1977, though it was expressed in different terms). I am not concerned here with the question of why [+spread] came to be associated with syllable-initial position; the mechanisms underlying this development are unclear to me. What is of

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we are forced to assume that original $*w$ first became g^h, and then changed to g in the other dialects. If on the other hand group 6 is the oldest, we simply have the common rule $w > g$, followed by a subsequent rule aspirating voiced consonants in dialects of groups 1 and 2.

interest for my current purposes is the way in which the phonology deals with the configurations produced by this rule.

Let us first consider the English case, where underlying plain voiceless stops become aspirated and plain voiced stops become voiceless. The change of plain voiceless stops to voiceless aspirates requires no explanation. The reason the plain voiced stops do not become voiced aspirates is that the configuration [-stiff, +spread] is not tolerated in English. In the terms developed in chapter 1, UG provides a marking statement *[-stiff, +spread] which disallows voiced aspirates. This marking statement corresponds to the articulatory difficulty involved in producing simultaneous voicing and aspiration: the rapid airflow across the glottis characteristic of aspiration renders the maintenance of a sufficient trans-glottal pressure differential (cf. chapter 4) extremely difficult.

In languages that allow voiced aspirates this marking statement is deactivated, whereas in languages such as English it is active. Violations of this constraint are repaired in English by means of negation, which produces [+stiff, -spread] consonants, i.e. plain voiceless stops. In the terms of Calabrese 1988, where this repair strategy was originally proposed, negation involves the inversion of binary values in a marking statement. Thus, negation would affect a [-stiff, +spread] configuration by reversing the feature specifications for [stiff] and [spread], giving [+stiff, -spread]. Calabrese assumes for various reasons I do not go into here that negation does not always produce licit feature configurations; in other words, the rule is not strictly speaking a simplification procedure. The voiced aspirate facts suggest a slightly different interpretation of negation, in which the procedure is simply a variant of delinking where both features in a marking statement are delinked instead of just one (40).

(40) laryngeal

[-stiff] [+spread]

Given the assumption made in this thesis that delinking of a feature value entails insertion of its opposite, this double delinking produces the same results as Calabrese's analysis in the case of voiced aspirates. The idea behind my interpretation is slightly different, however; negation is viewed as a process that results in both features in a marked configuration receiving their unmarked values.

Moving on to the Armenian case, the Armenian dialects deal with the illicit *[-stiff, +spread] configuration in four different ways: groups 1 and 2 allow it as is; group 3 delinks [+spread], giving plain voiced segments; group 5 (including standard western Armenian) delinks [-stiff], giving voiceless aspirates; and groups 4 and 7 apply negation, giving plain voiceless stops, as in English. Similar developments are attested in the modern Indo-Aryan reflexes of Sanskrit voiced aspirates, which become plain voiceless in Panjabi, voiceless aspirated in Gipsy, and plain voiced in Kashmiri and other Dardic languages (Turner 1966, Masica 1991; R = retroflex flap, ` = low tone).

(41)	Sanskrit	Panjabi	Gipsy	Kashmiri	gloss
	g^h*ōṭa*	*kō`Rā*	k^h*ori*	*gur*^{u}	horse
	b^h*rātṛ*	*pā`ī*	p^h*al*	*bōy*^{u}	brother
	d^h*ar-*	*tàr-nā*	t^h*er-*	*dar-un*	hold

To summarize, Armenian and Indo-Aryan employ the repair strategies in (42).

(42)

a. delinking of [-stiff] (group 5, Gipsy)

laryngeal

[-stiff] [+spread]

b. delinking of [+spread] (group 3, Kashmiri)

laryngeal

[-stiff] [+spread]

c. negation (groups 4 and 7, Panjabi)

laryngeal

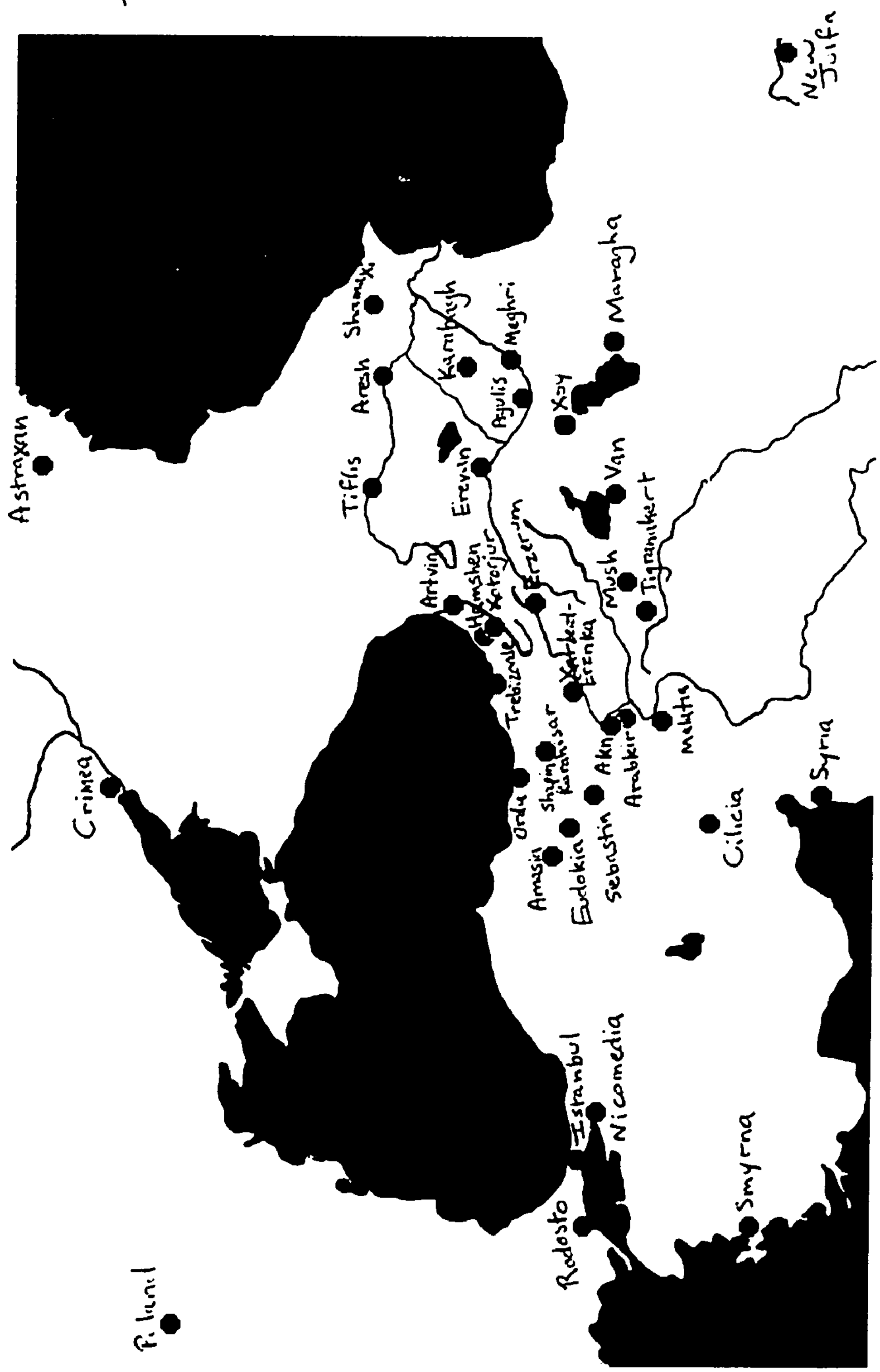
[-stiff] [+spread]

Two additional facts regarding the fate of the voiced aspirates in Armenian must also be accounted for. First of all, we must explain why the plain voiceless series does not become aspirated, as it does in English. It is possible that this development in fact occurred, but did not lead to a merger with the original voiceless aspirate series; Armenian would thus be similar to Korean (cf. Halle and Stevens 1971). Secondly, we must explain why in many dialects the original plain voiced series only becomes aspirated in initial position. I assume that this is related to the fact that word-initial position often allows contrasts not licensed in other positions (cf. Steriade 1994). A similar distribution of voiced aspirates is found in the Indo-Aryan languages Rajasthani and Lamani (Masica 1991:101-2).

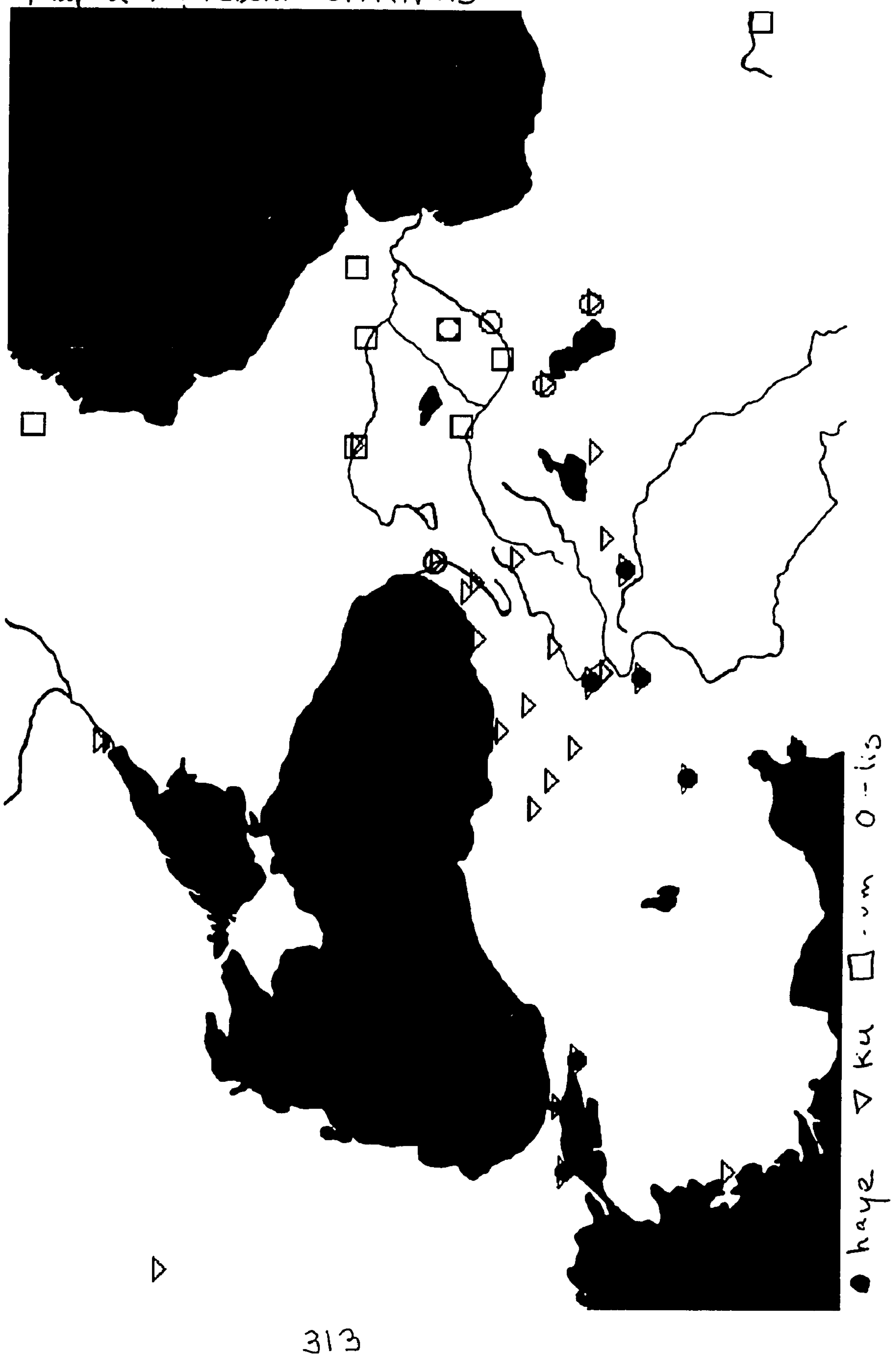
5.6. Conclusions

In this chapter I have presented a host of phonological processes involving laryngeal features in the Armenian dialect of New Julfa, and argued that a theory of contour segments is unable to account for them in a satisfactory manner. In its place I proposed an account revolving around activities of the marking statements *[+nasal, +spread] and *[-stiff, +spread], which serve to rule out infelicitous products of nasal voicing, fricative assimilation, and aspiration delinking. I have also suggested that contour segments show only edge effects and no anti-edge effects. Finally, I hope to have demonstrated that a model which incorporates independently motivated theories of constraints and repairs (Calabrese forthcoming) provides an important first step towards understanding the Armenian consonant shifts. Investigation of the developments undergone by the Common Armenian plain voiceless consonants is left for future research.

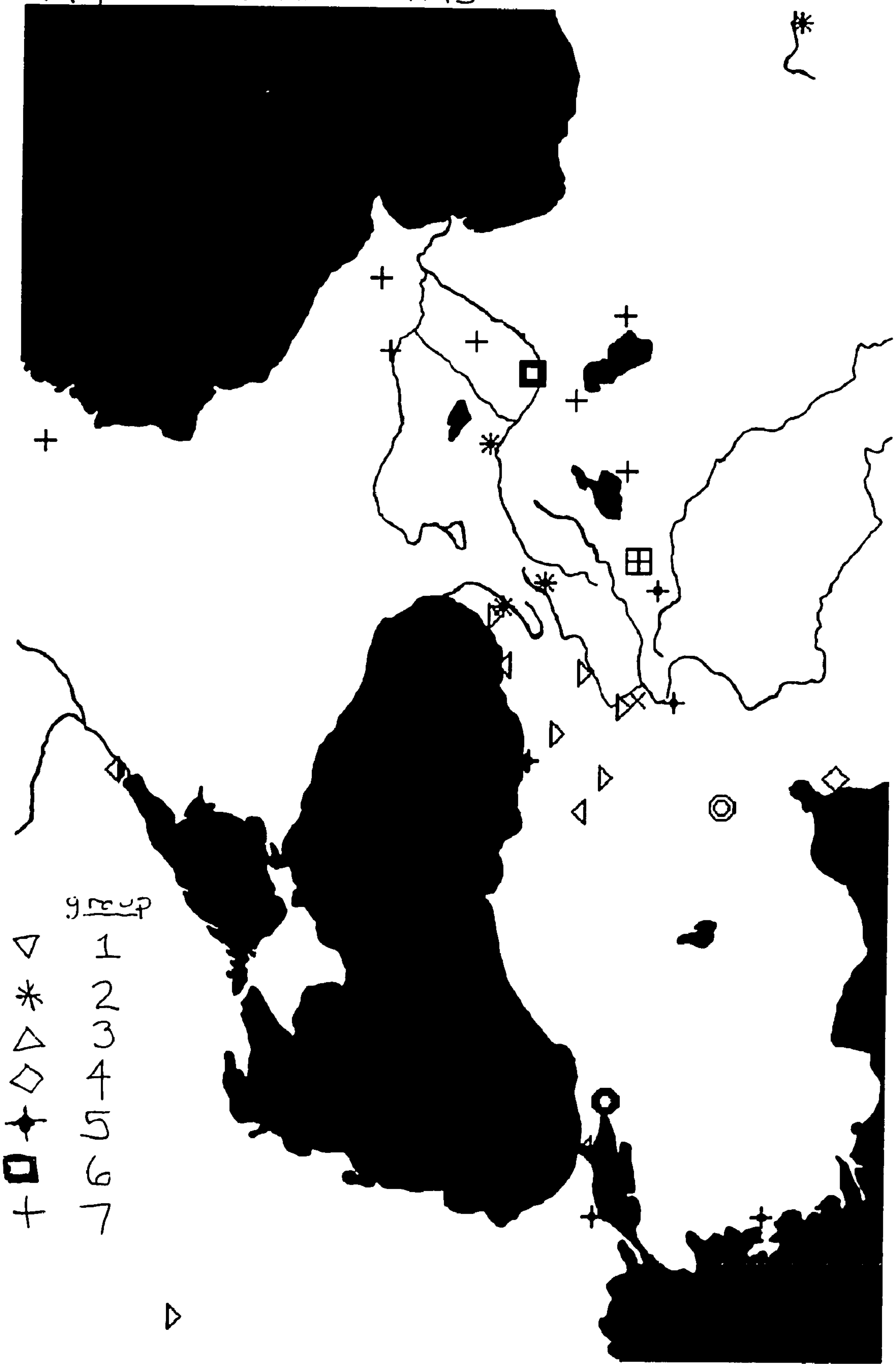
Map 1: Armenian Dialects



Map 2 : present formations



Map 3: Consonant Shifts



Map 4: Adjarian's Law

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