Compensatory lengthening: phonetics, phonology, diachrony

by

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Abstract

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The term *compensatory lengthening* (CL) refers to a set of phonological phenomena wherein the disappearance of one element of a representation is accompanied by a corresponding lengthening of another element. This study focuses on descriptive and formal similarities and divergences between CL of vowels triggered by consonant and by vowel loss.

This thesis argues that to account for the full range of existing compensatory phenomena as well as for the absence of certain logically possible outcomes of CL, it is necessary to distinguish synchronic and diachronic aspects of CL. On the basis of a typological survey of languages possessing CL, it is shown that CL through consonant and vowel loss are similar diachronically: both arise through phonologization of inherent duration of vowels and neither involves any transfer of length or weight. Rather, intrinsic phonetic vowel durations in both types are reinterpreted as phonologically significant upon a change in the conditioning environment or syllable structure. To account for the diachronic source of CL, a phonologization model is developed based on a listener-oriented view of sound change.

Though similar diachronically, CL through consonant and through vowel loss function differently in synchronic grammars. Because of this split, purely phonological

accounts, such as mora conservation, are inadequate to predict the full typology of CL. It is proposed that the nature of the split is due to a difference in the relationship between trigger and target for the two types of CL. Consonant loss in CVC CL is usually transparent, since it is always segmentally conditioned, assuring synchronic recoverability of its trigger and permitting synchronic CVC CL alternations to be modeled as moraic conservation within the syllable. By contrast, CVCV CL is rarely segmentally conditioned. In most cases the trigger of CVCV CL is not recoverable synchronically, and thus vowel length alternations become lexicalized or morphologized and do not result in synchronic compensatory processes. In those few cases where the loss of the trigger of CVCV CL is segmentally conditioned and thus synchronically recoverable, CVCV CL alternations remain transparent and formally comparable to CVC CL alternations.

Contents

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Chapter 1.
Introduction

1.1. Defining compensatory lengthening

This dissertation concentrates on the phenomenon of compensatory lengthening, looking at it from different angles. The term *compensatory lengthening* (henceforth, CL) refers to a set of phonological phenomena wherein the disappearance of one element of a representation is accompanied by a corresponding lengthening of another element.[1] In this dissertation we will be primarily concerned with CL processes as they affect vowel length; consonant length will be dealt with only in connection with (de)gemination.

Descriptively, CL of vowels represents the situation in which the lengthening of a segment is correlated with the deletion of a neighboring segment, either a consonant or a vowel. There are two main types of CL of vowels. The first, CL through consonant loss (CVC CL), is lengthening of a vowel which is correlated with the deletion of an adjacent consonant. This process is shown schematically in (1).

(1) $C_1VC_2 \rightarrow CV$:
closed σ, short V $\rightarrow$ open σ, long V:
one $\sigma \rightarrow$ one σ

[1] Both consonants and vowels have been claimed to trigger and undergo CL. Four logically possible types of CL processes are shown in (1'), as presented in Morin (1992).

(1') Four logical types of CL (Morin 1992).

type	lengthened segment	lost segment
1. CL_{VC}	V	C
2. CL_{VV}	V	V
3. CL_{CV}	C	V
4. CL_{CC}	C	C

When the lengthened segment is a consonant, the process can be reanalyzed as gemination (Morin's Type 3) or total assimilation (Morin's Type 4). Assimilatory processes are well beyond the scope of this study.

Note that the type of CL shown in (1), CL through consonant loss, is characterized by the lengthening of the vowel as a consequence of the loss of the consonant, and also by a change in syllable structure. A closed syllable with a short vowel (as a historical input or a synchronic input and/or underlying representation) ends up as an open syllable with a long vowel. In the case of CVC CL syllable count is preserved; the deleting consonant is usually tautosyllabic with the lengthening vowel (except in the case of so-called *double flop* which will be discussed in chapter 3 in connection with CL in Ancient Greek).

An example of CVC CL is shown in (2). In Lithuanian (Baltic), nasals are deleted if followed by voiceless fricatives, and are retained otherwise. The deletion of nasals is accompanied by the lengthening of the preceding vowel, producing synchronic *CVn ~ CV:* alternations.

(2) CL in Lithuanian

spr**ɛn**-dʒa	'decides'	spr**æː**-stɪ	'to decide'
s**ʊn**-tʃɛ	'sends'	s**uː**-stɪ	'to send'

CL through consonant loss is a typologically common process, and in Appendix 1 I show the results of a survey which located 55 languages belonging to 17 language families exhibiting this type of CL.

The second type of CL differs strikingly from the first one. CL through vowel loss is a process whereby the loss of the second vowel in a CVCV sequence is correlated with the lengthening of the first vowel in this sequence. The properties of CVCV CL are shown schematically in (3).

(3) $C_1V_1C_2V_2 \rightarrow C_1V_1{:}C_2$
open σ, short V → closed σ, long V:
two σ → one σ

CL through vowel loss is characterized not only by changes in syllable structure – from two open syllables with short vowels to a closed syllable with a long vowel, but also by the fact that the syllable count is not preserved as a result of this process. A disyllabic unit of the input becomes one syllable in the output once the second vowel is lost. Such CL is illustrated in (4), with an example of the diachronic development from Old Church Slavic (OCS) to Serbo-Croatian.

(4) shows that a short high lax vowel [ʊ] was lost at some point in the history of Slavic, and that in Serbo-Croatian, the loss of [ʊ] is correlated with the lengthening of the preceding vowel.

(4)	**OCS**		**Serbo-Croatian**	
	boru	>	bo:r	'forest'
	rogu	>	ro:g	'horn'
	medu	>	me:d	'honey'

CL through vowel loss is typologically a less common process than CL through consonant loss, even though it is by no means rare or exotic. However, while CVCV CL is quite common historically (see Appendix 2 for a survey of languages which exhibit CL through vowel loss), synchronic alternations of the type CVCV → CV:C are not frequently found (I was able to locate only two languages, Lama (Gur) and Baasaar (Voltaic), which arguably has CVCV → CV:C alternations). Usually, CL through vowel loss results in synchronic vowel length alternations which are either lexicalized or morphologized. The reasons for such an asymmetry will be discussed in chapter 5.

This dissertation focuses on the analysis of both CL through consonant and through vowel loss we have just illustrated. The object of the investigation in this study are descriptive and formal similarities and divergences between these two types of CL.

The remainder of chapter 1 is structured as follows. Section 2 reviews descriptive generalizations made about different types of compensatory processes in the past,

concentrating on CL of vowels through both consonant and vowel loss, and presents an overview of treatments of CL in the phonological literature. Section 3 outlines the basics of the phonologization model developed in this study to account for CL as a diachronic process. Finally, Section 4 presents a summary of the organization of the rest of the dissertation.

1.2. Theoretical approaches to compensatory lengthening: an overview

CL has been important for phonological theory for a long time, even though the reasons for its importance changed with the advent of new theoretical frameworks. An interesting and intriguing fact about CL is that it depends on two formally independent processes: the deletion of one segment and the lengthening of another. The challenge for phonological theories has always been either in unifying these two phenomena or in accounting for them as unrelated events.

Given these two possibilities, there are two main theoretical approaches to CL: either to deny the connection between the loss of one segment and the lengthening of the other, or to treat CL as some kind of preservation of phonetic or phonological entities. The first approach is represented by the phonetic weakening hypothesis of de Chene & Anderson (1979) which holds that all instances of CL through consonant loss can be analyzed into two independently motivated processes of weakening of a consonant to a glide and subsequent monophthongization of a complex syllable nucleus. CL in the de Chene & Anderson's model is not a compensatory process. According to their main argument, "there is no such distinct phonetic process as compensatory lengthening, and accordingly no unified phonetic explanation (such as 'preservation of syllable weight' or the like) should be sought" (De Chene & Anderson 1979: 507). This phonetic weakening hypothesis which applies only to the CVC type of CL will be further discussed in chapter 3.

The second type of analysis (that is, some type of unification of segment loss and segment deletion) is much more widespread. Both phonetic and phonological models have been developed with the assumption that segment loss and lengthening in CL processes are crucially connected. A phonetically-based account of CL through vowel loss is developed in Timberlake (1983b, 1993). The underlying idea of Timberlake's work is that CL through vowel loss depends on the preservation of phonetic duration. Timberlake's approach is developed specifically to account for CL through vowel loss in Slavic dialects and will be further discussed in chapter 4.

By far the majority of the conservation approaches have been phonological rather than phonetic. There are many versions of formal treatments of CL. In the frameworks of autosegmental and prosodic phonology, CL is accounted for as conservation of a timing unit, either a CV or X skeletal slot (Clements & Keyser 1983, Lowenstamm & Kaye 1986 among others), or conservation of a syllabic subconstituent, such as the mora, within a prosodic unit (Hyman 1985, McCarthy & Prince 1986, Hock 1986, Hayes 1989 among others).

The mora conservation hypothesis is perhaps the most influential and widespread contemporary treatment of CL (Hyman 1985, McCarthy & Prince 1986, Hayes 1989). The idea behind the moraic conservation approach is that the deletion of a consonant leaves a stray mora to which the preceding vowel reassociates, acquiring an additional unit of length. This necessarily connects the deletion of one segment with the lengthening of the other.

Thus, in conservation models CL is, unlike for de Chene & Anderson (1979), truly *compensatory*, in that its application involves either the augmentation of some property of a segment Y *in response to*, or *to make up for* deletion or shortening of some segment X (Timberlake 1983b), or alternatively a literal transfer of some phonological property of a deleting segment X to a new segmental host Y (Hayes 1989, among others).

These two approaches to CL differ in the level of representation to which they refer: while the former approach appeals to a notion of isochrony, or preservation of the actual phonetic duration of a word or string, the latter relies on a notion of preservation and transfer of elements of the phonological representation (CV slots, X slots, or moras).

One of the challenges in formulating a synchronic model of CL is its opacity. CVC CL processes are inherently opaque since alternations are triggered by the loss of a moraic segment, but morification and syllabification are not generally supposed to be specified in the input. Thus, some intermediate level of representation is required, such that the relevant moras may be first inserted and then subsequently deleted as a later stage. For this reason, modeling CL in optimality theory (OT) remains problematic. This may account for the lack of optimality-based treatments of CL. To solve or avoid the opacity problem, the existing accounts of CL couched in OT use extended versions of the moraic approach with no derivational component (Lin 1997, Sprouse 1997, Zec 1998), or choose not to refer to moras, as in Lee (1996) who analyzes CL as preservation of numerical integrity of segments within a word, or reanalyze CL as coalescence rather than deletion with subsequent lengthening (Sumner 1999).

1.3. CVC and CVCV CL diachronically: the proposed phonologization model

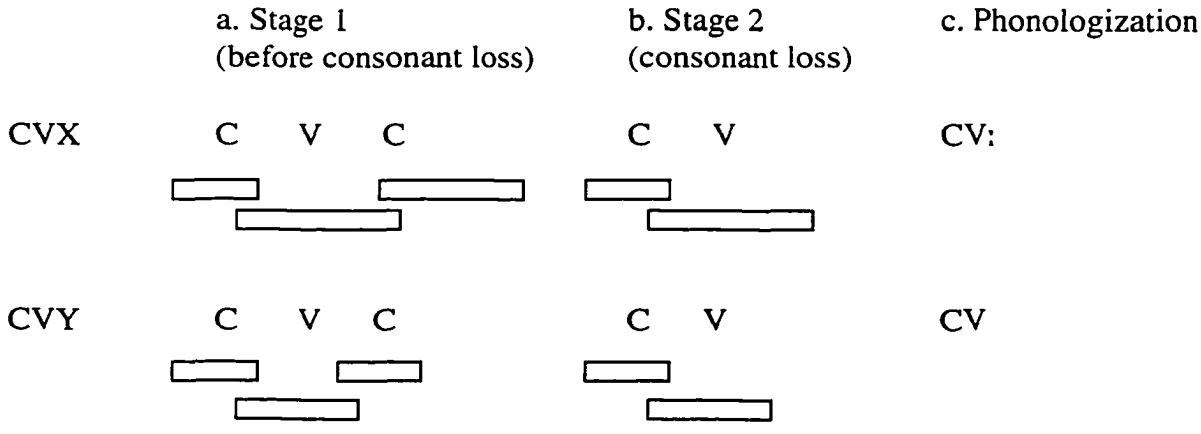
In this study, I argue that in accounting for the full range of existing compensatory phenomena as well as for the absence of certain logically possible variations on CL, it is necessary to distinguish between the synchronic and diachronic aspects of CL. Past formal accounts do not differentiate between synchronic and diachronic cases of CL. In fact, most examples in Hayes (1989) represent diachronic sound changes rather than synchronic alternations. In chapters 3 and 4, I show that CL through consonants and vowel loss are similar diachronically: they both arise through phonologization of inherent duration of vowels. However, I argue that the mechanism of the reanalysis is different for

CVC and CVCV CL, which leads to their asymmetric behavior as synchronic alternations. To account for the nature and the source of the asymmetry, I develop a phonologization model based on a listener-oriented view of sound change (Ohala 1981).

1.3.1. Origins of CVC CL

In the cases of diachronic CL through consonant loss, vowels which are phonetically longer in the environment of neighboring consonants are realized as phonemically long with the loss of conditioning environment. (5) shows a hypothetical situation to illustrate this point. Imagine that in a certain language, X is a consonant with longer vocalic transitions, for example, a glide, and Y is a consonant vocalic transitions to which are much shorter, for example, a stop. Prior to the deletion of the consonants, both vowels are correctly parsed as short, since the length of the transitions is correctly parsed by listeners as caused by the neighboring consonant and is thus discounted (5a). When both X and Y are lost is the language in question (5b), the transitions can be reinterpreted as a part of vowels, and the vowel which is inherently longer in the environment of X than in the environment of Y is more likely to be reinterpreted as contrastively long.

(5) Phonologization of vowel length: CL through consonant loss



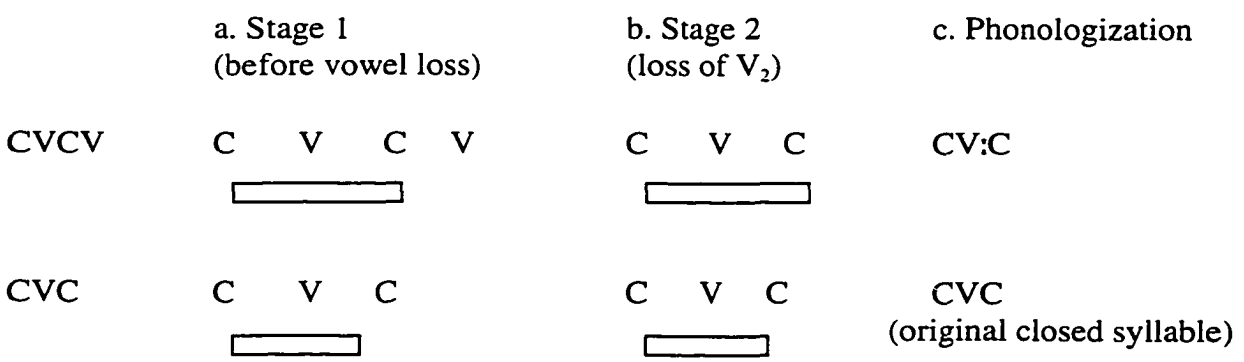
A detailed study of the cases of CL through consonant loss will be presented in chapter 3.

1.3.2. Origins of CVCV CL

To account for CL through vowel loss, it is important to notice that vowels in open syllables are typically realized cross-linguistically longer than vowels in closed syllables (Maddieson 1985, Rietveld & Frauenfelder 1987, among others). I argue that this generalization is what allows us to model most examples of CVCV CL as a phonologization process.

Consider a schematic example of CL through vowel loss in (6). Prior to the deletion of the final vowel, the longer vowel duration characteristic of open syllables is correctly parsed by listeners as a phonetic consequence of syllable structure in the first syllable of a CVCV sequence, and is discounted (6a). The vowel is interpreted as phonologically short, as is intended by the speaker. Upon deletion of the final vowel however, the duration of the vowel in the newly-closed syllable becomes inexplicable, since it is longer than is expected in the closed syllable (6b). The listener therefore parses the longer duration as intended by the speaker, and reinterprets the vowel in question as phonologically long (6c):

(6) Phonologization of vowel length: CL through consonant loss



The main focus of chapter 4 will be a detailed study of the cases of CL through vowel loss.

1.3.3. Listener-oriented sound change

The view of sound change assumed here is listener-oriented: intrinsic phonetic properties of the speech signal are misparsed and reinterpreted, yielding phonologization (Ohala (passim), Blevins and Garrett 1998, among others).

Ohala (1992) discusses umlaut and nasalization to illustrate hypocorrection as a listener-oriented sound change. For example, in Hindi the loss of a nasal consonant results in the nasalization of a preceding vowel. The table in (7) in based on the the stages of nasalization in Hindi proposed by Ohala (1992):

(7)	**Time 1**	**Time 2**
speaker says	[ṽN]	[ṽN]
	↓	↓
listener parses	/VN/	/ṽ/

At the Time 1, the vowel which is followed by the nasal is predictably nasalized and thus discounted by the listener. At the Time 2, however, the vowel is analyzed as distinctively nasalized, since the environment conditioning nasalization – the nasal – is lost.

I propose that CL in an analogous process to the hypocorrective umlaut and nasalization (Ohala 1981, 1992, 1995). In the case of CL, the vowel duration is present in the string in question at all times and is reanalyzed as phonemic length upon changes of the environment. Thus, CL as a historical process does not in fact involve any transfer of length or weight. Rather, intrinsic phonetic vowel durations in are reinterpreted as phonologically significant upon a change in the conditioning environment or syllable structure.

The main difference between the conservation accounts of CL (that is, formal phonological accounts and Timberlake's isochrony model developed for the Slavic CL) and the phonologization model just outlined is that the phonologization hypothesis does not assume any transfer of weight upon the loss of a segment in either CVC or CVCV CL.[2]

1.4. CVC vs. CVCV CL: synchronic divergence

After accounting for the diachronic source of CL through consonant and vowel loss, I show that vowel length alternations resulting from the two types of CL function differently in synchronic grammars. While CVC CL remains a transparent synchronic phonological process which can be modeled as optimization of syllable structure, CVCV CL rarely stays transparent. As long as its historical trigger is not recoverable synchronically, CL through vowel loss cannot be modeled as a compensatory process; it is usually lexicalized or bound to specific morphological alternations which are non-optimizing. Chapter 5 will state descriptive generalizations as well as present analyses of synchronic CL processes, concentrating on the differences between phonologically and morphologically conditioned alternations.

1.5. Organization of the dissertation

The rest of the dissertation is organized as follows. Chapter 2 is devoted to the question of whether conservation approaches adequately account for the full array of facts known as compensatory lengthening. After a short review of the principles and formalism of the existing conservation models, chapter 2 discusses predictions of conservation approaches with respect to CL. A number of the predictions of moraic theory, the most influential of

[2] While I propose an explicit mechanism of the CL sound change, isochrony might be a valid phonetic notion in some languages, but the process of phonologization of vowel length remains unclear and somewhat unfathomable under the isochronic account.

conservation approaches, are shown to be problematic. First, the moraic approach predicts that, since only the deletion of a weight-bearing segment can trigger lengthening, a language has to have an independently established weight distinction in order to have CL. However, languages with no evidence of moraic status of consonants (e.g. Piro or Ngajan) still exhibit CL. Second, moraic theory predicts the deletion of onsets not to cause CL, since onsets cannot bear weight. There is counterevidence to this claim as well: I discuss the case of CL through onset deletion in Samothraki Greek. Third, according to moraic theory, only weight-bearing segments can be relevant in CL processes. However, in Slavic, the nature of non-moraic intervening *onset* segments affects the outcome of CL.

The examination of problems presented in chapter 2 reveals that the moraic approach to CL both under- and overgenerates. I show that all cases of CL where moraic theory undergenerates are diachronic. Chapters 3 and 4 concentrate on the understudied area of segmental conditioning of CL and provide historical and phonetic motivations for the split between synchronic and diachronic cases. I demonstrate that both CVC and CVCV CL ultimately have the same phonetic motivation, resulting from phonologization of inherent duration.

Chapter 3 presents a typology of cases of CL through consonant loss based on a newly constructed database of 55 languages belonging to 17 different languages families, and provides in-depth case studies of CL in Ancient Greek, Kabardian, Latin, Lithuanian, the Ngajan dialect of Dyirbal, and Turkish. The examination of these data reveals that the phonetic motivations for CVC CL are always twofold: on the one hand, it is only a subset of consonants which deletes in any given language, and there are always phonetic motivations (articulatory or perceptual) for why a certain consonant is lost in a particular environment (glides can be misheard as vowels, nasals are very often lost before fricatives or voiceless stops, *h* is often misheard as a part of a vowel, especially if it is

followed by a sonorant, etc.). On the other hand, the deletion of a consonant does not always entail lengthening the preceding vowel. When such lengthening does take place, there is a clear phonetic motivation for it. I propose that in the instances of consonant loss, only the deletion of consonants the elongated transitions to which can be misparsed as intrinsic to the vowel can cause CL. Alternatively, the deleting consonant itself can be mistaken as a part of the vowel. In most cases of CL, lengthened vowels were phonetically longer in the environment of lost consonants and thus could be reanalyzed as phonemically long with the loss of the consonant through the mechanism of hypocorrection (Ohala 1981). In chapter 3, I also account for apparent counterexamples, such as CL through the deletion of glottal stops, templatic CL in Hebrew, and analogical CL through degemination in Indic.

Chapter 4 examines CL through vowel loss, concentrating mainly on Slavic, as it presents the most complex case. The outcome of CL in Slavic languages (schematically, $C_1V_1C_2V_2 \rightarrow CV_1{:}C$) depends on the nature of the intervening non-moraic consonant (C_2), as well as the nature of V_1 (only mid vowels lengthen), and also on accentuation and on the position of the deleting vowel in the word. I argue that in the cases of CL through vowel loss, extra phonetic length is already present in the vowel. At the time when the second vowel in a CVCV sequence is lost, the first vowel finds itself in a closed syllable. Since the duration of a short vowel in an open syllable is usually much longer than the duration of a short vowel in a closed syllable, phonologization of that phonetic length occurs, so the vowel is reanalyzed as long.

Chapter 5 deals with theoretical implications of the analyses proposed in the dissertation. I show that CL processes through deletion of consonants and through deletion of vowels function differently in synchronic grammars. Because of this split, purely phonological accounts of CL, such as mora conservation, are inadequate to predict the full typology of CL. I account for the nature of the split synchronically as a difference

in trigger/target relationship for the two types of CL. Consonant loss in CVC CL is always segmentally conditioned, assuring synchronic recoverability of its trigger and permitting synchronic CVC CL alternations to be modeled as moraic conservation within the syllable. By contrast, CVCV CL rarely results in synchronic compensatory processes. In most cases the trigger of CVCV CL is not recoverable synchronically, and thus vowel length alternations become lexicalized or morphologized, even though they may be phonologically conditioned. In those few cases where the loss of the trigger of CVCV CL is segmentally conditioned and thus synchronically recoverable, CVCV CL alternations remain transparent and formally comparable to CVC CL alternations.

Chapter 2.
Conservation approaches to compensatory lengthening

2.1. Introduction

This chapter is devoted to the question of whether conservation approaches adequately account for the full array of facts known as compensatory lengthening. All conservation approaches, phonetic or phonological, share a general idea that CL is conservation of some unit that reflects timing either directly or indirectly. What distinguishes these approaches is how they define such a timing unit. Different conservation analyses of CL refer to timing units of various degree of abstractness, such as CV or X skeletal slots, moras, or even absolute duration.

Even though most of the conservation approaches to CL are phonological, the main insight of conservation models is expressed in the phonetic idea of isochrony as early as in Timberlake (1983b). The notion of isochrony is not uncontroversial[3], but in the phonetic literature, isochrony has been used to refer to a phenomenon whereby the phonetic duration of a word tends to remain constant (Abercrombie 1964). Trask (1996: 186) defines isochrony as "a type of speech rhythm in which units of a certain type tend strongly to be produced at regular intervals of time – that is, in which each such unit takes the same length of time to pronounce".

Timberlake (1983b) extends the accepted notion of isochrony to express the idea of conservation of phonetic duration. He suggests that Late Common Slavic was subject to isochrony on a level of a word, arguing that phonetic reduction (the loss of a vowel) in a syllable was compensated for by increased phonetic duration in the preceding syllable

[3] It remains to be seen if isochrony is a physical reality or a tendency which is manifested in the production or perception of a word. While it has been postulated that isochrony is a valid phonetic notion in some languages (see Abercrombie 1964 for English), it has been also claimed that isochrony cannot be defined as a purely phonetic effect, and that lexical and syntactic factors have to be taken into account (Lehiste 1972).

due to a tendency of words to remain of constant duration.[4] Timberlake's theory is prescient insofar as it appeals to scalar categories and integrates phonetics into phonology long before the advancement of phonetically-grounded phonological theories (as, for instance, Flemming 1995).

The idea of isochrony as interpreted by Timberlake (1983b) can be viewed as a phonetically-oriented conservation model of CL. However, the implementation of the idea of direct conservation of phonetic duration remains problematic and difficult to substantiate, since it is by no means true that CVV and CVC syllables have the same phonetic duration.[5] Additionally, Timberlake's interpretation of isochrony is rather teleological, since the driving force of the "desire" of words or syllables to remain of constant duration is not defined under his model.

Phonological approaches are better equipped to implement the idea of isochrony formally insofar as they do not refer to phonetic duration directly, but rather treat CL as conservation of more abstract timing units. These units of timing has been defined as CV slots (McCarthy 1979, 1981, Clements & Keyser 1983), X slots (Levin 1985, Lowenstamm & Kaye 1986), and moras (Hyman 1985, McCarthy & Prince 1986, Hock 1986, Hayes 1989).

In the rest of the chapter, I will present an overview of past conservation models of CL and suggest that purely representational accounts do not account for the full range of data and that a reference to diachronic development of CL processes is crucial in understanding their synchronic properties. Section 2 will present the main assumptions of early autosegmental theories of CL, such as CV phonology and X theory, and section 3 will concentrate on the basic tenets of moraic theory. In section 4, I will discuss the

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[4] See also McRobbie (1990) for an argument that isochrony is a phonetically valid principle in Skolt Sámi, responsible for CL of vowels preceding shorter consonants.

[5] Barnes (2001) shows that in Turkish vowels in CVC syllables tend to be longer than in CV syllables, which is not cross-linguistically expected. This could be due to "isochronic" tendencies of CVC and CV: (heavy) syllables, but remains to be tested.

problems which moraic approach faces in accounting for CL, and section 5 will outline the beginnings of the phonologization analysis to be developed in later chapters.

2.2. Autosegmental phonology

The main point of disagreement between conservation approaches to CL is what unit of timing is conserved. I am aware of only one analysis which treats CL as a direct conservation of segments (Lee 1996)[6], and all other treatments of CL define the conserved unit in terms of prosodic/autosegmental material.

The need of levels of representation independent of segmental strings was recognized in work by Williams (1976), Goldsmith (1976), Liberman (1975), Liberman & Prince (1977), among others, and led to the development of the theory of *Autosegmental Phonology*, introducing phonological models in which prosodic properties of strings, such as tone and stress, were treated as independent levels of representation. Since the early autosegmental models provided satisfactory solutions to previously intractable problems, they were naturally extended to account for other phonological processes, including CL.

Examples adapted from Hayes (1989) illustrate the organization of the syllable in CV theory (1a) and in X theory (1b).

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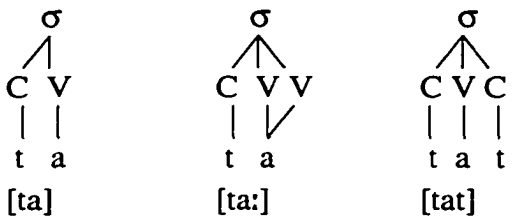
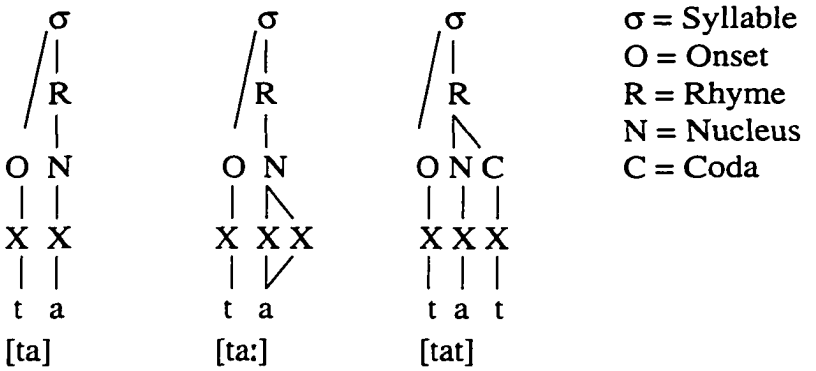
[6] The attempt to treat CL as segmental conservation is presumably due to the fact that CVC CL alternations are opaque if treated with reference to syllable structure, and thus present a problem for OT (see Chapter 5 for a fuller discussion). Lee (1996) treats CL, as well as metathesis and coalescence processes as "the outcome of an endeavor to conserve to the utmost extent possible the numerical integrity of segments of a morpheme". This approach relies heavily on the use of diacritics and loses insight present in moraic treatments of weight-related phenomena. To avoid CL through the loss of onsets, Lee uses a constraint STROLE which compares "syllabic structure" of the input and the output (Lee 1996: 4). Since Lee neither posits the existence of underlying syllable structure nor refers the reader to any intermediate stage, the correctness of the analysis is far from self-evident, since it is unclear if it can derive the basic CVC CL pattern.

(1) a. CV Theory



b. X theory

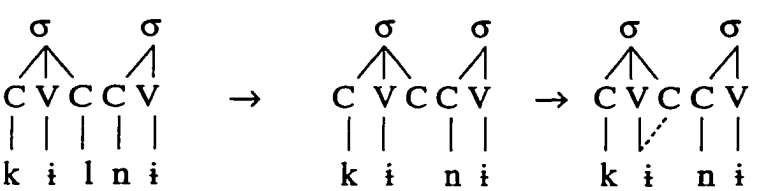


In (2), there is an example of CL through *l*-deletion in the Ižma dialect of Komi stated in the formalism of CV phonology (e.g. Clements & Keyser 1983). The central insight of CV phonology which was kept by all later autosegmental approaches to CL is that the deletion of a segment happens only on the segmental tier, which leaves an empty slot on the prosodic (or skeletal) tier. The melody from the preceding vowel subsequently spreads to the following empty tautosyllabic position, resulting in a long vowel.

(2) Komi *l*-deletion in CV phonology

a. /kɨl-nɨ/ → kɨ:nɨ 'to hear'
hear-INF

b.



Proponents of the X theory dispense of CV phonology on the grounds that the C/V representation of skeletal slots appears to be too restrictive. Certain skeletal slots seem not to discriminate between consonants and vowels, as can be demonstrated on the above example of CVC CL, where deletion of a consonant is followed by lengthening of a vowel. However, while the C/V specification of skeletal slots is too specific, representation of segmental positions in terms of unified X slots may be too general. In his seminal 1989 article, Hayes convincingly argues that, contrary to predictions of X theory, double linkings to *onset* + *nucleus*, if they exist, do not represent length, and length-creating operations involve only spreading onto rhyme positions. Thus, the moraic approach, which does not have any of the problems associated with either CV theory or X theory, is the best representational approach developed so far to account for CL.

2.3. Moraic approach to compensatory lengthening

In this section, I will turn to predictions with regards to CL made specifically by moraic theory. As we have seen, moraic theory accounts for CL in terms of mora conservation. The moraic conservation hypothesis covers more typological ground than any other approach, since on one hand it claims to account for both CL through consonant and through vowel loss, and on the other hand, it does not explicitly differentiate between CL as a diachronic sound change and synchronic CL alternations. It turns out, however, that both of these distinctions need to be recognized in order to account for the full array of CL facts.

In this chapter and in the rest of the thesis, I will show that CVC and CVCV CL function differently in synchronic grammars and will argue that distinguishing diachronic processes from synchronic alternations is crucial for understanding the nature of this split. My goal in the rest of this chapter is to address false predictions of the moraic approach in respect to CL.

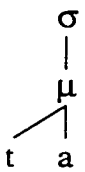
2.3.1. Moraic theory: an overview[7]

The notion of mora as a unit of weight is relatively uncontroversial and long recognized. For example, the concept of a mora counting language was already used by Trubetzkoy (1939) to characterize stress assignment in Classical Latin. The current definition of mora arose from work on accentuation (e.g. McCawley 1968, Newton 1972), and was later extended to become a general characterization of syllable structure.

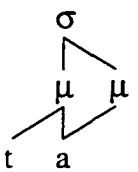
In all contemporary versions of moraic theory (Hyman 1985, Hock 1986, McCarthy & Prince 1986, Hayes 1989, and the following work), mora is used to denote syllable weight. In most generative accounts, short vowels are mapped to one mora, and long vowels – to two moras, but the representation of consonants varies even within the moraic framework.

Hyman (1985) assumes that all segments are underlyingly moraic, and the universal *Onset Creation Rule* removes moras from prevocalic (onset) consonants. Such consonants are subsequently associated with a following mora, as shown in (3).

(3) a. CV



b. CVV

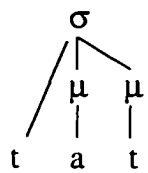


Hyman's version of the moraic approach is used in recent OT-based analyses, e.g. Lin (1997) assumes underlying moraicity of all segments in order to account for CL in Piro. However, a more widespread approach holds that only vowels and geminate consonants are moraic underlyingly (Hayes 1989). According to Hayes, coda consonants are only assigned moras by a language-specific rule which he dubs *Weight-by-Position* principle. *Weight-by-Position* is only applicable to languages which recognize CVV and CVC

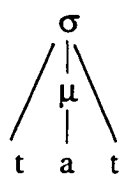
[7] For a detailed review of recent developments in moraic framework, see Broselow (1995).

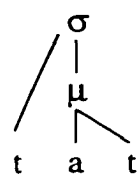
syllables as equally heavy. In these cases, a coda consonant in a CVC syllable can be assigned a mora (4). Otherwise, the coda consonant is adjoined either directly to the syllable node (5a) or to a mora of the preceding nuclear vowel (5b).

(4) CVC – heavy



(5) CVC – light

a. 

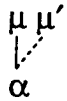
b. 

In chapter 1, we briefly described the basic tenets of the moraic treatment of CL. To review, in order to capture the appearance of a transfer of vowel length from one place in a string to another, it is proposed by the proponents of moraic account that CL occurs when a mora-bearing segment is deleted, but its mora persists in the representation. This stray mora is then reassociated to a nearby vowel, making that vowel long. Moraic approach assigns CL an analysis such as that in (6), constructed on the basis of the *s*-deletion in Latin.

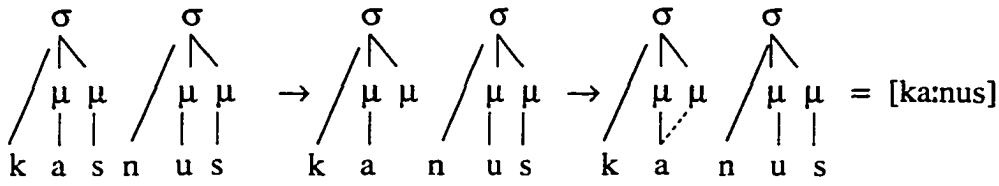
(6) Latin *s*-deletion in moraic theory (Hayes 1989: 262)

a. s → ø / ___ [+son, +ant] (segmental tier only)

b. Compensatory lengthening



where μ′ is a segmentally unaffiliated mora

c. 

(6) demonstrates that in Latin, according to the analysis proposed by Hayes (1989), *s* deletes before sonorants only on the segmental tier. The rule responsible for the segmental deletion (6a) is supplemented by a prosodic rule (6b) which states that if a mora is not affiliated to any segmental material, it is filled by spreading from an immediately preceding vowel. (6c) illustrates these two rules in action on the example of a Latin word [ka:nus] 'gray'.[8]

2.3.2. Moraic approach: predictions and problems

The preceding sections have described a set of mechanisms which are used to account for CL in the moraic approach. The goal of this section is to state and test predictions of moraic approach in respect to CL. It will be demonstrated below that a number of predictions of moraic theory are false, and that both CVC and CVCV types of CL are problematic for it. Here I will concentrate on several specific problems. First, moraic approach predicts that, since only the deletion of a weight-bearing segment can trigger lengthening, a language has to have an independently established weight distinction in order to have CL. However, languages with no evidence of moraic status of consonants (e.g. Piro or Ngajan) still exhibit CL. Second, moraic theory predicts the deletion of onsets not to cause CL, since onsets cannot bear weight. There is counterevidence to this claim as well. Third, according to the moraic approach, only weight-bearing segments can be relevant in CL processes. However, in some languages (e.g., in Friulian or in various dialects of Slavic), the nature of non-moraic intervening *onset* segments affects

[8] It is unclear if there is evidence for synchronic status of *s*-deletion in Latin, even though this example is presented as a synchronic alternation in Hayes (1989).

the outcome of CL. Slavic CL presents yet another problem for moraic theory which cannot account for jer vocalization short of proposing half moras. After laying out the issues just mentioned, I will discuss the issues of adjacency and directionality in respect to CL as a mora transfer.

I will argue that the cause of the problems (except, perhaps, theory-internal ones) lies in not distinguishing diachronic phonetic lengthening processes from synchronic CL alternations. Specifically, I will show that, while CL as a sound change does not involve any direct transfer of weight, the account of synchronic CL alternations can be modeled in terms of moraic approach.

2.3.2.1. Independent weight distinction

The independent weight distinction hypothesis has its roots in the argument first made by de Chene & Anderson (1979) and developed by Bichakjian (1986) that CL is a structure-preserving change, which in essence means that compensatory processes cannot be the primary source of vowel length, and that a necessary condition for the development of contrastively long vowels through CL processes is the independent existence of a length contrast in the language (de Chene & Anderson 1979: 517). However, there are several counterexamples to this claim (see Gess 1998 for discussion), such as Ngajan (Dixon 1990), Occitan (Kiparsky 1996), Friulian (Hualde 1990), Andalusian Spanish (Hock 1986), Piro (Matteson 1965), Dinka (Andersen 1990) and Komi (Collinder 1960).[9] It is

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[9] Turkish can probably be added to this list, since, according to Kornfilt (1997), native Turkish vowels are phonemically short, and long vowels are the result of loss of the voiced velar fricative intervocalically with vowel coalescence (1'a-c) and postvocalically (1'd-e).

(1')	a. alacagiz	[alaja:z]	'we shall take'
	b. agir	[a:r]	'heavy'
	c. aga	[a:]	'master'
	d. degdi	[de:di]	'he touched'
	e. dag	[da:]	'mountain'

Since postvocalic and intervocalic [ɣ] were arguably lost at the same time, one cannot argue for the existence of vowel length distinction prior to CL. However, borrowed words in Turkish can have phonemically long vowels.

claimed that in all these languages which belong to different language families, CL is the source of phonemic vowel length. For example, Collinder comments that in Mordvin and in Permian all vowels are short, but in the related Ižma dialect of Komi,

> "a non-palatalized *l* has disappeared ... in closed syllables, and the preceding vowel has been lengthened. This has brought about an opposition between short and long vowels; e.g. *pi*, son, boy ~ *pii*, cloud, *pu*, tree, wood ~ *puu*, red whortleberry..."

Dinka (Anderson 1990), a Nilotic language, is perhaps the most striking of counterexamples to de Chene & Anderson's statement that CL is a structure preserving sound change since in Dinka CL through vowel loss brought to life a ternary vowel length distinction.

As is clear from the counterevidence and convincingly argued for by Lin (1997) and Gess (1998), de Chene & Anderson's hypothesis that CL is a structure-preserving sound change does not hold. Hayes (1989) modifies de Chene & Anderson's prediction, making it more restrictive. According to Hayes, the existence of CL in a language implies the existence of an independent weight distinction in that language. This follows directly from the formalism of moraic approach. Given that CL is defined as a mora transfer, only the deletion of a weight-bearing segment can trigger lengthening. It is axiomatic in moraic theory that only vowels or weight-bearing codas can be moraic. Thus, CL through vowel deletion is predicted to be possible with no independent requirements (a deleting vowel will always bear a mora), while CL through consonant deletion requires moraicity

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(2')	gazi	[ga:zi:]	'warrior for the faith' (Arabic *gha:zi*)
	beraber	[bera:ber]	'together' (Persian *bara:ber*)

De Chene & Anderson (1979: 523) discuss the Turkish data in (1') and (2') as an example of indeterminate chronology, but other cases just mentioned show that CL does not have to be a structure-preserving change.

of the deleting consonant, that is, the existence of syllable weight distinction in a given language.

Now we will more closely consider the development of CL in two unrelated languages, Ngajan and Piro. Ngajan, a dialect of Dyirbal spoken in Australia, has acquired vowel length through CVC CL (Dixon 1990). In Ngajan, *y*, *l*, and *r* were lost in syllable codas with CL of preceding vowels. The data in (7) exemplifies CL in Ngajan, as compared to a different dialect of Dyirbal, Mamu, which retains the high glide and the liquids and has no distinctive vowel length. Notice that CL in Ngajan is a diachronic process, and no synchronic alternations which involve CL are present in the language.

(7) Ngajan and Mamu dialects of Dyirbal (Dixon 1990)

	Mamu	**Ngajan**	
a.	wa**y**nyji-	wa**ː**nyji-	'to go up'
b.	ma**r**bu	ma**ː**bu	'louse'
	ŋam**ir**	ŋam**iː**	'hungry'
c.	gu**l**gu	gu**ː**gu	'brought together'
	bu**l**al	bul**aː**	'firefly'

In the case of Ngajan, all the tests for the existence of heavy vs. light syllable distinction fail. Firstly, neither Ngajan nor Mamu have independent vowel length distinction. Secondly, stress in Ngajan is not quantity sensitive. Thirdly, Ngajan does not seem to have a minimal word condition, at least of the type which depends on the difference between heavy and light syllables. So, Ngajan does not possess any independent evidence that consonants whose loss triggers CL are moraic.

Piro, an Arawakan language spoken in Peru, also has CL through consonant loss. Synchronic CL alternations in Piro involve deletion of consonants as well as deletion of vowels. Piro has a boundary vowel deletion (BVD) rule that removes the final vowel of

each lexical root and derived stem at each state of derivation. Lin (1997) analyzes vowel length alternations in Piro as CL through consonant loss, since the loss of a vowel as a result of BVD does not trigger lengthening, as is shown in (8a). BVD is consistently blocked if its application would create a cluster of more than two consonants. However, sometimes BVD creates clusters of two consonants[10] which are not permitted due to language-specific cooccurrence restrictions. Simplification of such non-permissible clusters results in vowel lengthening (8b), which Lin (1997) analyzes as moraic conservation.

(8) Piro (Lin 1997)

a. Suffixation, vowel deletion, no consonant deletion, no CL

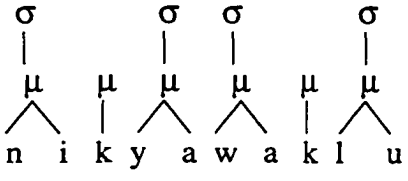
/nik**a**-ya-wak**a**-lu/	[nikyawaklu]	'to eat it there'
to eat-LOC-place-it		

b. Suffixation, vowel deletion, consonant deletion and CL

/nik**a**+ka/	→	nikka	→	[nik**a**]	'he is eaten'
(he)-to eat-PASS					

Piro CL is intriguing due to the fact that the language seems to have only open syllables. According to the analysis developed in Lin (1997), which relies on Matteson's (1965) description of syllable structure in Piro, only CV sequences are syllabified, so Piro has no codas and at most one onset consonant in a syllable. All other segments are moraic but not syllabified. The proposed syllabification of a Piro word is shown in (9).

(9)



[10] These clusters include certain combinations of consonants which are similar in place and/or manner of articulation, e.g. *pp, *tt, *kk, *t-ts, ts-s, *affricate-affricate, *fricative-fricative, *rr, *ll, *rl, *lr, etc. For the full list of disallowed clusters, see Lin (1997: 405).

The interpretation of Piro syllable structure shown in (9) implies that Piro does not have an independent weight distinction within the syllable, unless it is a syllable with a long vowel. Thus, Piro only partially supports Hayes's prediction. Indeed, CL is triggered only by weight-bearing segments, but the fact that these segments are moraic does not imply the existence of weight distinctions within a syllable.

We conclude that the independent weight distinction appears to be a strong prediction of the moraic approach which does not always hold. However, it is very hard to test this prediction, since the fact that a language does not employ weight distinctions does not necessarily entail the absence of such distinctions. We will now turn to other predictions of moraic approach which are easier to test.

2.3.2.2. Onset deletion

Hayes (1989) explicitly states that onset deletion should not cause CL, since onsets do not contribute to weight and cannot be moraic. However, CL through onset loss exists, which constitutes the main objection to this prediction. The example of CL though onset loss in Samothraki Greek (Newton 1972) is shown in (10).

(10) CL through onset loss in Samothraki Greek

	Standard	**Samothraki**	
a.	ad**r**as	ada**ː**s	'man'
	samaθ**r**aki	samaθa**ː**k	'Samothraki'
	pad**r**eya	padi**ː**ya	'marriage'
	Standard	**Samothraki**	
b.	**ru**xa	**uː**xa	'clothes'
	rota	**oː**ta	'ask!'

According to Hayes (1989), the only possible CL process through onset deletion is *double flop* [11], which can be described as the deletion of a post-consonantal onset with the subsequent resyllabification of the coda consonant into the onset with the loss of its mora, as, for example, in Ionic dialects of Greek (**odwos* > *o:dos*). While the examples in (11a) could possibly yield to such an analysis (if we hypothesize an unlikely syllabification of *obstruent* + *r* clusters as heterosyllabic), the forms in (10b) crucially show that *r*-loss in Samothraki Greek cannot be accounted for by invoking a mechanism of *double flop*.

Hayes (1989) discusses Samothraki data as well as *r*-deletion in Onondaga (Michelson 1986) and dismisses these two as counterexamples to the prediction that CL through onset loss should not possible. Hayes proposes that both Samothraki and Onondaga cases involve an intermediate stage in which *r* is in the coda and thus is moraic. This account may well work for Onondaga, however, it is crucial that in Samothraki, all *r* was lost unconditionally, but only the deletion of *r* in onsets was accompanied by CL. The reflex of a lost coda *r* is *i*, as demonstrated in (11).

(11) Coda *r* deletion in Samothraki Greek

Standard	**Samothraki**	
xarti	xaiti	'paper'
karðia	kaiðia	'heart'

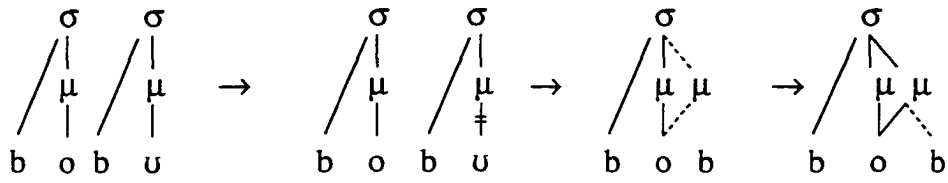
A fuller description of the Samothraki Greek data and an analysis of CL through onset loss in Samothraki will be offered in chapter 3.

[11] *Double flop* was proposed for Ancient Greek by Steriade (1982) and subsequently restated by Hayes (1989) in terms of moraic theory. For a detailed discussion of *double flop*, see chapter 3, section 3.2.1.4.

2.3.2.3. Intervening segments

Yet another prediction of moraic theory is based on an assumption implicit in the formalism of the approach that CL is a context-free process which depends only on the trigger and the target. Specifically, moraic approach models CL through vowel loss in the following manner. The deletion of the final vowel of the CVCV string results in an ill-formed syllable consisting of a consonant onset and an empty nucleus. Through a process of *parasitic delinking* proposed by Hayes (1989), the onset consonant is detached from its syllable node. At this point, the stray mora is free to reassociate to the vowel of the preceding syllable. Parasitic delinking is illustrated in (12) on the example of Slavic CVCV CL.

(12) Slavic CVCV CL (after Hayes 1989 on Middle English)



It can be seen from the discussion above that the moraic approach makes the following prediction: since intervening onset consonants in CVCV CL are not associated to any prosodic structure at the time of the reassociation of the stray mora, they should have no way of interacting with the application of CL.

However, in CL through vowel loss, the nature of *non-moraic* onset segments can affect the outcome of CL. For example in Slavic or Romance (specifically, Friulian), the realization of C_1VC_2V CL depends crucially on the identity of the intervening C_2. While some intervening consonants permit CL to take place, others appear to block it. In (13), there is an example of diachronic CVCV CL in Polish (West Slavic).

(13) Polish (Timberlake 1983a)

a.	*domʊ	>	do:m	'house' (Old Polish)
	*vozʊ	>	wo:z	'cart'
	*dōbʊ	>	dā:b	'oak'
b.	*soku	>	sok	'juice'

When the second vowel in a CVCV sequence is lost, the first vowel lengthens before sonorants, voiced fricatives, and voiced stops, as in (13a), but does not lengthen before voiceless stops, as in (13b). Moraic approach has no way of accounting for this state of affairs. It sufficient just to state this as a problem now, and an account of these facts will follow in chapter 4.

2.3.2.4. Adjacency

A basic fact which a theory of CL must account for is the observation that the trigger and the target of CL are always in some relation of adjacency to one another. This adjacency, however, cannot be defined as strictly local, since there are cases of CL through consonant loss where the deleting consonant and the lengthening vowel are not adjacent (as in Tehrani Farsi and Ionic Greek). In the cases of CL through vowel loss the trigger and the target of CL are always adjacent vowels, but they are also not strictly local since in most cases they are separated by one or two consonants. These facts seem to suggest that adjacency *per se* is not a valid notion in describing CL processes. However, on the other hand, there are no long distance diachronic CL sound changes or synchronic CL alternations (for example, loss of a final vowel never triggers lengthening of a vowel in the first syllable in a trisyllabic word). To account for this generalization, either a loose version of adjacency or an independent motivation for why CL alternations tend to remain local is called for.

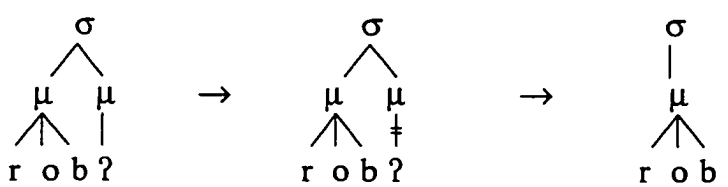
Moraic theory offers an approach to adjacency developed mainly for the instances of CVC CL. Under the moraic approach, CL through consonant loss is viewed as spreading a vowel melody onto a syllable-final empty position. The fact that nothing but the melody of the preceding vowel can spread onto a stranded mora is assured by the principle of *no association line crossing*, an axiom of autosegmental phonology which is a part of *the well-formedness condition* of Goldsmith (1976).

Tehrani Farsi illustrates the problem of adjacency in moraic theory in respect to processes of CL through consonant loss. (14) shows variation between formal and colloquial varieties of Tehrani Farsi. Colloquial forms exhibit CL through the loss of a glottal stop.

(14)	**Formal**	**Colloquial**	
a.	**roʔb**	**roːb**	'terror'
	læʔn	**læːn**	'cursing'
b.	**robʔ**	**roːb**	'quarter'
	ʃæmʔ	**ʃæːm**	'candle'

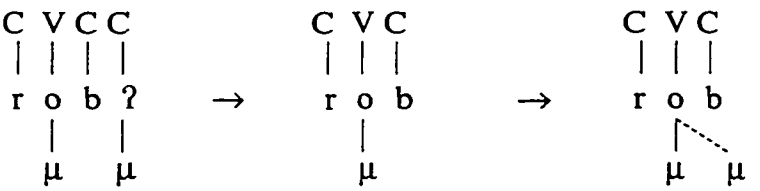
Note that in (14a) the lost segment is strictly adjacent to the lengthening vowel. However, in (14b) the trigger and the target of CL are not adjacent. With the deletion of the glottal stop in (14b) no resyllabification takes place and thus CL is predicted to be blocked by no association line crossing (15).

(15)



Darzi (1991) proposes that only glottal segments are moraic in Tehrani Farsi and resolves the issue of the crossing of association lines by separating a CV tier from a moraic tier, as in (16).[12]

(16)



Darzi's proposal correctly accounts for the Farsi data and could even be extended to account for CL through vowel loss, but runs into a number of problems of its own. Firstly, the model in (16) predicts that a loss of a coda consonant can cause lengthening of the vowel in the following syllable, since there are no association lines to prevent the spreading. This problem can possibly be fixed by referring specifically to syllable structure and defining CL as a process which applies within a syllable. A more serious problem of Darzi's account is that it does not match the standard prosodic hierarchy. Under Darzi's account, syllables represent groupings of segmental material, but do not constitute a higher level of prosodic hierarchy in respect to moras which goes against the main insight of various work on syllable-related phenomena and syllable typology.[13]

In the chapters to follow, I propose a solution to the adjacency problem. In the case of CVC CL, I rely on the intuition present in most moraic accounts of CL that CL through consonant loss is preservation of syllable weight. This accounts for the adjacency effects in most CVC CL alternations, as well as for alternations such as in Tehrani Farsi where the trigger of CL is not immediately adjacent to the target, but they are tautosyllabic. However, in the case of CVCV CL, this account by definition is not valid, since CVCV CL necessarily involves a disyllabic unit. Insofar as such cases remain

[12] See chapter 3 for the analysis which supports Darzi's proposal of the moraicity of glottal segments in Tehrani Farsi (see also Sumner 1999 for an opposite view).
[13] See Blevins 1995 for an overview.

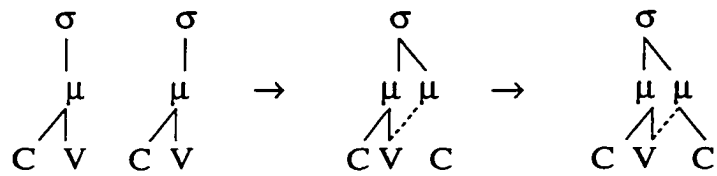
phonologically conditioned, I propose that they can be modeled as moraic conservation within a foot. However, I show in chapter 4 that CL through vowel loss rarely results in phonologically conditioned alternations. While the source for adjacency for phonologically and lexically or morphologically conditioned alternations lies in the facts of diachronic development of CL through vowel loss, moraic conservation is not relevant for the latter case. The question of adjacency in CL will be further addressed in chapter 5.

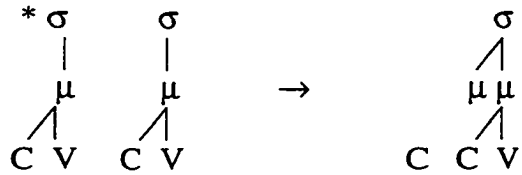
2.3.2.5. Directionality in CVCV compensatory lengthening

A second basic fact about both types of CL is that the directionality of CL is always right-to-left. In CL through consonant loss, the directionality simply follows from the assumption that only loss of moraic consonants can trigger CL, and onsets are never moraic.

However, CL through consonant loss is triggered only by the loss of the second vowel in a CV_1CV_2 sequence, and the loss of V_1 never results in lengthening of V_2. In moraic theory, the directionality problem of CVCV CL is solved by invoking Hayes's mechanism of *parasitic delinking*, discussed in earlier sections. To review, by virtue of the parasitic delinking mechanism, an onset consonant is detached from its syllable node after the deleting of a tautosyllabic vowel, so the stray mora would be free to reassociate to the vowel of the preceding syllable, as shown in (17a). This approach correctly derives the observed right-to-left directionality of CVCV CL processes. Were the first vowel of a CVCV string to delete (as in 17b), its mora would be incapable of reassociating to the vowel to the right, blocked by the intervening association line of the onset of the following syllable. Thus, the moraic approach predicts that alternations of the type *tama* → *ta:m*, the hypothetical example in (17a), are possible, while alternations of the type *tama* → *tma:* (17b) should be non-existent.

(17) Directionality and moraic theory

a.  *tama* → *ta:m*

b.  *tama* → *tma:*

The moraic account of directionality facts in CVCV CL just outlined also depends on a number of theory-internal underlying assumptions. First, as in the case of adjacency, the solution depends on the principle of *no association lines crossing*. This principle would not hold if moras are assumed to be on a separate plane (see Darzi 1991 discussed in the previous section) or if consonants and vowels are analyzed as being on separate tiers (e.g., in McCarthy 1986). Second, as was already mentioned, the solution heavily relies on the *parasitic delinking* proposal, which is not independently motivated and thus remains a stipulation.

In chapter 4, I will show that the directionality of CVCV CL is constrained by the historical development of vowel lengthening in languages which exhibit the process in question, and account for apparent counterexamples to this analysis, such as minimal size condition and rhythmic vowel deletion.

2.4. Conclusions

We conclude that both CL processes through consonant and vowel loss cause problems for moraic approach. These problems are summarized in (18).

(18) Problems for mora conservation approach

CVC, CVCV	the existence of independent weight distinction adjacency problem directionality problem
CVC	onset deletion
CVCV	the nature of intervening C

The existence of independent weight distinction is predicted for both CL through consonant and through vowel loss, and the issues of adjacency and directionality also concern both types of CL. The problem of CL through onset deletion is evidently connected with the deletion of a consonant, so it concerns only CVC CL, and the importance of the nature of the intervening non-moraic onset for the outcome of CL is specific of CVCV CL.

After the examinations of the problems shown in (18), we conclude that mora conservation account both undergenerates and overgenerates. We sort the problems just discussed from this point of view in (19).

(19) Undergeneration and overgeneration

- Undergeneration
    1. independent weight requirement
    2. onset deletion
    3. the nature of intervening C

- Overgeneration
    1. adjacency problem
    2. directionality problem

Solutions to the problems outlined above will follow from the analysis of CL presented in the following chapters. I argue that incorrect predictions of moraic theory which arise from undergeneration vs. overgeneration require different treatments. The

crucial insight in accounting for all the facts of CL is that both CL through consonant and through vowel loss have the same cause diachronically, which will be demonstrated in chapters 3 and 4, but they are to be characterized differently as synchronic alternations. The failure to understand firstly the diachronic causes of compensatory processes and secondly the fact that synchronically they belong to different domains creates these problems.

Where moraic approach undergenerates, we need to appeal to a diachronic account. I argue that both CVC and CVCV CL arise through phonologization of inherent phonetic duration of vowels which becomes possible with the loss of conditioning environment in the case of CL through consonant loss (CVC CL) and with the change in syllable structure in the case of CL through vowel loss (CVCV CL). The phonologization model developed in chapter 3 for CVC CL and in chapter 4 for CVCV CL accounts for the absence of independent weight requirement in diachronic CL, for the existence of CL through deletion of onsets, and for the ability of an intervening onset consonant in CVCV CL to interfere with its outcome. It is important to notice that all the problems listed under the *undergeneration* rubric involve diachronic developments, and are not applicable to synchronic alternations.

After accounting for diachronic data, I show in chapter 5 that where moraic approach overgenerates, synchronic solutions need to be sought. While the problems connected with CVC CL yield naturally to a phonological optimization account, to account for CVCV ~ CV:C alternations, it is necessary to invoke notions of lexicalization and morphologization.

Chapter 3.
Conditions on CVC compensatory lengthening

3.1. Introduction

To understand the typology of synchronic CL alternations it is necessary to understand the phonetic origins of CL. In the following two chapters I provide a diachronic account of CL of vowels and develop a phonologization model, which accounts for the rarity in synchronic grammars of alternations which have CL through vowel deletion as their historical source.

In this chapter, we investigate diachronic CL of vowels through consonant loss, whereby lengthening of the vowel is correlated with the deletion of an adjacent (usually tautosyllabic) consonant. Hayes (1989) divides this type of CL into three subtypes: "classical" CL (schematically, CVC → CV:, e.g. PIE **nisdo-* > Sanskrit *ni:da*), CL by prenasalization (schematically, /amba/ → [a:^{m}ba]; common in Bantu), and so called *double flop* (e.g. **odwos* > *o:dos* in Attic Greek), when the deletion of a post-consonantal onset results in the lengthening of the preceding vowel. Since CL by prenasalization fits the pattern of "classical" CL inasmuch as it produces alternations of the CVC → CV: type, I treat it as a similar process. Instances of double flop will be also discussed under the rubric of the CVC CL mainly because I contend that "classical" CL and double flop have the same phonetic motivation, and thus can be treated in the same way as instances of CVC CL in the Ancient Greek dialects.

As discussed in previous chapters, the traditional explanation of CVC compensatory lengthening in moraic theory has been to say that the deletion of a consonant leaves a stray mora behind, the preceding vowel is then reassociated with that mora, thus acquiring an additional unit of length (Hayes 1989 and Hock 1986, among others). This insight is already present in Whitney (1886: 84), who describes CVC CL as

the "absorption by a vowel of the time of a lost following consonant". As we saw in chapter 2, moraic theory is one of several frameworks that encode Whitney's insight formally.

But what is the phonetic explanation behind CL? One possibility is that CL represents conservation of syllable duration. However, the one explicit phonetic account of CL in the literature, namely de Chene & Anderson (1979), argues explicitly against this view.

According to de Chene & Anderson, all instances of CVC CL can be analyzed into "two independently motivated processes of weakening of a consonant to a glide (either semivocalic or laryngeal) and subsequent monophthongization of a complex syllable nucleus." In other words, de Chene & Anderson treat CVC CL as weakening through monophthongization and thus contend that lengthening is not a unitary process. They argue that a decomposition of CL into two independent phonetic processes makes the apparent formal similarity of the processes involved an "uninteresting epiphenomenon, for which no significant account would be necessary or available." This is a rather strong claim since it is this "apparent formal similarity" which is the emphasis of all autosegmental accounts of CL.

Contra de Chene and Anderson, however, detailed studies of the historical phonetics of CVC CL processes have subsequently shown that CL cannot always be decomposed into gliding of the postvocalic consonant with subsequent monophthongization of the vowel. As Hock (1986: 435) comments in his discussion of several case-by-case studies of CL, de Chene & Anderson's framework has "not proposed as explanations for all cases traditionally labeled loss with compensatory lengthening, but only for a certain subset, however poorly that subset may be defined." In many cases, as for example, in PIE **nisdo-* to Sanskrit *nīḍa-* change, de Chene & Anderson's explanation is indeed the best account available, but there are cases where

there exists a more straightforward phonetic explanation of the facts. For example, CL from nasal loss is better treated as the reinterpretation of a longer phonetic duration of a nasalized vowel as phonemic. In this chapter, I will attempt to improve the definition of those subsets of CL processes which can be accounted for by invoking different phonetic mechanisms of sound change.

In the rest of this chapter, I present a typological overview of CVC CL patterns, concentrating on the differences between diachronic and synchronic phenomena. In subsequent sections, I will look at a number of representative case studies from the point of view of the phonetic motivations for the CL in various languages. From a typological survey of CVC CL in 55 languages from 17 language families compiled for this study (see Appendix 1), it emerges that phonetic motivations for CVC CL are always twofold.

First, only a proper subset of the consonant inventory deletes in coda position in any given language. There are no languages which uniformly get rid of all of their postvocalic consonants, and there are presumably no languages which delete all consonants unconditionally, since it would produce a language with vowels only.[14] In each case of CVC CL, there are phonetic motivations (articulatory or perceptual) for why a certain class of consonants is lost in a particular environment. For example, glides can be misheard as vowel transitions, nasals are often lost before fricatives or voiceless stops, *h* is often misheard as a part of a vowel, especially if it is followed by a sonorant, and so on.

Second, the deletion of a consonant may but need not entail lengthening of the preceding vowel. When such lengthening does take place, there is a clear phonetic motivation to it. For example, vowel to glide transitions are very long and, given similar

[14] There are cases of so-called *conspiracies*, as, for example, in Proto-Slavic, when various developments had as effect of producing exclusively CVCV syllable structure. However, this did not happen solely by loss of all coda consonants: various processes like loss of (almost) all final consonants, simplification of clusters by elimination of a member of a cluster (first or second), dissimilation, etc.

formant structure, can be misheard as a part of the vowel, vowels are longer before nasal consonants than before oral, and so on.

To account for the parameters of CVC CL, I propose a phonologization model, which appeals to phonetic motivations, laid out in chapter 1, to account for the historical development of the CL process. I argue that in most cases of CL, target vowels were phonetically longer in the environment of certain following consonants. The subsequent loss of such length-triggering consonants led, by the mechanism of hypocorrection (Ohala 1981), to reanalysis of the extra phonetic length on preceding vowels as phonemic.

The phonologization model makes an important prediction: only the deletion of consonants whose transitions can be mistaken for a portion of the vowel or which can otherwise affect the phonetic duration, or the perception of the phonetic duration, of the preceding vowel should be able to cause CL. Since the phonologization model is based on the inherent phonetic duration of the vowels, it predicts the absence of CL when the lost segments are stops (which do not cause any phonetic lengthening of preceding vowels), assuming of course that there is no evidence for the stages of either fricativization or gliding of these segments. There are several apparent counterexamples to this prediction, but I argue in section 3.3 that they are better analyzed as instances of templatic morphology (Semitic) or analogy (Indic), rather than CL *per se*. These are the cases where "formal similarities" indeed play a role, and the explanation of such cases, e.g. of Indic CL through degemination, lies in phonological analogy. It is my contention that, contra de Chene & Anderson, the "apparent formal similarity" of CL processes is indeed a very interesting and promising area of research. Formal similarity of any processes arises with phonologization of certain phonetic patterns. After a phonetic process is phonologized, the speakers of the language are in principle capable of extracting an overall pattern, which can, and very often is a source for analogies.

3.2. Phonologization of coda loss

In this section, we consider phonetic motivations behind the cases of CL through consonant loss. We will argue that the loss of coda consonants results in CL of preceding vowels only when the vowels are inherently longer in the environment of these lost consonants and shorter otherwise. With the loss of conditioning environment, the duration of vowels in question becomes inexplicable and thus these vowels are likely to reinterpreted by listeners as phonemically long.

Sections 3.2.1, 3.2.2, and 3.2.3 will illustrate CL through the loss of glides, liquids, and nasals respectively. In section 3.2.4, I will show that CL through the loss of fricatives happens only through the stage of *h*, which is arguably a glide, and section 3.2.5 will concentrate on CL through the loss of a velar stop in Turkish, again through a glide stage. Finally, apparent counterexamples to the prediction that only the loss of segments which have an acoustic effect of lengthening of preceding vowels can cause CL will be addressed in section 3.3.

3.2.1. Glides

In this section, we will turn to the analysis of CVC CL through the loss of glides. Among languages in the corpus which exhibit the effects of CVC CL are Abkhaz (Caucasian), Akkadian (Semitic), Ancient Greek, Friulian (Romance), Kabardian (Caucasian), Lillooet (Salish), Turkish, and Ngajan dialect of Dyirbal (Australian). In Abkhaz, Akkadian, Kabardian, Friulian, Turkish, and dialects of Ancient Greek, the loss of both *j* and *w* causes the preceding vowel to lengthen, while in Ngajan only the deletion of a palatal glide triggers CL.[15]

[15] There is a phonemic *w* in Dyirbal, which deletes intervocalically in Girramay, in which the pronunciation of /uwu/ is always [u::] with a very long vowel. In other dialects, pronunciations [uwu] and [u::] are both judged acceptable (Dixon 1990: 5).

CL through glide deletion is the closest to what de Chene & Anderson (1979) call compensatory lengthening through monophthongization. As was mentioned earlier, de Chene & Anderson (1979) argue that compensatory changes can be always analyzed as the combination of a *weakening* of the postvocalic consonant to a glide, followed by the monophthongization of the resultant sequence. Since in the cases of CL through the loss of glides it is not necessary to posit the weakening stage, de Chene & Anderson's interpretation of CL through the loss of glides is monophthongization of an original *vowel-glide* sequence. I argue, however, that such CL processes are *not* always best analyzed as simple instances of monophthongization. The *vowel-glide* sequences in question are not necessarily diphthongs originally; the [j] and [w] phonemes instantiated in such sequences can have clear consonantal distribution, being able, for example, to occur in the onset position (as in Kabardian and Ngajan). In such cases, one would still have to posit an intermediate stage of diphthongization before being able to proceed to monophthongization.

I propose the following explanation for the lengthening of the vowel after the loss of a glide. First, transitions from a vowel to a glide are very long in comparison with, for instance, vowel to stop transitions.[16] If the glide is not heard in some environments (which are often language specific and will be discussed in the upcoming sections), the preceding vowel can be easily reinterpreted as phonemically long. Given the length of vocalic transitions (which can be even longer than the glide itself), *vowel-glide* sequences can even be reanalyzed as long vowels unconditionally, without going through a diphthongal stage, contrary to the de Chene & Anderson's proposal. At this point, it is necessary to consider the data on glide deletion in detail.

[16] The duration of vowel to stop transitions is usually 30-50 ms, while transitions to glides can easily be up to 80 ms in duration.

3.2.1.1. Turkish: postvocalic glide loss

Both *j* and *v* undergo optional deletion in Turkish. Although Kornfilt (1997) classifies *v* as a weak voiced labio-dental fricative, I analyze the deleting *v* in Turkish as a glide; it is a glide phonetically in certain environments. For example, Kornfilt (1997: 485) notes that "[v] becomes the glide [w], itself not a distinctive segment in the language, when it is in intervocalic position." More importantly, *v* can also become a glide in coda position in Turkish, unless it is followed by an obstruent.

Conditions on the deletion of *j* and *v* are different, but I argue that they share one common property: these segments delete specifically in the environments where they are not heard, independently of their position in the syllable. The presence or absence of CL depends on the possibility of reinterpretation of a preceding vowel as long.

j-deletion

As described by Sezer (1986: 231), "in informal speech, *j* is deleted after a front vowel and a following sonorant consonant or [i]". The deletion is exemplified in (1). Note that *j* deletion leads to CL of a preceding tautosyllabic vowel (1a); a vowel in a preceding syllable is unaffected (1b):

(1) Vowel length variation in Turkish

a.	øjle	ø:le	'thus'
	dyjme	dy:me	'button'
	ejlyl	e:lyl	'September'
	sejret	se:ret	'watch'
	tejmen	te:men	'lieutenant'
b.	iji	ii	'good'
	dejil	deil	'is not'

The examples of CL in (1a) call for a straightforward phonetic explanation. Since *j* has very high second and third formants (F2 and F3, respectively), and so do front vowels, the dynamics of F2 and F3 change from a front vowel to a palatal glide is not easily detectable, so the glide can be misinterpreted as a part of vocalic transitions, and not as a segment on its own. Subsequently, the vowel can be reanalyzed as long.

Intervocalic *j* deletes for similar reasons: it is not easily detected in the environment of front vowels. However, as shown in (1b), the deletion of an intervocalic glide does not result in lengthening of the preceding vowel. This can be motivated by perceptual properties of VV sequences: since vowel-to-vowel transitions are very long, a two-vowel sequence is not likely to be reinterpreted as a three-vowel one. Additionally, a phonotactic constraint prohibiting sequences of more than two vowels is surface-true in Turkish: *k* and *g*, which normally delete intervocalically, fail to do so when the preceding vowel is long (*ɨftirak* 'participation', *ɨftira:k-ɯ* 'participation-possessive', not the expected **ɨftira:-ɯ*). This is presumably due to a ban on V:-V (Sezer 1981, Inkelas & Orgun 1995).

When *j* is preceded by a back vowel, glide deletion fails to apply (2); F2 and F3 transitions from non-front vowels to the palatal glide are easily detectable:

(2) No variation after non-front vowels

kajmak	'dairy cream'
kujruk	'tail'

Yet another condition on deletion of the palatal glide in Turkish is that the glide must be followed by a sonorant consonant or [i] for the optional deletion to occur.

(3) mejdan *me:dan 'square'

While we can attribute the deletion of the glide in the environment of the following [i] to the same phonetic motivation as its deletion after front vowels (that is, *j* is misheard by listeners as a part of the following vowel)[17], the environment of the following sonorant consonant, which allows deletion of *j*, is probably connected with the listeners' ability to judge the end of a vowel or a glide. Stops (and less so, fricatives) provide the possibility of clear segmentation between them and a preceding sonorant. This is what prevents *j*-deletion in [mejdan] in (3). In the case of sonorants, however, the segmentation is not so clear since there are no sharp discontinuities in transitions from one sonorant to another (Ohala, p.c., Javkin 1979).

Kornfilt's description of the pronunciation of *j* supports the account proposed above, even though it raises certain questions about the interpretation of the data. Kornfilt (1997) states that in colloquial styles the palatal glide

> "is pronounced "lightly" in syllable final position, when it follows a front vowel and triggers compensatory lengthening of that vowel:
> teyze [te:jze] 'mother's sister'."

This description along with the example suggests that there are dialects in which the vowel is phonetically long (whatever its phonological status may be), and in which the glide does not disappear completely. Kornfilt's example provides suggestive evidence that at least in this case of CL vowel lengthening precedes consonant loss.[18]

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[17] Here one could only speculate on why all preceding front vowels are good enough environment for the deletion of *y*, while only the following [i] allows deletion. It could hypothetically be possible that falling transitions from [j] to a vowel other than [i] are more salient than rising transitions. However, at this point I have no good argument to support this speculation.

[18] In Tunisian (Hock 1986: 443-444) vowels can also lengthen when consonants get reduced but not lost (glosses are not provided):

šeffaʔni > šeffa:ʔni

šmaʔtkum > šma:ʔtkum

v-deletion

In colloquial Turkish, *v* is (optionally) lost when it is followed by a labial consonant (4a) or a rounded vowel (4b), or when it is preceded by a rounded vowel (4c) (Sezer 1986: 231). *v* deletion triggers compensatory lengthening of a preceding tautosyllabic vowel (4a):

(4) Turkish: *v*-deletion

a.	øvmek ~ ø:mek	'praise-infinitive'
	ovmak ~ o:mak	'rub-infinitive'
	savmak ~ sa:mak	'rebuff-infinitive'
	sevmak ~ se:mek	'love-infinitive'
b.	davul ~ daul	'drum'
c.	øver ~ øer	'praise-aorist'
	ovar ~ oar	'rub-aorist'
	duvar ~ duar	'wall'

The deletion does not apply when *v* is followed by an obstruent (5):

(5)	øvdy	'praise-past'	*ø:dy
	ovdu	'rub-past'	*o:du
	savdɯ	'rebuff-past'	*sa:dɯ
	sevdi	'love-past'	*se:di

According to Sezer (1986: 232), "it is not easy to subsume the *v*-deletion facts under a straightforward formulation". Sezer does not attempt to formulate a rule for *v*-deletion, because he runs into problems stating conditions for the past tense forms in (5), which show that the preceding labial is not sufficient to trigger *v*-deletion.

Recall that the loss of a segment, *v* is this case, is crucially connected with its perceptibility. If *v* is preceded or followed by a sonorant, it is presumably quite sonorous

itself and thus can be reinterpreted as vocalic transitions to or from a labial sonorant. In the past forms in (5), however, *v* is too fricated when it is followed by an obstruent to be interpreted as vocalic, and thus no deletion takes place.[19]

3.2.1.2. Kabardian: postvocalic glide loss

In Kabardian (a Northwest Caucasian language closely related to Circassian, spoken in the Caucasus, mainly in the Kabardino-Balkar republic), *w* and *j* delete postvocalically. Their deletion triggers CL of the preceding tautosyllabic vowel, whose quality is also affected:[20]

(6) Kabardian (Colarusso 1992: 32-33)

/q'əw/	[q'u:]	'swan'
/psa-w/ life-predicate	[pso:]	'alive, living'
/bəj/	[bi:]	'enemy'

Here again, the phonetic explanation for CL triggered by the loss of glides is connected with the fact that a *vowel-glide* sequence can easily be reinterpreted as a long vowel. Note that proposing a diphthongal stage for *vowel-glide* sequences in Kabardian, as de Chene & Anderson's (1979) account requires, seems unnecessary since, firstly, Kabardian does not tolerate diphthongs (it has 49 phonemic consonants, and only one or two vowels), and secondly, *j* and *w* have consonantal distribution, occurring freely as onsets or codas.

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[19] One can hypothesize that *v* is also more sonorous when followed by a sonorant and less sonorous (has more high frequency noise) when followed by an obstruent. A similar situation is observed for /v/ in Russian (Kavitskaya 1999).

[20] Colarusso believes that Kabardian has two vowels, /a/ and /ə/, even though there is a lot of controversy on the subject of the predictability of /ə/.

3.1.1.3. Ngajan: postvocalic glide loss

In the Ngajan dialect of Dyirbal, the palatal glide *j* is lost, with associated lengthening of the preceding vowel. Example (7) compares Ngajan with the more conservative Mamu (which is a more southern dialect of Dyirbal):

(7)	**Mamu**	**Ngajan**	
a.	wajnjdʒi-	wa:nydʒi-	'to go up'
b.	burrubaj	buʀuba:	'a boil'
c.	bujbu	bi:bu-	'to spit at'
d.	njurruj	njuʀi:	'snot'

The Ngajan dialect has three phonemic vowels: /i/, /a/, and /u/. (7) shows that after /a/ and /u/, the palatal glide is lost with CL (/ij/ sequences are non-existent in Dyirbal). With the deletion of *j*, the preceding *a* lengthens, keeping its quality, as in (7a) and (7b), but the preceding *u* is colored by the glide, surfacing as a long high vowel /i:/, as in (7c) and (7d).

3.2.1.4. Ancient Greek: postconsonantal glide loss

A celebrated series of examples of CL due to glide loss comes from the dialects of Ancient Greek. At various points in the history of Ancient Greek, loss of such segments as [n], [s], [j], and [w] occurred. In this section we will consider only the deletion of [j] and [w] accompanied by the lengthening of the preceding vowel. CL in Ancient Greek is discussed by a number of authors, including Allen (1973), Lejeune (1987), de Chene & Anderson (1979), Ingria (1980), Steriade (1982), Hock (1986), Wetzels (1986), Hayes (1989), Schmidt (1992), Sihler (1995), and many others.

The first CL: j-loss

By the process which is called *the first CL* in the literature on Greek, in clusters of the type V_1RjV_2 (where R represents any sonorant), the loss of *j* results in a dialectal split. In Lesbian and Thessalian dialects, *j* is lost with gemination of the preceding sonorant, while in other dialects of Ancient Greek, the loss of *j* in V_1RjV_2 sequences triggers lengthening of V_1, if V_1 is [i], [e], or [u] and the intervening sonorant is not an [l], as exemplified in (8) (Wetzels 1986: 304).

(8)

	Lesbian/Thessalian	**Elsewhere**	
*klin-jo:	klinno:	kli:no:	'tend'
*krin-jo:	krinno:	kri:no:	'judge'
*phther-jo:	phtherro:	phthe:ro:	'destroy'
*kten-jo:	ktenno:	kte:no:	'kill'
*olophur-jo:	olophurro:		'lament'
*olophur-jomai		olophu:romai	'lament'

If V_1 is [a] or [o] and R is any sonorant but [l], then the reflexes are shared by all dialects, yielding a diphthong which does not undergo monophthongization (Wetzels 1986: 303):

(9)

*daw-jo: > *daj-wo:? > dajjo:	'kindle'
*phan-jo: > phajno:	'show'
*ankon-ja > ankojna	'embrace'
*mor-ja > mojra	'lot'
*khar-jo: > khajro:	'rejoice'

If the intervening sonorant is an *l*, then the glide disappears and its loss is compensated for by the lengthening of the liquid (Wetzels 1986: 304):

(10)

*angel-jo: > angello:	'announce'
*g^wal-jo: > ballo:	'throw'
*pojkil-jo: > pojkillo	'embroider'

A phonetic explanation of the first CL in Greek needs to take into consideration both the nature of the intervening consonant and the effect of palatalization on the neighboring vowel. If a consonant in a *Cj* sequence is phonetically palatalized (which is very often the case), F2 and F3 targets for the preceding vowel are significantly higher than for the same vowel before a non-palatalized consonant, producing an effect of a palatal glide being heard not after, but before the consonant.

Given this explanation, the phonetic reason that in Greek the first CL affected only sequences with intervening sonorants lies in the fact that palatalization of a sonorant usually affects the whole segment, resulting in higher F2 and F3 throughout the sonorant, while palatalization of a stop is manifested as a palatal off-glide, with the burst remaining the same as in the stop's plain (non-palatalized) counterpart.[21]

To account for the gemination of [l] in (10), I hypothesize that [l] was already slightly palatalized in the dialects of Ancient Greek, so the [lj] cluster did not result in a significant enough change in F2 and F3 of the preceding vowel for the perceptual metathesis to happen.[22] Instead, the palatalized [l] followed by the palatal glide is heard as long [ll], given that the transitions from the lateral to the palatal glide are also very long.

---

[21] This account invokes a perceptual phonetic sound change, which can presumably be replicated in a phonetic laboratory. Indeed, in teaching Russian to American students, I noticed many instances of palatalization of the consonant being heard as some kind of diphthongal property of the preceding vowel, for example, [banʲa] 'bath' was misheard and pronounced as [baʲnʲa] or even [bajna]. However, there is a problem with this view of *j*-deletion in Greek. In terms of F2 and F3, [u] has the lowest possible F3, so one would predict that it will pattern with [o] and [a], yielding a diphthong rather than a long vowel in dialects other than Lesbian and Thessalian. The only reflex of this change with [u] I was able to find shows a long vowel, which remains rather mysterious. One could note, though, that there are languages (like English) which have [aj] and [ej] diphthongs, but don't have [uj]. Thus, a phonotactic constraint on certain diphthongs appears to be present in Greek.

[22] The term 'perceptual metathesis' is proposed by Blevins & Garrett (1998).

The first CL: w-loss

In the dialects of Ancient Greek, *w* was lost word-initially, intervocalically, and post-consonantally. In all dialects, word-initial and intervocalic *w* disappeared without leaving any trace and without causing CL, as shown in (11).

(11)

*woikos > oikos	'house' (Mycenean *wo-i-ko-*)
*werg- > ergon	'work' (Mycenean *we-ka-ta* 'worker')
*newos > neos	'new' (Mycenean *ne-wo*)
*dwejos > deos	'fear'

However, the treatment of the postconsonantal *w* varied depending on the dialect. In East Ionic (and partially in Central Ionic), and in the dialects of Thera, Cyrene, Cos, Rhodes and Western Argos, loss of postconsonantal *w* resulted in lengthening of a preceding vowel, while elsewhere (e.g. in Attic and Mycenean) *w* was lost without CL (12).

(12)

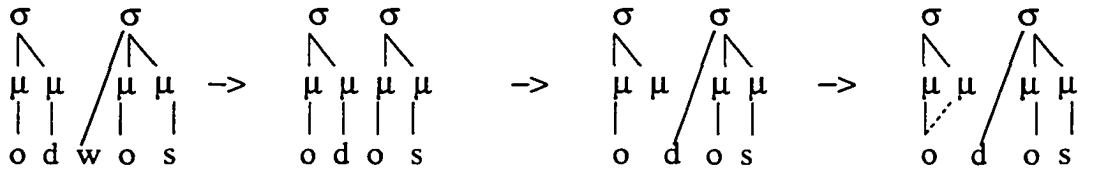
	Ionic	**Attic**	**Mycenean**	
*ksenwos	kse:nos	ksenos	ke-se-nu-wi-ya	'stranger'
*korwos		koros		'boy'
*wrodon		rrohdon		'rose'
*odwos	o:dos	odos		'threshold'
*wiswos	i:sos	isos	wi-so-wo	'equal'
*orwos	o:ros	oros		'boundary'
*kalwos	ka:los	kalos		'beautiful'

Following Allen (1968) and Lejeune (1972), Steriade (1982) suggests that *Cw* clusters were syllabified differently in Attic and Ionic at the time of *w*-loss. According to Steriade, the occurrence of CL in Ionic but not in Attic implies that *Cw* clusters were heterosyllabic in Ionic but tautosyllabic in Attic. For example, *odwos* would be syllabified as [o.dwos] in Attic, but as [od.wos] in Ionic. In Ionic, deletion of *w* lead to resyllabification of the coda *d* as the onset, and this, in turn, triggered lengthening of the

vowel. In Attic, however, deletion of *w* from a tautosyllabic *Cw* cluster did not result in resyllabification; therefore, no vowel lengthening was triggered.

Steriade's analysis of the first CL in Greek was subsequently restated by Hayes (1989) in terms of moraic theory. Example (13) illustrates a moraic representation of *w*-deletion in Ionic Greek. Hayes (1989) dubs this process *double flop*.

(13) Double flop in Ionic Greek (Hayes 1989)



Wetzels (1986) suggests that it would be natural to try to unify the facts of CL-triggering *w*-deletion in Ionic in (12) with the facts of CL-triggering *j*-deletion discussed earlier. Treating *w*- and *j*-deletion as two-stage processes and reconstructing an intermediate stage where these segments would be brought to the coda position by metathesis is dismissed by Steriade (1982) and later by Wetzels (1986: 311), who states that:

> "If the long vowel were to be explained as the result of coda-*w* deletion or as the product of contraction, we would expect all *VwC* sequences to have yielded long vowels, but such a development did not take place."

This problem forced Steriade (1982) to propose different syllabification strategies for Attic and Ionic, while keeping the idea of *sonorant-j* metathesis, as proposed by Kiparsky (1967, 1968) which produces two significantly different explanations for the behavior of *consonant-glide* clusters in Ancient Greek.

I propose a solution to this apparent paradox. The phonologization model predicts that vowel lengthening will occur regardless of what syllable position the deleting

consonant bears, as long as the consonant affects phonetic duration of the preceding vowel prior to deletion, making it longer. The labialization on a consonant in a *VCw* sequence can be heard as a labial off-glide, but phonetically it does not have to be and probably was not identical to the original *Vw* sequences. The original *w* in *Vw* sequences does not get lost, while with the loss of the labial glide vocalic transitions to phonetically labialized consonants can presumably be reinterpreted as longer duration of the vowels and phonemicized as such.

This solution, though rather tentative, provides a different view on the controversial and problematic question of *w*-loss in Greek dialects. It is not necessary to advance the mechanism of double flop any more, which is a significant achievement since elsewhere in the world's languages CV resyllabification is never the source of CL.

The account proposed above also avoids positing different syllabification strategies for Attic and Ionic. If one assumed the Steriade's view of Greek syllabification, then one would have to say that Attic and Mycenean onset maximization represents the archaic type of syllabification, whereas CVC.wV structure of Homeric and Ionic is an innovation. This would then be one of those cases where Attic and Ionic diverge, and Attic patterns with a mainland dialect group which is not a particularly convincing assumption given other changes in the isoglosses.[23]

3.2.2. Liquids.

This section extends the reasoning employed in the previous section on glide deletion to cases in which liquid loss triggers CL. The same principles account for both CL through loss of glides and liquids: vocalic transitions from vowels to liquids are very long, and with the loss of a liquid, a vowel can be reinterpreted as phonemically long.

[23] I thank Andrew Garrett for pointing this out to me.

The languages in which deletion of liquids correlates with CL are a diverse group, including Turkish, French, Komi, Ngajan, Onondaga, and some dialects of English. The conditions on CL-triggering liquid deletion differ across languages. CL in Komi and French is triggered only by the loss of *l*, in British English and Western Anatolian Turkish dialects only the loss of *r* results in CL, and in Ngajan the deletion of both *l* and *r* causes lengthening of the preceding vowel.

The phonologization model developed in this chapter predicts that *VC* sequences in which the vocalic transitions into the *C* are long will be easily susceptible to CL. Long *VC* transitions certainly occur in *Vl* sequences, and also in those *Vr* sequences in which the *r* is an approximant. When *r* is a tap or trill, CL is less likely to occur, since vocalic transitions into a trill or a tap are considerably shorter than into an approximant and comparable of that of a stop. These expectations are borne out by most of the languages I have surveyed, as I will show in the remainder of this section. However, there are two apparent counterexamples, namely Tiberian Hebrew and Sanskrit, in which CL accompanies the loss of an arguably non-approximant *r*. The case of Tiberian Hebrew, where CL from *r*-deletion is the result of the interaction of certain morphological templatic requirements together with phonotactic constraints on certain geminates, will be discussed in Section 3.3.2. The question of CL through degemination of all geminate consonants including *r* in Indo-Aryan languages will be addressed in Section 3.3.3.

I now proceed to the case studies of CL through the loss of liquids. In section 3.2.2.1 we will consider *l*-deletion in Komi, and the loss of liquids in Ngajan and Turkish will be addressed in sections 3.2.2.2 and 3.2.2.3 respectively.

3.2.2.1. *l*-deletion in Komi

In Komi Iźma (Uralic), when a consonant-initial suffix is affixed to a stem ending in *l*, the final *l* is lost and the preceding vowel is lengthened. This process is shown in (14), with the examples of the infinitive suffix /-nɨ/ and zero nominative singular ending.

(14) Komi Iźma (Batalova 1982)

a.

	V-initial suffix	**C-initial suffix**	
stem	**1 sg. past**	**infinitive**	
lɨy-	lɨy-i	lɨy-nɨ	'shoot'
mun-	mun-i	mun-nɨ	'go'
kɨl-	kɨl-i	kɨ:-nɨ	'hear'
sulal-	sulal-i	sulo:-nɨ	'stand'

b.

	V-initial suffix	**C-initial suffix**	
stem	**elative sg.**	**nom.sg.**	
gort-	gort-ys	gort	'house'
vøl-	vøl-ys	vø:	'horse'
nyl-	nyl-ys	ny:	'daughter'

De Chene & Anderson (1979) account for the data in (14) by postulating an intermediate stage when syllable-final *l* becomes a back rounded semivowel /w/. This explanation is plausible phonetically and diachronically, and different stages of a similar development can be seen in French (alC > o:C) in (15).[24]

[24] An intermediate stage of this change can be illustrated on the example of Serbo-Croatian, where *Vl* > *Vo* syllable-finally, as in *dala* 'gave-fem.' vs. *dao* 'gave-masc'.

(15) **French**

autre [o:tr] < alterum 'other'
aube [o:b] 'dawn' < alba 'white' (fem. sg.)
faucon [fo:kõ:] < falconem 'falcon'
faut [fo:] 'is necessary' < fallit 'disappoints, is lacking'

Since the loss of *l* affects not only the length, but also the quality of the vowel, it is clear that *l* was either heavily velarized before its loss, or there was an intermediate stage where it was actually labialized. However, this intermediate stage does not necessarily have to take place, since velarization has a similar effect on the preceding vowel.

3.2.2.2. Liquid deletion in Ngajan

As we have seen in section 3.2.1.3, the Ngajan dialect of Dyirbal shows a length contrast for all three vowels, *a, i* and *u*. Vowel length in this dialect is associated with the loss of *r*, *l* or *j* at the end of a syllable. In this section, we focus on the loss of liquids.

In Ngajan, both *l* and *r* were lost historically at the end of a syllable, triggering CL of the preceding vowel. *r*-deletion is demonstrated in (16a), and *l*-deletion in (16b):

(16)

	Mamu	**Ngajan**	
a.	marbu	ma:bu	'louse'
	ŋamir	ŋami:	'hungry'
	murŋgal	mu:ŋga:	'cockatoo feather'
b.	gulgu	gu:gu	'brought together'
	bulal	bula:	'firefly'
	dʒalgur	dʒa:gu:	'meat'

The phonetics of vowel lengthening caused by loss of *l* was discussed above, but the question remains as to why the lengthening occurs before a rhotic which is a trill in

the contemporary Ngajan, and taps and trills are usually not associated with long vocalic transitions. The answer to this question is connected with the details of phonetic realization of rhotics in Dyirbal. According to Dixon (1990: 2), the distribution of rhotics in Dyirbal dialects is as follows:

> "other Dyirbal dialects have two rhotic or grooved-tongue phonemes: /rr/, generally pronounced as an alveolar tap or trill, and /r/, which is a semi-retroflex continuant, with the tongue tip turned back to touch the hard palate. Ngajan has neutralized this distinction and has a single rhotic phoneme..."[25]

Presumably, at the time of the change, Ngajan still had both rhotics at its disposal, since only the approximant is lost syllable-finally. The trilled rhotic is retained in Ngajan, and the preceding vowel remains short:

(17)

Mamu	**Ngajan**	
gurrga	guʀga	'neck'
digirr	digiʀ	'headache'

The phonetic realization of rhotics in Ngajan confirms our predictions as to what types of rhotics should cause lengthening of preceding vowels. Approximants, which have longer transitions, can be easily reinterpreted as a part of the vowel, and the vowel, in turn, can be reanalyzed as phonemically long with the loss of the following approximant rhotic, while trills or taps, whose transitions are much shorter, do not cause such lengthening.

3.2.2.3. Loss of *r* in Turkish

Another example, which bears on the phonetic nature of rhotic segments, comes from Turkish. Sezer (1986: 241) notes that in standard Turkish, *r* is optionally deleted in

[25] Dixon uses a small cap [ʀ] for this neutralized rhotic phoneme.

informal speech in the progressive suffix *-Ijor* (18) and in the word *bir* 'one' (19) when it is followed by another word. In these highly morphologized cases no CL takes place.

(18)	gylyjo(r)	'laugh' 3sg.
	gylyjo(r)sun	'laugh' 2sg.
	gylyjo(r)duk	'laugh' 1pl. PAST
	gylyjorum	'laugh' 1sg. CONT.

(19)	bir / *bi	'one'
	bi(r) saat	'one hour'
	bi(r) adam	'one man'
	birisi / *biisi	'someone'
	birden/ *biden / *bi:den	'suddenly'

On the other hand, in Western Anatolian dialects coda *r* is lost *generally*, causing lengthening of the preceding vowel. This change can be illustrated by comparing standard Turkish forms to their Western Anatolian counterparts in (20):

(20)	**Standard Turkish**	**Western Anatolian**	
	var	va:	'there is'
	verdi	væ:di	'(s)he gave'
	giderler	gidæ:læ:	'they go'
	piʃirir	piʃiræ:	'(s)he cooks'
	verir	viri:	'(s)he gives'

Kornfilt (1997: 487) notes that

> "the standard Turkish *r* is a tap, produced by the tip of the tongue thrown against the alveolar ridge. ... In the Istanbul pronunciation (which is used standardly elsewhere in Turkey, as well), both liquids are devoiced word-finally. ... Devoicing of the tap is more widely spread."

Since syllable-final *r* is often devoiced (if followed by a voiceless consonant or phrase-finally), we hypothesize that in some cases it will not be heard, and thus it may not be pronounced in certain high-frequency words or morphemes, as shown in (17) and (18). The deletion of the tap *r* would not cause CL precisely because it does not affect phonetic length of the preceding vowel. On the other hand, the situation in Western Anatolian dialects is different: there, *r* is more approximant-like and thus it regularly deletes syllable-finally, causing CL.

3.2.3. Nasals

CL through nasal loss introduces the issue of word-final consonant deletion which we have not seen so far. Word-final nasal deletion creates problems for de Chene & Anderson's claim that the loss of consonants which is not segmentally conditioned should not result in CL.

CL triggered by nasal deletion is a very common process in the languages of the world in terms of the number of languages which show its reflexes. Interestingly, however, its distribution across language families is rather limited. In my database it occurs only in two language families: Indo-European and Bantu. These families are, of course, large, and nasal-triggered CL occurs in many branches of each. In Indo-European CL through nasal deletion occurs in Germanic (Proto-Germanic *VNS has V:S reflexes in Gothic, Old Norse, Old English, Old Saxon, and Old High German), Greek, Latin, Baltic (Lithuanian and Latvian). In Bantu CL occurs, via prenasalization, in Luganda, Runyambo, Sukuma, Ruwund, and many other languages.[26]

Two questions need to be answered in order to produce a successful account of CL triggered by nasal deletion: firstly, in which environments and why nasals delete; and

[26] In our sample, CL through the loss of nasals happens only in languages which do not have nasal vowels. It is conceivable that vowel nasalization is inversely related to CL, and the existence of phonemically nasalized vowels, which are longer than their oral counterparts, prevents the reanalysis.

secondly, why deletion of a nasal would cause lengthening of the preceding vowel. A perceptually-based phonetic account seems to offer answers to both of these questions.

We start with an observation that in many languages nasals are lost only before voiceless fricatives, as in Ancient Greek and all of the Germanic examples. Nasal loss (without CL) is observed before voiceless fricatives in many more languages such as Western Ossetic (Henderson 1949), Chilean Spanish, Italian, Ciyao, and Swahili (Ohala & Busà 1995). Ohala & Busà (1995) argue that on the one hand, acoustic effects of voiceless fricatives on the preceding vowels known as *spontaneous nasalization* can be misinterpreted by listeners as actual nasalization, but on the other hand, they contend that

> "in nasal loss, listeners misinterpret a pre-existing nasal next to a voiceless fricative as the kind of spurious nasal element they have come to expect in this environment and thus discount it."

To support their argument, Ohala & Busà (1995) experimentally show that given a vowel-nasal sequence of a certain duration, "listeners are unable to detect the nasal when it appears before the voiceless fricatives [s] and [θ] but are able to detect if before the stop [t] (a following [z] produces an intermediate pattern)".

Additionally, voiceless obstruents tend to promote loss of nasalization, while voiced stops may have the effect of preserving the nasal or even reintroducing it if it had been lost (Ohala & Busà 1995; see also Greenlee & Ohala 1980, Ohala & Ohala 1991, 1993). According to Ohala & Busà (1995), "listeners misinterpret a pre-existing nasal next to a voiceless fricative as the kind of spurious nasal element they have come to expect in this environment and thus discount it." So, there is a good phonetic reason for nasals to disappear before voiceless fricatives which is the environment for nasal loss in the bigger part of the language sample we use. This environment can be safely but

uninsightfully reinterpreted as syllable final, since nasals are usually heterosyllabic with the following fricatives or stops. Thus, the question of CL being triggered by deletion of an onset nasal does not even arise: there is no reason for deletion of onset nasals, thus no reinterpretation or hypocorrection is possible.

The disappearance of nasals is only a part of the CL story; in order to complete it, one needs to propose an explanation for lengthening of the vowel which precedes the lost nasal. It has been noticed (Delattre 1962, Whalen & Beddor 1989, Beddor 1993) that nasalized vowels tend to be longer than their oral counterparts. Thus, at least in principle, phonetic length of nasalized vowels can be phonemicized as a consequence of nasal loss.

De Chene and Anderson (1979) present a possible analysis of nasal loss with CL which, as they remark, does not necessarily support their claims about CL being a two-stage process of consonant weakening and subsequent monophthongization:

> "[E]specially when clusters of homorganic nasal plus obstruent are being reduced, it would seem that a shift in the timing of the articulatory gestures could account for the observed results without any appeal to the notions of diphthong formation and subsequent monophthongization. If the gestures of lowering the velum and obstructing the oral tract for such clusters are simply delayed, the long (oral) vowel is obtained directly, without any intervening semivocalic stage."

Contrary to this statement, however, de Chene and Anderson then pursue the idea that nasal consonants do sometimes alternate with semivowels, and thus there is a possibility of the intermediate stage of nasal weakening which would support their general analysis of CL. The Ancient Greek data discussed below support such an interpretation. However, since in many languages the intermediate "gliding" stage is not attested, and there exists a more straightforward phonetic explanation which was outlined

above, we will accept de Chene and Anderson's statement just cited as a more plausible hypothesis.

In sum, nasals usually undergo deletion before fricatives for perceptual reasons (Ohala & Busà 1995). They trigger vowel lengthening since nasalized vowels are phonetically longer than oral ones and thus can be reinterpreted as long with loss of the nasal. The following sections will consider cases of CL though nasal loss in Ancient Greek, Latin, Lithuanian, Germanic and Bantu languages.

3.2.3.1. Ancient Greek: preconsonantal nasal loss

According to Wetzels (1986), the so-called *second CL* in Greek "is restricted to the secondary intervocalic cluster -ns- (< nt, ntj) and the primary word final -ns#". (21) presents an overview of the dialectal reflexes of the *ns* cluster in Greek dialects:

(21) The second CL in Ancient Greek: Dialectal reflexes of *ns* clusters (Wetzels 1986: 300).

Dialects	**1. VnsV**	**2. Vns#**	**Examples**	
West-Argolic	VnsV	Vns	1. antitukhonsa	2. tons
Thessalian	VnsV	Vs	1. pansa	2. tos
Arcadian	VnsV	Vs	1. poiensi	2. tos
Central Cretan	VnsV	Vns#V ~ Vs#C	1. omosansi	2.tons#V~tos#C
W/E Cretan	V:sV	Vns	1. pa:sa	2. tons
Doric (Thera/Cos)	V:sV	Vs	1. ago:sa	2. tos
Elean	V:sV	Vys~V:s	1. pa:sa	2. tays ~ ta:s
Cyrenean	VysV	Vs	1. paysa	2. tos
Lesbian	VysV	Vys	1. moysa	2. pays
Elsewhere	V:sV	V:s	1. Att. pa:sa	2. Att. ta:s

There are quite a few languages in which nasals are lost syllable-finally without causing CL. For example, de Chene & Anderson (1979) discuss data from Athapaskan languages and Navajo, where postvocalic nasals disappear without having any effect on vowel length. On the basis of these data, de Chene & Anderson argue that there are two

types of nasal loss. They distinguish among languages which lose nasal consonants in postvocalic position according to the presence or absence of segmental conditioning for the loss, that is, whether or not loss of the nasal is dependent on the identity of the following consonant. The prediction of this approach is that if the nasal is lost due to the character of the following consonant, the loss is "the outcome of a conditioned reduction of occlusion in the nasal". This is the type of process which, according to de Chene and Anderson, would lead to CL. On the contrary, the loss of nasals which is not conditioned by the nature of the following consonant is not expected to produce CL.

Greek dialects present a problem for de Chene & Anderson's account. (21) represents a dialect continuum along the dimension of *ns* clusters. In certain dialects, *n* is preserved before *s*, as in West Argolic; in other dialects, e.g. in Attic, *n* is uniformly lost before *s*, triggering CL word-medially and word-finally. In still other dialects, *n* deletes before *s* without affecting the quality of the vowel, as in Doric or Cyrenean.

This last set of dialects, as well as many languages with nasal loss withoung CL, as Western Ossetic, Italian, Swahili, *etc.*, counterexemplify de Chene & Anderson's predictions: even though the loss of a nasal is segmentally conditioned, it does not cause lengthening of the preceding vowel. Note, however, that in the dialects where *n* is lost but lengthening does not occur, the deletion of *n* is confined to the word-final syllable. The failure of the vowel to lengthen in this case can be due to the fact that word-final syllables stay closed regardless of the *n*-loss. Thus, it can be argued that, even if nasalized vowels in the last syllable in the word are as long phonetically as nasalized vowels word-medially, they do not necessarily get reanalyzed as long. In Latin, the deletion of word-final [m] which is obviously not conditioned by the following consonant does not lead to CL either, thus providing more support for de Chene & Anderson's hypothesis.

3.2.3.2. Latin: preconsonantal nasal loss

In Latin, *n* was lost before voiceless fricatives and a voiceless stop [k], yet another illustration of the phonetic tendency to lose nasals before voiceless fricatives and voiceless segments in general. This nasal loss gave rise to CL; Buck (1963) states that vowels in Latin "were regularly lengthened before *ns, nf, nx*[27], and *nct*" , as shown in (22):

(22)	co:(n)sul	'consul'
	i:nfra	'below'
	iu:nksi:	'join' 1 sg. perf. ind. act.
	iu:nktus	'join' perf. passive masc. nom. sg.
	i:(n)sanus	'insane'
	ko:(n)fe:cit	'he made'

Chronologically, as Buck (1963: 150) describes it, "in final *ns* the *n* was lost, with lengthening of the preceding vowel, in prehistoric times, as acc. pl. *-a:s, -o:s, -i:s, -e:s, -u:s* from *-ans, -ons*, etc.". Buck (1963: 150) characterizes the development of medial *ns* clusters and secondary final *ns* as follows:

> "In the case of medial *ns* and secondary final *ns* (from *nts*, etc.) the *n* lasted into the period of written records and so remained in the normal spelling. But here too its frequent omission in inscriptions (as the very common *cosul*, etc.) and lengthening of the preceding vowel indicate that it was weakly sounded or probably wholly lost in common speech at an early period, as it certainly was eventually."

[27] According to Sihler (1995), "lengthening before *nx* is but vaguely attested; on the one hand there is the epigraphic evidence of forms like CONIÚNXIT, while on the other hand Priscian expressly states that the first vowel of *vinxi* is short."

Word-final [m] was also lost in Latin, which is "shown by its frequent omission in early inscriptions and by the fact that it does not interfere with the elision of the preceding vowel when the next word begins with a vowel" (Buck 1963: 157), but no lengthening of the preceding vowel occurred.

3.2.3.3. Lithuanian: preconsonantal and word-final nasal loss

In Lithuanian, *n* is deleted before non-plosives (23a) and in word-final position (23b). According to Mathiassen (1996: 29), in a sequence *vowel+n*, "the *n* has merged with the preceding vowel to form a long nasalized vowel which is subsequently denasalized." There are four short vowels in Lithuanian: [i], [e], [a], and [u], and all of them are affected by CL.[28] Note that CL does not happen before affricates in 3rd singular forms, but it is regular before fricatives of the infinitive ending [sʲtʲɪ].

(23) Lithuanian (Mathiassen 1996)

a.	sʲpʲrʲɛn-dʒʲa	'decides'	sʲpʲrʲæ:-sʲtʲɪ	'to decide'
	sʲʊn-tʃʲɛ	'sends'	sʲu:-sʲtʲɪ	'to send'
b.	dʲirbʲæ: (< *dʲirbʲæn)		'having worked' (pret.part.act.m.pl.)	

The ban on nasals before fricatives in not absolute in Lithuanian, and CL processes have undergone morphologization. In loan-words like *sensacija* 'sensation' and in some native compounds like *gyvensena* 'mode of living', the nasal is tolerated before a fricative. This also holds for the future tense morpheme *-s* (cf. *gyvensiu* 'I will be living') and the present tense suffix *-st* (e.g. *sen-st-a* 'grows old'). There is no absolute prohibition on word-final *n* either, e.g. *siandien* 'today', *ten* 'there', even though Mathiassen (1996: 30) notes that "in the last two cases the *n* has become secondarily word-final due to the loss of a vowel".

[28] There is a different secondary lengthening process in Lithuanian which affects only /e/ and /a/ in stressed syllables.

As was discussed in Section 3.2.3.1 in conjunction with the Ancient Greek data, the fact that in Lithuanian the deletion of word-final *n* triggers lengthening of the vowel causes an additional problem for de Chene & Anderson's argument that long vowels result only from loss of nasals conditioned by the following consonant. While the Greek and Latin data are somewhat problematic and inconclusive, Lithuanian presents a clear counterexample to de Chene & Anderson's claim. Thus, we can conclude that, contrary to de Chene & Anderson's proposal, the nature of the consonant which follows the deleted nasal is not relevant to CL.

3.2.3.4. Germanic: pre-fricative nasal loss

In many Germanic languages, nasals are lost before voiceless fricatives with CL of preceding vowels. Though this process is similar to the cases of nasal deletion discussed above, Germanic presents an interesting instance of CL through the loss of nasals occurring within a syllable with a complex coda. This presents a problem for the moraic approach, which is forced to propose trimoraic syllables in Germanic to account for CL.

Prokosch (1939), de Chene & Anderson (1979), Hock (1986), Hayes (1989), Ohala & Busà (1995) and many others discuss the loss of nasals followed by a fricative, which is regularly accompanied by the lengthening of the preceding vowel, using Germanic reflexes of Proto-Germanic *VNS sequences as their main examples. As Prokosch (1939: 86-87) states,

> "*n* before *x* disappears in Primitive Germanic; in Norse, the nasal also disappears before *s* and *f*, and in the Anglo-Frisian group (OE Fris OS) before *s f θ*; a preceding short vowel is lengthened; *a* is always lengthened to *o:* in OE, sometimes in ON OFris. and OS."

The table in (24) shows reflexes of *nasal+fricative* clusters in various Germanic dialects:

(24) Reflexes of Proto-Germanic *VNS in Germanic dialects

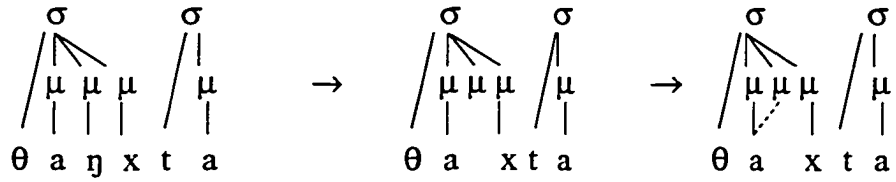
Germanic	**Gothic**	**Old Norse**	**Old English**	**Old Saxon**	**Old High German**	
faŋxana	fa:xan	fā:	fo:n	fa:xan	fa:xan	grasp
θaŋxta	θa:xta	θa:tta	θo:xte	θa:ta	da:xta	thrive
		gõ:s	go:s	ga:s	gans	goose
	uns	o:s	u:s	u:s	uns	us
	fimf		fi:f	fi:f		five
	kunθs		ku:θ	ku:θ	kund	known
	anθar		o:θer	o:θar	anθar	other

What is particularly interesting about the examples in (24) is that CL-triggering pre-fricative nasal loss can occur within a syllable. Thus Germanic **faŋxta* 'thrive' becoming Old High German *da:xta,* or Germanic **gans* 'goose' becoming Old Norse *ga:s* (and, with a shift in vowel quality, Old English *go:s*, and Modern English *goose*). After the deletion of the nasal, the syllable still remains closed, as in **ons* > *o:s* in Latin, which was discussed earlier.

These data present a problem for the moraic account of CL because syllables are assumed to be maximally bimoraic by most theories of syllabification. Thus, the deletion of a consonant in a complex coda is not predicted to cause CL. One possible solution would be to treat the triggering fricative as extrametrical, so that the nasal would be moraic and the syllable, bimoraic. But this is not an acceptable solution, since CL of this type occurs not only word-finally, but also word-medially, where extrametricality is not tolerated (Harris 1983, Pulleyblank 1983, Hayes 1989). According to Hayes (1989), the Germanic data require the postulation of trimoraic syllables. He proposes the derivation

in (25) for Germanic *θaŋxta* becoming Gothic *θa:xta*, claiming that "such a change is not derivable unless we suppose that the syllable *θaŋx* was trimoraic."

(25) CL in Germanic (Hayes 1989: 291)



Although trimoraic syllables are cross-linguistically unusual, there is little independent evidence in Germanic for or against Hayes's proposal. However, Latin has similar facts (**ons* > *o:s*), and possesses a weight-sensitive stress rule (Buck 1963). Thus there is independent evidence in Latin which shows that CVCC syllables are *not* heavier than CVC syllables. Thus proposing trimoraic syllables is not warranted.

3.2.3.5. Prenasalization: Bantu

The case of CL in Bantu is different from the nasal deletion just discussed because the segment conditioning lengthening of the preceding vowel is never lost. CL through prenasalization in Bantu languages has traditionally been analyzed as a reduction of the underlying coda nasal, yielding a prenasalized onset segment with the mora transfer to the preceding vowel. In (26), there are some examples of prenasalization from Luganda (Clements 1986: 52) and Runyambo (Hubbard 1995: 141).

(26) a. **Luganda**

/ku-linda/	'to wait'	->	[kuli:nda]
/mu-lenzi/	'boy'	->	[mule:nzi]
/ba-ntu/	'people'	->	[ba:ntu]

b. **Runyambo**

/ku-jend-a/	'to go'	->	[kuje:nda]
/o-mu-ntu/	'person'	->	[omu:ntu]
/tibákoma#nte/	'they don't see the cow'	->	[tibákoma:nte]

A phonetic account of CL caused by deletion of nasals can be extended to the Bantu data. Though the nasal in question is not lost, it is significantly reduced in comparison with full nasal stops. Prenasalized stops, fricatives or affricates are not necessarily acoustically or articulatorily longer than their non-nasalized single-segment counterparts (Ladefoged & Maddieson 1996: 119-123), that is, the length of a plain stop is comparable to that of prenasalized one. Thus, since nasalized vowels are longer than oral ones, and duration of the following NC sequence is roughly that of a single segment, these vowels can be reinterpreted as phonemically long.[29]

Assuming that the longer inherent duration of the vowels before nasals is indeed the phonetic basis for CL from nasal loss or prenasalization, the question is whether such a process is phonologically significant in Bantu languages. On the basis of tone assignment in Luganda and Runyambo, Hubbard (1995) argues that Maddieson's (1993) representation of prenasalization in a Bantu language Sukuma is relevant not only phonetically but also phonologically. A crucial difference between Luganda and Runyambo (which behaves like Sukuma in the Maddieson's example) is the tone-bearing potential of the string involved in CL from prenasalization. As shown in (27), the pre-consonantal nasal "counts" as a mora for tone assignment in Luganda, but not in Runyambo. In both languages tone is assigned to the 2nd mora of the verb stem (prefixes do not count):

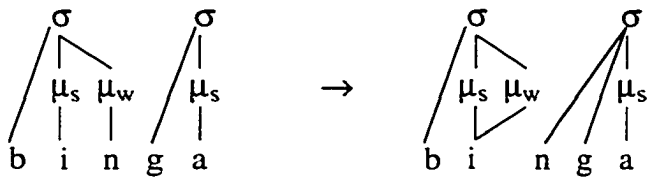
[29] Hock (1986: 431) compares Bantu CL from prenasalization to vowel lengthening before *sonorant + consonant* clusters from Old English (OE) to New English (NE), "which, as OE *cild* > *chi:ld*, NE *child* shows, may take place without a shift in syllable boundary".

(27) **Luganda**: a-bíng-a... 'he who chases' [abiínga...]
3sg-chase-FV

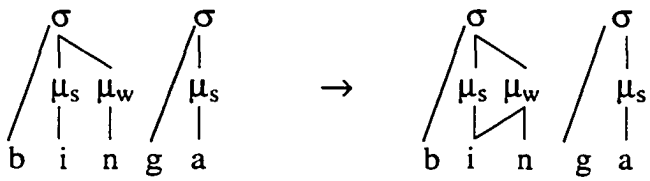
Runyambo: a-bing-á... 'he chases' [abiingá]
3sg-chase-FV

On the basis of the phonetic durations of vowels in CVC, CVNC, and CVVC sequences in Luganda and Runyambo, Hubbard shows that in Luganda long vowels which are created by CL are as long as underlying long vowels, while in Runyambo compensatorily lengthened vowels are only 1.5 times as long as the underlying ones. The structural moraic account suggested for these languages by Hubbard is similar to that of Clements's (1986) account of Luganda (28a), but proposes an additional mechanism of mora sharing for Runyambo (28b):

(28) a. **Luganda**



b. **Runyambo**:



An interesting complication to the account just presented comes from Ruwund (Nash 1992). In Ruwund (29), long vowels from CL through prenasalization can bear tones, as in Luganda, and the prenasalization patterns are identical to those of Luganda. However, vowels which are followed by nasal geminates are also long and can bear tones, while nasals also remain long, at least phonetically.

(29) Ruwund (Nash 1992)

/a-nnam/ PL-animal	a:nnam	'animals'
/wa-m-men/ 3SUBJ-1OBJ-saw	wa:mmen	's/he saw me'

The patterns of vowel lengthening in Luganda, Runyambo, and Ruwund are examples of phonologization strategies differing from language to language. In all three languages, the reduction of *nasal-obstruent* clusters and phonetic vowel lengthening are identical. However, while in Luganda vowel length is phonologized, in Runyambo longer phonetic duration of nasalized vowels does not seem to give rise to a phonological reanalysis. Ruwund represents yet another case, when longer duration of vowels before nasals is sufficient for the reanalysis of short vowels followed by nasal geminates as phonologically long.

3.2.4. Fricatives

The case of CL through the loss of fricatives is not predicted by the phonologization model. Though they can be quite long themselves, fricatives usually do not have a lengthening effect on the neighboring vowels, and transitions from vowels to fricatives are comparable to these of stops and are not long either. In this section, we will see that whenever CL is a result of the loss of a fricative, the fricative necessarily goes through an intermediate stage of an approximant, as predicted by the phonologization model.

Among languages which exhibit loss of fricatives with CL are Greek, Latin, Sanskrit, Persian, Tiberian Hebrew, Turkish, and Kabardian. The most common fricatives to undergo deletion are *h*[30] and *s*. Firstly, we will consider data from Turkish, Persian, and

[30] Most phonetic manuals (e.g. Ladefoged & Madiesson 1996, Pullum & Ladusaw 1996) classify *h* as a voiceless glottal fricative, but mention that is can be an approximant. Since the phonetic nature of *h* is not always clear (especially in the case of dead languages), I chose to discuss it in the section on fricatives.

Kabardian, where only *h* deletes. Secondly, *s*-deletion in Greek and Latin will be discussed. In the case of *s*-deletion in Greek, *s* went through the stage of *h* and only later disappeared. In Latin, *s* has arguable developed into a voiced glottal approximant, *ɦ*, and was later lost with CL.

The phonetic basis for CL through the loss of glottal approximants is fairly well understood: the noise after the vowel is interpreted as the vowel itself. As mentioned by Ladefoged & Maddieson (1996: 325) and shown by Keating (1988), "the shape of the vocal tract during *h* or *ɦ* is often simply that of the surrounding vowels". Only in Semitic languages (in Tiberian Hebrew in particular and maybe in Tigre) the impossibility of gemination of fricatives other than *s* and *h* produces long/short vowel alternations. This process will be discussed in section 3.3.2 as an instance of morphologically conditioned CL.

3.2.4.1. Turkish

Sezer (1986: 230) states that in Turkish *h* is deleted before a continuant or a nasal stop in syllable-final position, as shown in the examples (30) and (31). Phonetically, Turkish *h* is classified neither with fricatives, nor with glides, and is described by Kornfilt (1997) as a central glottal approximant.[31]

(30)	kahya ~ ka:ya	'steward'
	fihrist ~ fi:rist	'index'
	tahsil ~ ta:sil	'education'
	kahve ~ ka:ve	'coffee'
	mahsus ~ ma:sus	'special to'

[31] Kornfilt (1997) mentions that in syllable final position, when following a high tautosyllabic vowel, this segment [h] is pronounced more "heavily" than elsewhere:

ihlamur 'linden tree' [ɯhlamuɾ].

This phonetic detail, however, does not affect the pattern of *h*-deletion in colloquial Turkish.

(31) mehmet ~ me:met man's name
rahmet ~ ra:met 'God's mercy'

While *h* drops out before continuants and nasals, it does not delete before oral stops (32).

(32) sahte ~ *sa:te 'counterfit'
sohbet ~ *so:bet 'chit-chat'
mahkum ~ *ma:kum 'inmate'
kahpe ~ *ka:pe 'harlot'
ahtʃɨ ~ *a:tʃɨ 'cook'

This situation mirrors *j*-deletion in colloquial Turkish, which was discussed in section 3.2.1.1. The account of *j*-deletion (or rather, the reasons for the persistence of *j* before oral stops) can be extended to *h*-deletion: oral stops which follow approximants allow the listener to separate clearly the end of the approximant from the beginning of the following segment, that is, the stop, while in the case of *approximant-sonorant* sequences no clear segmentation is possible.

Additionally, *h* deletes intervocalically or after a voiceless consonant (33) and (34), but not after a voiced consonant (35). No CL occurs in (33) or (34). The reasons are again connected with perceptual properties of VV sequences: vocalic transitions in such sequences are always very long, so no possibility of reinterpretation of a two-vowel sequence as a three-vowel one arises.[32]

(33) myhendis ~ myendis 'engineer'
sihirbaz ~ siirbaz 'magician'
tohum ~ toum 'seed'

[32] Also, as was already mentioned, Turkish doesn't allow V:-V except in maybe one or two loans, e.g. [isra:el], but never in derived environments.

(34)	syphe ~ sype	'suspicion'
	meʃhur ~ meʃur	'celebrity'
	ishal ~ isal	'diarrhea'
	metʃhul ~ metʃul	'unknown'
(35)	imha: ~ *ima:	'destruction'
	merhum ~ *merum	'the late'

While sequences of voiced consonant followed by *h* are preserved (35), after a voiceless consonant, *h* is simply not heard (34). Since *h* has no effect on a vowel which is separated from it by another voiceless consonant, it deletes without CL.[33]

3.2.4.2. Persian

In Modern Persian, "in colloquial speech, *h* tends to disappear in all except initial positions" (Lazard 1992). Word-finally, *h* frequently drops out after all vowels, without causing lengthening:

(36)	**Standard**	**Colloquial**	
	ʃâh	ʃâ	'king'
	kolâh	kolâ	'hat'
	sahih	sahi	'just, exact'
	bedeh	bede	'give' imperative
	jâzdah	jazda	'eleven'

However, before consonants, *h* deletes with CL of the preceding vowel:

(37)		**Standard**	**Colloquial**	
	a.	fahmidi	fa:midi	'you have understood'
		ehterâm	e:terâm	'respect'

[33] Note that the environment of *h*-deletion in (34) is structurally identical to that of *w*-deletion with double flop in Ancient Greek. Even though words like [syphe] are most probably syllabified as [syp.he], no resyllabification with lengthening of the vowel happens.

b.	ʃahr	ʃa:r	'city'
	fohʃ	fo:ʃ	'abusive language'

Examples of *h*-deletion in colloquial pronunciation in (36) and (37) demonstrate that in Modern Persian word-internal and word-final coda consonants behave differently with respect to CL. In both cases, *h* is in the coda. Word-finally *h* deletes without causing vowel lengthening, while word-internally its deletion triggers CL, even when the syllable in question is doubly closed and remains closed after *h*-deletion, as in (37b). This is problematic for the moraic approach which would have to posit two types of *h*: the one which triggers lengthening and the one which does not. To rescue the moraic account, one would have to propose extrametricality of word-final consonants in Modern Persian.[34] However, if one considers extrametricality as an available but not insightful and thus unattractive solution, a phonetic explanation can be offered. Postvocalic *h* is likely to be very short word-finally, so it can be interpreted as a part of the preceding vowel without vowel lengthening. The existence of transitions from *h* to the following consonant ensures that the *h* is longer, and this makes it possible for the listener to reinterpret word-medial *Vh* sequences as long vowels.

The differences between *h*-deletion in Modern Persian and Turkish demonstrate the gradient nature of the phonetic tendencies which cause CL. Recall that in colloquial Turkish postvocalic *h* is preserved before an oral stop; that is, *sahte* 'counterfeit' does not become *sa:te*. But in colloquial Persian, *ehterâm* 'respect' becomes *e:terâm*, regardless of the nature of the consonant which follows the *h*.[35]

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[34] CVC syllables are scanned as heavy in Classical Persian meter, but Modern Persian metrics is not quantitative any more, so this cannot be used as a definitive argument against final consonant extrametricality. Hayes's (1989) solution proposing trimoraic syllables without appealing to extrametricality would correctly derive (37b), but will run into a problem accounting for the data in (36): if doubly closed syllables in (37b) are trimoraic, then syllable-final *h* in (36) must be moraic. Since *h* in the examples in (36) deletes without CL, this solution is not acceptable.

[35] Additionally, *h* often drops after consonants in final and medial positions with or without lengthening of the preceding vowel, as in (1'a), and sometimes with the lengthening of the consonant, as in (1'b). Lazard (1992) does not clearly state conditions for the lengthening, even though from the data he provides one gets an impression that there is no lengthening when *h* is lost after an obstruent.

3.2.4.3. Kabardian

In Kabardian, *h* behaves analogously to the palatal glide *j*, which was discussed in Section 3.1.1.3. Kabardian data is quite complex, and here we will not consider all the details which are orthogonal to CL. It suffices to mention that in (38), the verbal plural personal index form, /ha/, undergoes metathesis when attached to the 3rd person prefix (Colarusso 1992). In the resulting surface sequence, *h* is dropped and the /a/ is lowered and lengthened.

(38) /Ø-j-ha-ʎaaɣʷ-n-ś/ -> /Ø-j-ah-ʎaaɣʷə-n-ś/ -> [jɑ:ʎɔɣʷɣʷínś]
3-3-pl-see-fut-affirmative
'They will see it'

(38) shows that vowels which receive their length from CL and underlyingly long vowels have different properties in respect to stress in Kabardian. Two points are important here. First, Colarusso (1992: 16) states that on nouns and pronouns stress "is confined to the last stem morpheme, and does not shift back to most affixes". Second, Colarusso (1992: 18) takes the conservative position and analyzes Kabardian vowel inventory as having two vowels, /a/ and /ə/. He admits later, however, that in certain disyllabic nouns and adjectives (and apparently verbs, as can be seen in (38), even though

---

(1') a. sobh sob 'morning'
safhe safe 'page, disc (phonograph record)'
b. lâmazhab lâmassab 'godless'

Lazard (1992) also observes that "*h* drops, in particular, very frequently in the plural suffix *-hâ* and the enclitic particle *ham* (without compensatory lengthening)":

(2') zanhâ zanâ 'women'
boʃqâbhâ boʃqâbâ 'plates'
man-ham man-am 'I, too'
kutʃek-ham kutʃek-am 'little, also'

Since the examples in (2') are highly morphologized, one can hypothesize that leveling is at work: the variation in vowel length triggered by *h*-deletion, which is exhibited by forms in (37a) and (37b), was eliminated in favor of one of the two possible variants.

Colarusso does not explicitly state it), long /a:/ is not further "analyzable", that is, not derived.[36] Such long *a*'s are shortened when not under stress, as in (38), where stress shifts to the last syllable. However, the long vowel which results from CL remains long.

Long vowels which do not reduce in unstressed positions are also found in loan words, as in (39).[37] They also result from the loss of *h* with CL.

(39) Loan words with unreducing /ah/ (Colarusso 1992: 33)

/sahbəy/ -> [sɑ:bɪ:́]	'baby' (from Arabic)
/nahrt/ -> [nɑ́:rt^{h}]	'Nart' (a race of heroes) (from an Iranian language, perhaps Ossetic)
/nahrt-x̂^{w}/ -> [nɑ:rt^{h}ú:x̂^{w}]	'corn, maize' (lit., Nart-millet) (both roots of Iranian origin)

Why would underlying long vowels undergo reduction in unstressed positions, while vowels which are the result of CL resist it? Reduction in Kabardian is a phonological process which affects "unanalyzable" long vowels, as well as underlying /a-a/ sequences, which also get shortened when not stressed. Thus, the only source of unstressed long surface vowels is CL, since long *a*'s which result from /ah/ (by metathesis or without it) do not get reduced. A possible explanation of this fact would be that unstressed long vowels were introduced to Kabardian through borrowing (/ah/ in borrowed words was reinterpreted as a surface long [ɑ:] which does not undergo reduction). After that, an analogical extension to other /ah/ sequences (such as the plural suffix) can be posited.

[36] If /a:/ is not derived, I do not see a way of excluding it from Kabardian vowel inventory.

[37] Another source of irreducible long [ɑ:] is associated with initial syllables (Colarusso 1992:33).

3.2.4.4. Greek

CL in Greek is different from Turkish, Kabardian, and Persian examples we have seen since it is the fricative *s* which deletes with lengthening of the preceding vowel. As was mentioned earlier, this kind of CL is not predicted by the phonologization model; *s* does not have any phonetic effect on the duration of neighboring vowels. In the following section we will see that *s*-deletion in Greek necessarily went through a stage of *h*, and thus Greek does not present a counterexample to the phonologization account.

It is generally assumed that Proto-Indo-European **s+sonorant* and **sonorant+s* clusters first became Proto-Greek **hn* (Lejeune 1987, Kiparsky 1967), and from this intermediate stage, Proto-Greek **VhnV* developed into *VnnV* in Lesbian and Thessalian dialects, and into *V:nV* in other dialects of Ancient Greek (that is, the change in question happened before the second CL, which affected only word-final and secondary **Vns* clusters). [38] Dialectal reflexes of primary *s+sonorant* and *sonorant+s* clusters are shown in (40).

(40) Dialectal reflexes of *s+sonorant* and *sonorant+s* clusters in Ancient Greek.

	Lesbian/Thessalian	**Elsewhere**	
*ekrinsa	ekrinna	ekri:na	'I judged'
*a:ngelsa	a:ngella	a:nge:la	'I announced'
*ephthersa	ephtherra	ephthe:ra	'I destroyed'
*g^{w}olsa:	bolla:	bo:la:	'council'
*awso:s	awwo:s	Ion. ae:o:s; Att. heɔ:s	'dawn'
*selasna	selanna:	Ion./Att. selæ:næ:	'moon'
*khesr-ns	kherras	khe:ras	'hand' (acc.pl)
*naswas	nawwos	na:wos > neɔ:s	'temple'

Given the proposed *s* > *h* change, the dialectal split shown in (40) yields to phonetic explanation. There is evidence that aspirated *rho (< *sr)* was originally realized

[38] As was mentioned earlier, in secondary word-medial *ns* clusters *n* was lost with lengthening of the preceding vowels in Attic/Ionic.

a voiceless *r* (Wetzels 1986: 315). Sonorants which were preceded or followed by *s* or its later incarnation *h*, could be partially devoiced as well. In partially devoiced sonorants, there is no clear segmentation between the period of voicing and the voiceless portion of the signal, so the voiceless portion *following* the voiced portion of the sonorant could be misheard as *preceding* it. Obviously, this hypothesis requires experimental verification, but if such a leap can be made, it is natural to assume that after the perceptual metathesis the *h* portion (which, as was mentioned before, often has formant structure of a neighboring vowel) could be reanalyzed as a part of the preceding vowel.

Wetzels (1986: 316) assumes that both *s+sonorant* and *sonorant+s* sequences were heterosyllabic in Common Greek. Since the Mycenean data shows onset maximization (Lejeune 1987, Steriade 1982, Viredaz 1983), I see no reason to assume heterosyllabicity for all such clusters in Greek, especially since Wetzels himself argues (on different grounds) that the change *s* > *h* does not involve any reference to syllable structure.

3.2.4.5. Latin

In Latin, *s* was lost before most voiced consonants, obstruents or sonorants, with CL of the preceding vowel (Sihler 1995: 213 among others), as exemplified in (41).

(41)	i:dem	'the same'	< *is-dem
	iu:deks	'judge'	< *yowos-dik-
	ni:dus	'nest'	< PIE *ni-sd-o
			(cf. Vedic *ni:da-* 'resting-place, nest')
	ka:nus	'gray'	< *kasnus
	ko:mis	'courteous'	< *kosmis
	fide:lia	'pot'	< *fideslia
	pre:lum	'oil press'	< *pres-lo-

Unlike in Greek, before voiceless consonants, *s* is preserved, as in (42):

(42) dispo:no: 'I distribute, arrange'
distuli: 'I dispense'
discerno: 'I part, separate' (cf. di:duco: 'I split, separate')

However, despite this difference, the account of *s*-loss in Greek can be in principle extended to Latin. De Chene & Anderson (1979: 512) propose the following explanation for the Latin change:

> "Our posited intermediate development involves the loss of occlusion in (preconsonantal) *[z], leading to the voiced glottal spirant [fi]. ...the loss of autonomous occlusion in such a change leads immediately to a stage in which the resulting segment assimilates directly to the tongue position of the adjacent vowel; furthermore, since it is already voiced (unlike the voiceless *h* of Greek...), it is only minimally distinct from a vowel (differing perhaps in voice quality, but in no other feature). Consequently, syllable-final [z] should merge with a preceding vowel as soon as it loses its distinct occlusion... If the resulting vowel is interpreted as distinctively long, we have a case of compensatory lengthening."

De Chene & Anderson's account of Latin *s*-loss is based on an assumption that *s* undergoes voicing assimilation not only before voiced obstruents but also before voiced sonorants. Also, this account makes a prediction that voiced [fi] is a better candidate to trigger CL than voiceless [h], which requires further investigation.

3.2.5. Stops

This section concentrates on CL through the loss of oral stops. We predict that only the deletion of those stops which lengthen a preceding vowel will give rise to CL. It is well known that certain (nondeleting) stops do trigger lengthening of the preceding vowels,

but only when they are voiced, as was shown for English (where vowel length is phonemisized) and many other languages, including French, Russian, Korean, German, Danish, Norwegian, Swedish, Hindi, and Persian (see Rietveld & Frauenfelder 1987, Kluender 1988, among others).[39] Surprisingly, there are no cases where the loss specifically of voiced stops triggers CL.

The most common stop to delete with CL is glottal stop. Languages in the database covered here in which glottal stop deletes with CL are Colloquial Tehrani Farsi, Ket, Leti, Wanka Quechua, Mohawk, Klamath, Bella Coola, and Choktaw. Nondeleting glottal stops usually have a shortening, rather than a lengthening effect on the preceding vowel, so it is hard to account for why their loss would result in vowel lengthening and, as CL through degemination, it presents an apparent counterexample to the phonologization account. Section 3.3.1 will present an account of CL through glottal stops.

There are cases where the deletion of consonants (including voiced ones) which do not cause phonetic lengthening of surrounding vowels nonetheless triggers phonological lengthening of these vowels. In section 3.3.2, I will argue that in Tiberian Hebrew, the lengthening occurs for morphological reasons. In Indo-Aryan languages, that is, in Sanskrit, Prakrit languages, and Modern Indic languages such as Hindi, Gujarati, and Bengali, lengthening of vowels correlates with degemination of consonants, but voicing of the geminate is irrelevant to the process. Section 3.3.3 will show that degemination in Indo-Aryan languages represents an instance of phonological analogy whereby consonantal length is reanalyzed as length of vowels.

The closest case I have of CL triggered specifically by a voiced stop is Turkish *g*-deletion. In Turkish and West Saxon, *g* is the only postvocalic stop which was lost with

[39] On the basis of Arabic data, which does not show vowel lengthening before voiced segments, Mitleb (1984) argued that voicing effect on vowel duration is a tendency but not a universal.

CL of the preceding vowel. In the following section, we will consider *g*-loss in these languages.

3.2.5.1. CL through *g*-loss

In Turkish, certain synchronically vowel-final stems are acting as consonant-final for purposes of suffix allomorph selection. This is exemplified in (43). In (43a), suffix-initial *j* is not lost after the stem-final long vowel. However, in (43b), *j* is lost, even though the forms in (43b) are nearly identical to those in (42a).

(43)

	absolutive	**dative**	
a.	bina:	bina:ja	'building'
	dua:	dua:ja	'prayer'
b.	mevzu:	mevzua	'topic'
	da:	daa	'mountain'
	tɨ:	tɨa	'crothchet needle'

Words in (43b) are so-called *dağ-type words* which historically ended in a *g*. In standard Turkish, *g* was lost with CL of the vowel which preceded it. Stems in (43b) and other formerly *g*-final words are written with an orthographic **g** (as, for example *değdi* 'he touched', *dağ* 'mountain', etc.), which is not pronounced in the standard language. Kornfilt (1997) notes that in some dialects, this segment is pronounced as a voiced velar fricative [ɣ] in the onset position. According to Kornfilt, when this segment is in syllable final position and cannot be resyllabified with a following vowel, it deletes with CL of the preceding vowel, as in /tʃaɣdaʃ/ → [tʃa:daʃ] 'contemporary'.

Sezer (1986: 245) notes that along with the dialects which lost the *g* and the dialects which have a voiced velar fricative, there are also dialects which retained both intervocalic and syllable-final *g* (that is, a voiced velar stop). In dialects which retain *g* in some way, vowels which precede [g] or [ɣ] do not lengthen.

West Saxon presents another case of CL where *g* was lenited to a fricative, [ʒ] in this case, before it disappeared completely. West Saxon examples, which are attested in texts both with *g* and without it, and Proto-Germanic reconstructions are shown in (44) (de Chene & Anderson 1979: 510).

(44)

Proto-Germanic	**West Saxon**	
*frignjan	frignan, fri:nan	'to ask'
*thegnaz	-θegn, -θe:n	'young man, thane'
*magadin-	mæ:gden, mæ:den	'young person (dim.)'

De Chene & Anderson (1979) analyze the West Saxon change in (44) as "a case in which transition of a velar stop to a glide was followed by monophthongization of the resulting complex nucleus to a long vowel". However, as they themselves note, the monophthongization happened several centuries later than the loss of *g*, and these two stages do not have to be regarded as connected. Thus, the West Saxon data can be best treated as an instance of the fricativization and development of glides from velar stops with subsequent CL through glide loss.

Two questions need to be answered in conjunction with the Turkish and West Saxon data: why would *g* delete, and why would a vowel preceding it lengthen? As to the first question, *g* is often missing from voiced stop inventories in the languages of the world. This is likely to be connected with aerodynamic constraints on voicing in obstruents (Ohala 1992, 1995). Since voicing requires sufficient airflow through the glottis, as soon as the oral pressure equals the subglottal pressure, the voicing will be extinguished. This can be overcome by expanding the oral cavity volume to lower the oral pressure and to absorb more air coming from the lungs. However, as Ohala (1995) states it,

> "... there are fewer options for vocal tract enlargement the further back the obstruent is articulated. Thus voiced velar stops are often missing in languages that use the voicing contrast in stops at other places of articulation; they may lose their voicing, their stop character or both. This is the reason why /g/ is missing (in native vocabulary) in, e.g., Dutch, Thai, Czech."

As to the lengthening of the neighboring vowel, we can conclude from the Turkish and West Saxon data that on its way to oblivion, voiced velar stop [g] lenited to a fricative, [ɣ] or [ʒ] first. The existence of this intermediate stage is supported at least in Turkish by the fact that in some dialects the reflexes of *g* are [g] or [ɣ]. Further lenition of a voiced fricative to a glide is a quite plausible development.

Thus *g*-deletion in Turkish and West Saxon is not actually the deletion of a voiced stop, since *g* weakened *en route* to deleting, but rather CL through glide deletion.

3.3. Apparent counterexamples

In the following sections, we will discuss apparent counterexamples to the phonologization model of CL. Section 3.3.1 will present an account of CL through the loss of glottal stops. I argue that when the deletion of glottal stops causes CL, the deleting segments are not stops, but approximants phonetically and phonologically. Section 3.3.2 discusses CL in Hebrew which is templatic and can be triggered by all non-geminable consonants. Finally, CL through degemination in Indo-Aryan is addressed in section 3.3.3 where it will be argued that this type of CL is a case of phonological analogy.

3.3.1. Glottal stop[40]

The fact that deletion of glottal stops can be correlated with CL is rather puzzling and does not at first glance appear to be predicted by the phonologization model. Glottal stops do not share phonetic characteristics with segments that trigger vowel lengthening, such as glides, liquids or fricatives. We have mentioned before that voiced stops often cause lengthening of preceding vowels, but glottal stops are voiceless, and should thus pattern with voiceless stops, which usually have a shortening effect on preceding vowels.

Nonetheless, glottal stops are the only non-nasal stops which regularly participate in CL alternations. CL through the loss of glottal stops is quite common. It is documented in such languages as Tehrani Farsi (Indo-European), Ket (isolate language of Siberia), Leti (Austronesian), Wanka Quechua (Quechuan), Mohawk (Iroquoian), Klamath (Penutian), Bella Coola (Salish), and Choktaw (Muskogean).

I argue that the solution to the glottal stop puzzle can be obtained by closer examination of the phonetic properties of entities traditionally classified as "glottal stops". They can be subdivided into two types, as summarized in (45):

(45) Types of glottals

a. Suprasegmentals

- glottal phonation type
- floating tone

b. Segmentals

- glottal stop
- glottal approximant

The first type (45a) represents the situation when a glottal segment is analyzed as a phonation type, as in Mixtec (Macaulay & Salmons 1995) and Cayuga (Doherty 1993), or a floating tone, as in Southern Min dialects (Chung 1996). The second possible

[40] An earlier version of this section was presented at the LSA annual meeting 2000.

situation is when a glottal stop is treated as a separate segment (45b). In this case, glottal stops are analyzed as stop-like segments or as glottal approximants.

In this section we will be concerned only with the second type of glottals since only glottal *segments* are described as regularly participating in alternations which involve vowel length. It is well-known that there is always great variability in the phonetic realization of *vowel+glottal stop* sequences. Glottal segments described as glottal stops can vary from phonetic stops with a full glottal closure to vocalic segments which have weaker constriction of vocal cords, and can even be realized as just laryngealyzation on the vowel (Ladefoged & Maddieson 1996). I argue that the glottal elements whose deletion triggers CL are always of the vocalic type, and that deletion of true phonetic glottal stops never causes CL, just as the phonologization model predicts. We now proceed to case studies of CL through the loss of glottal stops.

3.3.1.1. Ket

Ket (an isolate language of Siberia, spoken at the Enisei river) presents an example of CL through the loss of glottal stops. In Ket, glottal stops either delete with lengthening of the preceding vowel or freely alternate with vowels, as illustrated in (46).

(46) Ket (Dulzon 1964)

bi?l^{j} ~ biel^{j} ~ bi:l^{j}	'far'
i?t ~ iet ~ i:t	'birch-bark box'
du? ~ duo	'smoke'
ku?s^{j} ~ kuos^{j}	'wigwam'
ke? ~ keə ~ ke:	'big'
ka?t ~ ka:t	'parka'
da?skant^{j}ə ~ da:skant^{j}ə	'she narrates'

I argue that the synchronic variation in Ket mirrors the diachronic fate of the glottal stops. They fluctuate between glottal approximants and vowels; when they surface as vowels, monophthongization completes the CL process.[41]

A question might arise as to why should a vowel which alternates with a glottal stop should be qualitatively different from the preceding vowel, as in the diphthongal intermediate Ket forms in (46). A possible answer is that vocalic features are not specified underlyingly on glottal segments. Thus, a vocalized glottal stop is by default a neutral, central vowel, which in the forms in (46) assimilates to some degree to the preceding vowel.

3.3.1.2. Tehrani Farsi

In Farsi, as in Ket, deletion of glottal stops triggers lengthening of preceding vowels. While in Ket we could only speculate as to the phonetic nature of the glottal stop, in Farsi there is hard phonetic evidence supporting the claim that CL-triggering glottal elements are vocalic.

In modern colloquial Tehrani Farsi, lengthening of vowels is triggered by loss of glottal segments (/h/ and /ʔ/) only (Darzi 1991). In (47) we see examples of a glottal stop deleting with CL of the preceding vowel in various prosodic environments. (47a) shows CL triggered by the deletion of a glottal stop when it is the only coda in a syllable in word medial or word-final position. (47b) illustrates CL when a glottal stop is in a complex coda and is adjacent to the lengthened vowel, and (47c) provides an example of CL through the loss of a glottal stop which is a part of a complex coda and is not directly adjacent to the vowel which undergoes lengthening.

[41] Unfortunately, I have no access to Ket recordings to confirm my contention that the so-called glottal stop in Ket is vocalic, but Dulzon (1964) states that the segment traditionally described as a glottal stop in Ket is "vowel-like".

(47)	**Formal**	**Colloquial**	
a.	te**ʔ**mir	te:mir	'repair'
	ʃo**ʔ**be	ʃo:be	'branch'
	su**ʔ**	su:	'bad'
b.	ro**ʔ**b	ro:b	'terror'
	læ**ʔ**n	læ:n	'cursing'
c.	rob**ʔ**	ro:b	'quarter'
	ʃæm**ʔ**	ʃæ:m	'candle'

The data in (48) show that CL through the deletion of /h/ mirrors CL through the deletion of glottal stop. (48a) shows CL triggered by the deletion of a *h* as a single coda, and (48b-c) illustrate deletion of *h* in a complex coda.

(48)	**Formal**	**Colloquial**	
a.	tehran	te:ran	'Tehran'
	sohbæt	so:bæt	'talk'
	kuh	ku:	'mountain'
b.	bæ**h**s	bæ:s	'discussion'
	læ**h**n	læ:n	'language'
c.	sob**h**	so:b	'morning'
	sol**h**	so:l	'peace'

Darzi (1991) proposes a moraic account of CL in colloquial Tehrani Farsi. His solution holds that glottals *h* and *ʔ* are the only moraic codas in Tehrani Farsi and thus only the deletion of glottal segments is predicted to cause CL. However, Darzi's proposal is problematic in that he holds that both glottals in Farsi are obstruents which explicitly contradicts Zec's (1995, 1988) theory of sonority constraints on syllable structure.

According to Zec, sonority effects on moras are relational in nature. Consonants above a (language-specific) sonority threshold are moraic; consonants below that threshold are not. Since glottal stop is the least sonorous segment, if glottal stop is moraic in coda, Zec predicts all other coda consonants to be moraic as well. This, in turn, predicts that the deletion of any coda should cause CL in colloquial Tehrani. However, even though any consonant can delete syllable-finally, as shown in (49), only the deletion of glottal segments results in vowel lengthening:

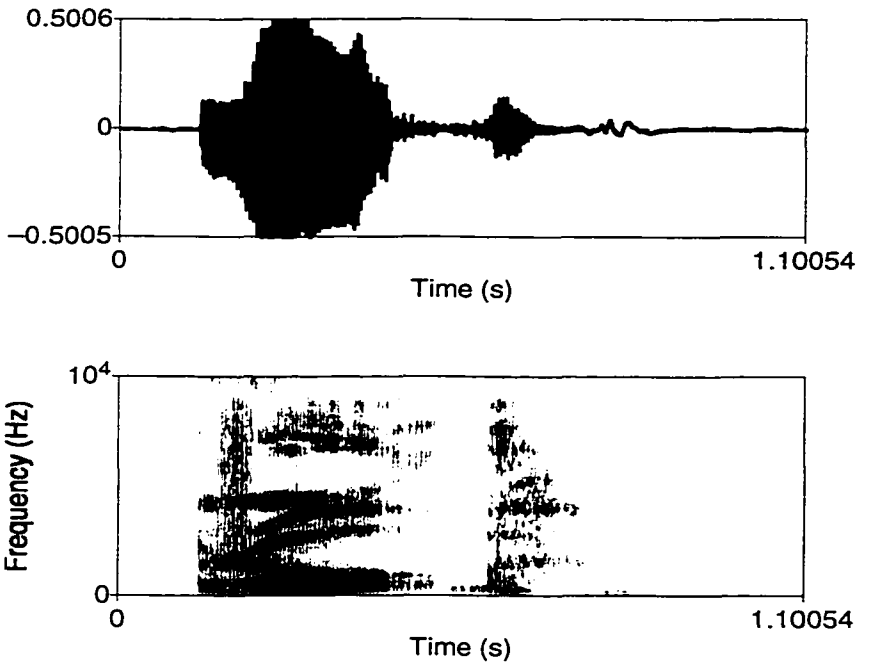
(49)

Formal	**Colloquial**		
doz**d**	doz	'thief'	(voiced stop [d] deleted)
fek**r**	fek	'thought'	(trill [r] deleted)
ʔæ**z**	ʔæ	'from'	(fricative [z] deleted)

Thus, if a glottal stop is analyzed as moraic, we are confronted with a theoretical problem, which can be resolved if this segment is analyzed as a phonological approximant. Phonetic evidence supports this claim.

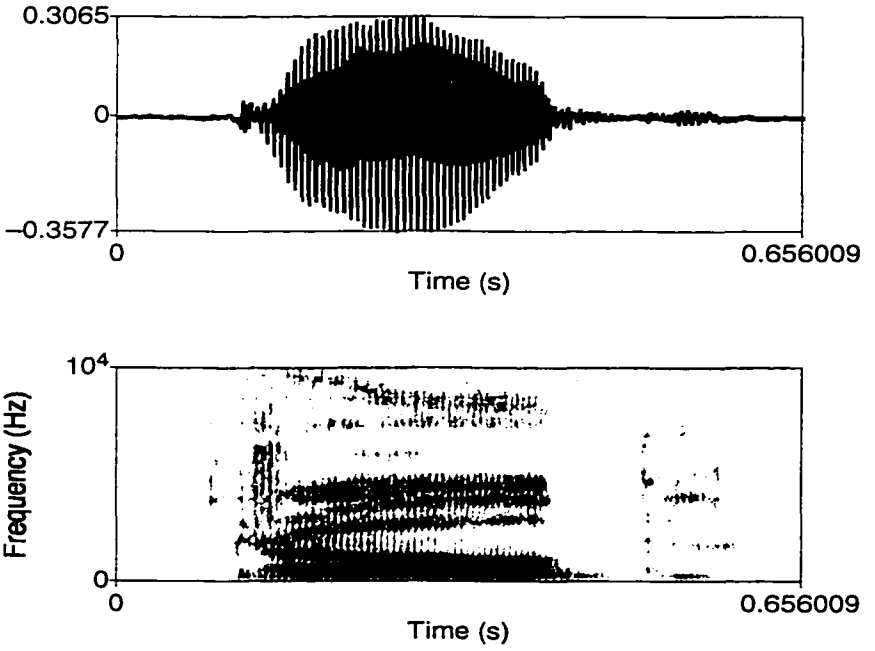
Phonetic data from two speakers recorded for this study confirms that glottal stops in Farsi are firstly very vocalic even in careful pronunciation; and secondly at least phonetically glottal approximants even in careful pronunciation. Example (50) shows a waveform and a spectrogram of a speaker of modern Tehrani Farsi pronouncing the word [ro**ʔ**b] 'terror' in formal speech. No glottal deletion and no CL take place in (50).

(50) ro?b 'terror' (formal speech)



In (51), there is a spectrogram of the same word pronounced in a colloquial mode with the deletion of the glottal and CL by the same speaker:

(51) ro:b 'terror' (colloquial speech)



Note that the glottal segment in (50) is indeed very vocalic and not obstruent-like. In (50) there is no silent closure, as would be expected for a "true" glottal stop.

It has been observed (and we can also observe it on the spectrogram in (50)) that the shape of the vocal tract in a glottal approximant is that of surrounding vowels, parallel to what is observed for *h*, with creaky voice on the vowel. Glottals *h* and *ʔ* are both produced by a laryngeal gesture and make no demands on the vocal tract configuration, which is therefore determined by the adjacent segments (Pierrehumbert & Talkin 1992: 93). Thus, the noise after the vowel can be interpreted as the vowel itself, so the vowel is reanalized as phonologically long due to the additional phonetic length contributed by the laryngealized part.

It is also significant, that in the grammars of Persian, glottal "stop" was described as a glottal stricture (Matthews 1956), a pharyngeal voiced strident glide (Giunashvili 1965), or just a glide (Windfur 1979). We can conclude, thus, that the glottal segment in Tehrani Farsi does not have a stop-like character and can be described as a phonetic and phonological approximant.

3.3.1.3. Implications of the analysis

The analysis just proposed predicts that only the deletion of certain kinds of glottal segments, namely, phonological approximants will result in CL. Synchronically, glottal approximants which result in CL are predicted to be moraic in codas, while glottal stops whose deletion does not trigger CL are predicted to be weightless. The moraicity becomes important in languages which allow only certain kinds of codas to be weight-bearing (Zec 1988, 1995). If a variety of possible phonetic realizations of glottal stops potentially corresponds to different phonological representations in respect to their moraic status, glottal stop is predicted to occupy different places in the sonority hierarchy in different languages. This prediction is supported by the cross-linguistic observations

on the distribution of glottal stops. In some languages, glottal "stop" patterns with sonorants since it is an approximant, and in others it patterns with obstruents since it is a stop.

For example, in Karok[42] (Bright 1957) the distribution of glottal stops suggests that they were lost with CL (glottal stops in the coda are very rare in Karok, occurring almost exclusively in directional particles). Additionally, glottal stop patterns with the glides *h, r, y,* and *w:* all belong to the non-geminable set of consonants. This presents evidence that glottal stop is an continuant in Karok. (Notice that since all non-geminable consonants except the glottal stop can occur in codas, the restriction on gemination does not stem from constraints on possible codas.)

On the basis of Semitic data, McCarthy (1994) includes glottal stop in the natural class of gutturals. Catford (1977) defined approximants as having "non-turbulent flow when voiced; but the flow becomes turbulent when they are made voiceless", which seems to include all "gutturals" but the glottal stop. This definition was modified by Clements (1990) to require oral stricture for non-approximants. Thus, according to Clements's definition, all gutturals including glottal stop are phonologically approximants.

On the other hand, there are languages in which glottals stops pattern with obstruents in respect to various phonological processes, noticeably, in respect to syllable weight. For example, in Kwakwala (Zec 1988, 1995) glottal stop patterns with non-sonorants in being non-moraic in distinguishing heavy vs. light syllables for the purposes of stress assignment. This means that it functions as an obstruent phonologically.

(52) shows syllable templates for stem types for Proto-Athapaskan, as reconstructed by Leer (1979).

(52) CVV, CVVT, CVV?, CVT

[42] Also pronounced Karuk.

Keren Rice (p.c.) suggests that absence of CV and CVʔ implies minimum bimoraicity of the stems in Proto-Athapaskan. If the final glottal stop is the only non-moraic (that is, the least sonorant) stop in Proto-Athapaskan, we can explain the absence of *CVʔ based on bimoraicity; otherwise a uniform account of the absence of these two forms is not available.

Finally, the fact that so-called glottal stops can be phonologically either stops or approximants predicts that there may be languages which contrast these two types of glottal segments. Indeed, in Gimi, a Papuan language of the Eastern Highlands of Papua New Guinea, the two types of glottals are described as phonologically contrastive by Ladefoged and Maddieson (1996). A near minimal triplet from Gimi is shown in (53):

(53) Gimi (Maddieson 1996)

haʔo	'shut'
ha*oʔ	'many'
hao	'hit'

The Gimi segment represented by an asterisk (*) lacks an IPA symbol. Since it is voiced and involves some glottal activity, Ladefoged and Maddieson (1996) propose that it might better be called a creaky voiced glottal approximant rather than a stop.

3.3.2. Hebrew: morphological compensatory lengthening

Tiberian Hebrew raises a number of questions concerning both the validity of the account of CL through consonant loss presented so far and its applicability to CL in Hebrew. The inventory of segments which cause CL in Tiberian Hebrew cannot be easily accounted for through mechanisms of phonetic change. Here I will argue that it is not necessary to invoke phonetic explanation for CL in Tiberian Hebrew, since it is a clear case of a templatic, morphologically conditioned process.

There are a number of processes in Hebrew which cause gemination of root consonants. Here we will consider only a couple of them.[43] For example, the initial consonant of the root geminates if it is preceded by the definite article *ha*, as in (54a), or by the past proclitic *wa* (54b), or by the proclitic *mi* meaning 'from' (54c).

(54)	a.	seefer 'book'	ha**ss**eefer 'the book'
		geʃem 'rain'	ha**gg**eʃem 'the rain'
	b.	yoomar 'he will say'	wa**yy**oomar 'he said'
		neetsee? 'we will leave'	wa**nn**eetsee? 'we left'
	c.	po 'here'	mi**pp**o 'from here'
		ʃaam 'there'	mi**ʃʃ**aam 'from there'

A number of consonants, such as *?*, *ʕ*, *ħ*, *h*, and *r*, do not geminate in these contexts; instead, vowels which precede them are lengthened, as exemplified in (55a) for the definite article, in (55b) for the past proclitic, and in (55c) for the proclitic 'from'. This process produces synchronic alternations in vowel length, which Lowenstamm & Kaye (1986) call compensatory lengthening.

[43] For the full range of data see Lowenstamm & Kaye (1986), Prince (1975).

(55)	a.	ʔiiʃ 'man'	**haa**ʔiiʃ 'the man'
		ħaam 'people'	**haa**ħaam 'the people'
		haar 'mountain'	**haa**haar 'the mountain'
	b.	ʔoomar 'I will say'	**waa**ʔoomar 'I said'
		ʔədabbeer 'I will talk'	**waa**ʔədabbeer 'I talked'
	c.	ro 'beginning'	**mee**ro[44] 'from beforehand'
		haahaar 'the mountain'	**mee**haahaar' 'from the mountain'

We have seen other languages in which *h* and glottal stop trigger CL, for example, Persian (both *h* and *ʔ*), Kabardian (only *h*), or Ket (only *ʔ*), but other consonants are quite unusual in this role. It is also worth noting that in Tiberian Hebrew back fricatives trigger CL, while *s* undergoes gemination, while cross-linguistically *s* is the most common fricative to delete with CL.

Almost the same set of consonants *ʔ ʕ ħ h r* never appears geminated in Tiberian Hebrew and Tigre, "even in morphological environments in which other consonants are geminate."[45] Obviously, there is an unviolable phonotactic constraint against geminating *ʔ ʕ ħ h r* in Tiberian Hebrew. On the other hand, templatic morphology requires a bimoraic (preferably CVC) shape for the clitics discussed above. To resolve the phonotactics problem and to fit the template, the vowel in a clitic gets lengthened.[46]

---

[44] Long /i/ and /u/ surface as [ee] and [oo] respectively.

[45] Both Hebrew and Tigre lack the velar/uvular fricatives *χ* and *ʁ* (Hoberman 1996:842).

[46] There are cases in which gemination is absent, but CL is not observed either (Lowenstamm & Kaye 1986: 104). Apparently, this is another possibility of resolving the morphological requirement, but examples with CL are the overwhelming majority.

The case of CL in Tiberian Hebrew is significantly different from the instances of CL discussed above. Arising through phonotactic co-occurrence restrictions (that is, by the impossibility of gemination of certain segments), it is purely morphological and is required by language-specific, and moreover, morpheme-specific templatic requirements.

3.3.3. Indo-Aryan: compensatory lengthening through degemination

For the reasons that vowels are not phonetically longer in the environment of following voiceless obstruents, the phonologization model predicts that CL through the loss of such segments should not occur. Thus there is no reason to expect CL through degemination of obstruents either. However, CL through degemination is a prominent feature of Indo-Aryan. The following section presents an account of this apparent counterexample to the phonologization account.

Jeffers & Lehiste (1979: 12-13) argue that some changes traditionally labeled as CL can be analyzed as "a series of phonetic processes" which occur separately but together produce a result which can be formally represented as the CVC → CV: change. (56) shows the development of PIE **nisdo-* to Vedic (and Classical) Sanskrit *ni:d-* 'nest' where the original *s* went through stages of voicing assimilation, retroflexion, gliding, and finally loss of glide with CL:

(56)	PIE	nisdo-	
		nizd-	voicing assimilation
		niẓd-	retroflexion of *z* after *i*
		niẓḍ-	retroflexion of dental stops after retroflex sibilants
		niyḍ-	gliding of retroflexed consonants
	Sanskrit	ni:ḍa-	contraction of a palatal vowel and palatal glide

Along with *ni:d-*, Wackernagel (1957: 272) lists Vedic *edhi* 'be' and *sed-* 'sit' and Avestan *hi:ẓ-* from **hizẓ-* as examples of *s*-loss.[47] Wackernagel states that loss of *s* in Vedic resulted in synchronic alternations in certain verbal paradigms, as shown in (57), emphasizing that third plural perfective form of 'sit' is not **sazdire*, as would be expected, but *sedire*, with *s*-loss and the change of vowel quality.[48]

(57)

	3 pl perf.	**3 sg. active**	
a.	bhejre	babhaja	'divide'
b.	sedire	sasada	'sit'

We have seen that CL through *s*-deletion, as, for example, in Latin and Greek, is clearly phonetically motivated. This is also the case in Vedic, where only *s* deletes with CL. In Classical Sanskrit, an additional set of consonants participates in CL, but only *s*-loss remains synchronic (or at least having synchronic alternations), as in some compounds, "namely, in certain Vedic compounds with **dus**: **dudabha**, **dudaç**, **dudhi**, **dunaça**, **dunaça**...; and the language of every period, certain compounds of **sas**, with change of its vowel to an alterant quality...: **sodaça**, **sodha** (also **saddha** and **saddha**), **sodant**" (Whitney 1886: 199d).

There is also a restriction on geminate *r*'s in Sanskrit, even across word boundaries. As Whitney (1886: 179) describes it,

> "a double **r** is nowhere admitted: if such would occur, either by retention of an original *r* or by conversion of **s** to **r**, one **r** is omitted, and the preceding vowel, if short, is made long by compensation.
>
> Thus, **puna: ramate**, **nrpati: rajati**, **matu: rihan**, **jyoti:ratha**, **du:rohana**."

---

[47] "Dass das Ai. vor *d(h) d(h)* ursprünglichen Sibilanten irgendwie einbüsste, erkannten für *edhi sadhi nida-pid-* schon Bopp" (Wackernagel 1957: 272).

[48] Note that /a/ does not lengthen with the loss of *s*, but becomes [e]. Since /a/ is the lowest vowel, transitions to the following palatal segment could be possibly reinterpreted as vowel height and not vowel length.

The process of the degemination of *r* with CL is a pivotal point in understanding the nature of CL through degemination in Indic. Since there is a constraint on geminate *r*'s in the language (even across word boundary), *r* dissimilates by becoming an *s*. If the vowel before *s* is short, *s* is lost and the vowel preceding it lengthens. This process is shown schematically in (58).

(58) Stage 1: punar **r**amate
Stage 2: punas **r**amate
Stage 3: puna: **r**amate

Thus, since there is a form *puna:*, if it is followed by any *r*-initial word, and there is also an independently existing form *punar*, the deletion of *r* through the stage of *s* creates a possibility of analyzing tokens with the long vowels as a result of degemination.

Additionally, dental stops are lost with CL of the preceding vowel after their complete assimilation to the following dental, as in *ta:dhi* from Vedic *tad-dhi* (Whitney 1886: 198c). I hypothesize that the degemination of *r* could be extended to the case of dental fricatives. *h* is also lost with CL before voiceless and murmured dentals. (Phonetic reasons for *h*-loss with CL were discussed above, and we shall not reiterate them here). According to Whitney (1886: 222b)

> "...before a dental mute (**t, th, dh**) in verb-inflection and in derivation, its [h's – D.K.] euphonic effect is peculiarly complicated: it turns the dental into a lingual (as would **ç**); but it also makes it sonant and aspirate (as would **dh**...); and further, it disappears itself, and the preceding vowel, if short, is lengthened".

(59)	/ruh-ta/	ru:dhá
	/leh-ti/	lédhi
	/guh-tar/	gu:dhár
	/meh-tum/	médhum
	/lih-tas/	li:dhás
	/lih-dhvam/	li:dhvám

To test if our analogical hypothesis is correct, we should now consider data from Middle Indo-Aryan and Modern Indic languages, such as Hindi and Bengali.

In Prakrit languages, as for example in Pali, geminates were created by assimilatory processes, as in (60a). On the other hand, certain Sanskrit words have doublets in Pali (Hock 1986: 441), with long vowels and single consonants corresponding to short vowels and geminate consonants, as in (60b).

(60)		**Sanskrit**	**Pali**	
	a.	*karsya:m(i)	kassa:mi, ka:sam	'I will/would do'
		(-)hartum	hattum-, ha:tum	'to hold'
	b.	ni:da	ni:la-, nidda-	'abode, nest'
		sthu:la	thu:la, thulla-	'big'
		pu:jya-	pu:ja, pujja-	'to be worshipped'

Pali doublets in (60) could conceivably be created by analogical mechanisms. First of all, there was a process of consonant gemination in Pali, shown in (61), which created many roots of the CVCCV type, with a short vowel and an intervocalic geminate.

(61)	**Vedic**	**Pali**	
	karma	kamma	'work'
	matsya	maccha	'fish'
	hasta	hattha	'hand'
	hasti:	hatthi:	'elephant'
	sapta	satta	'seven'
	asta	attha	'eight'

However, the forms with geminates were considered colloquial, and Old Sanskrit pronunciation remained in educated speech, introducing correspondences of the type CVCCV = CV:CV, as (60b).[49] Each word with the geminate in (60b) has its counterpart with the long vowel, and after such relations between roots were introduced, doublets in (60a) could be created analogically. Lehiste (70: 42) states that

> "there are ... languages in which the quantity of a given segment must be related to the quantity of other segments in the sequence. For example, in Icelandic, Norwegian, and Swedish ... there exists an inverse relationship between the quantity of a vowel and that of the following consonant, so that a short vowel is followed by a long consonant, and a long vowel is followed by a short consonant."

Lehiste contends that the domain of such quantity patterns must be a syllable, and provides several possible explanations of these facts. The discussion amounts to the idea that somehow the speakers are able to equate vocalic and consonantal length. Presumably, it is more naturally achieved for geminates than for other consonant clusters.

Regular changes from Middle to Modern Indic created more forms with CL through degemination. Hindi reflexes of Middle Indic forms with geminates are shown in (62).

(62)	**Middle Indic**	**Hindi**	
	mittha(k)a-	mi:tha:	'sweet'
	kamma-	ka:m	'work, deed'
	cunna(k)a-	cu:na:	'powder'
	sacca	sa:c	'truth'

[49] Phonetic duration of these sequences is not equal: since a long vowel has greater duration than a long consonant, thus it is difficult to talk about preservation of word-duration in this case (but see Miranda 1984).

In Bengali (Chatterji 1970: 259), "double consonants of Middle Indo-Aryan were simplified to a single consonant, and there was compensation for this loss of quantity in the consonant of the syllable ... by lengthening the preceding vowel". Examples from Bengali are in (63) (Mojumder 1972: 79):

(63)

Vedic	**Pali**	**Bengali**	
karma	kamma	ka:m	'work'
matsya	maccha	ma:ch	'fish'
hasta	hattha	ha:t	'hand'
hasti:	hatthi:	ha:ti	'elephant'
sapta	satta	sa:t	'seven'
asta	attha	a:t	'eight'

Since many Vedic words have come down to Bengali directly from Pali, there is a possibility of an analogical change similar to the one outlined above. The existence of both forms of the shape CVCCV and forms of the shape CV:CV could cause the change. This points to a possibility of a long consonant being formally, phonologically (since phonetically these are very different entities) equated with a long vowel.

De Chene & Anderson (1979) argue that CL cannot arise though degemination of consonants. Aware of the Indic data, they suggest that geminates can become preaspirated (as happened in Modern Icelandic), with the subsequent loss of aspiration giving rise to long vowels. This account of Indic has, however, successfully been dismissed by Hock (1986: 439-440), who points out that "the Icelandic phenomenon in question occurs only with voiceless-stop clusters, not in other contexts". The problem with explaining the facts of degemination arises for de Chene & Anderson precisely because their goal is to unify all instances of CL phonetically. Thus, they do not allow for any differences in the phonologization patterns of CL, so analogical developments of the kind proposed above are not predicted by their theory.

3.4. CL through onset loss

As was discussed in chapter 2, moraic theory makes a strong prediction that lost onsets cannot cause lengthening of following vowels, since onsets do not contribute to syllable weight. In this section I will provide an analysis of the counterexamples to this claim, when deletion of a clearly non-moraic onset segment triggers CL. Three examples of such a process come from Romanesco Italian (Loporcaro 1991), Samothraki Greek (Newton 1972), and Onondaga (Michelson 1986). Interestingly, all three cases involve deletion of onset liquids, *l* in Romanesco Italian and *r* in Samothraki Greek and Onondaga.

3.4.1. Romanesco Italian

Yet another case of CL through onset deletion is present in Romanesco Italian, a variety of Italian spoken in Rome. In Romanesco, the initial *l* of the definite article /lo la li le/ (masculine singular, feminine singular, masculine plural, and feminine plural) and of the object clitic /lo la li le/ (him, her, them masculine, them feminine) optionally deletes when followed by an unstressed vowel, which is thereby lengthened (Loporcaro 1991: 280). The deletion of *l* in Romanesco is exemplified in (64):

(64) l-deletion in Romanesco Italian (Loporcaro 1991)

a.	lo ˈstu:pido	o: ˈstu:pido	'fool'	masc.sg.
	la ˈstu:pida	a: ˈstu:pida		fem.sg.
	li ˈstu:pidi	i: ˈstu:pidi		masc.pl.
	le ˈstu:pide	e: ˈstu:pide		fem.pl.
b.	lo ˈb:ru:ʃo	o: ˈb:ru:ʃo	'I burn it (masc)'	
	la ˈb:ru:ʃo	a: ˈb:ru:ʃo	'I burn it (fem)'	
	li ˈb:ru:ʃo	i: ˈb:ru:ʃo	'I burn them (masc)'	
	le ˈb:ru:ʃo	e: ˈb:ru:ʃo	'I burn them (fem)'	

Notice that *l* deletes with CL only in morphemes listed in (64), and does not in other comparable cases, e.g. *lo'rɛntso* 'Lawrence' and *la'vo:ra* 'he works' never surface as **o:'rɛntso* and **a:'vo:ra*.

The duration of transitions to and from a vowel in the case of *l* is very long if the *l* is in either onset or coda position, so it is conceivable that the loss of the onset *l* can result in CL of the following vowel. The fact that CL in Romanesco is heavily morphologized and occurs in only two morphemes suggests that CL through onset loss cannot give rise to synchronic alternations, since onset cannot bear weight and thus the phonetic duration of the vowel can be reinterpreted as phonemically long, but synchronic loss of a segment cannot be equated with weight transfer. In the following sections, we will see cases of CL through onset deletion in Samothraki Greek and Onondaga which are more regular and not morphologized.

3.4.2. Samothraki Greek

According to Newton (1972), in a dialect of Greek spoken on the island of Samothraki, *r* was lost in all positions, except word-finally. Intervocalically, *r* was deleted without vowel lengthening, as shown in (65). The data in (65) also illustrates the fact that in all dialects of the northern Aegean Islands (Thasos, Samothraki, Lemnos, and Lesbos) mid vowels raise and unstressed high vowels delete.

(65)

Standard	**Samothraki**	
tirí	tií	'cheese'
psarádes	psaáðis	'fisherman'
hóra	úa	'hour'
forá	fuá	'time'
kávuras	kávuas	'crab'
méra	mía	'day'

Newton states that /r/ "between a vowel and consonant... converts to [i]". This description refers necessarily to the coda *r*, since there are no complex onsets consisting of segments of falling or equal sonority in Greek. The deletion of the coda *r* is exemplified in (66): first, *i* was epenthesized between *r* and the following consonant, and second, intervocalic *r* was lost (xartí > xaritί > xaití 'paper').

(66)

Standard	**Samothraki**	
xartí	xaití	'paper'
karðiá	kaiðiá	'heart'

Word-initially and when preceded by a consonant, that is, in the onset, *r* was lost with lengthening of the following vowel, as shown in (67):

(67)

	Standard	**Samothraki**	
a.	ád**ra**s	áda**:**s	'man'
	samaθ**rá**ki	samaθa**:**k	'Samothraki'
	p**rá**sinos	p**á:**snus	'green'
	pad**re**yá	pad**i:**yá	'marriage'
b.	**rú**xa	**ú:**xa	'clothes'
	róta	**ó:**ta	'ask!'

It is important that word-initial *r+high vowel* sequences [ru] or [ri] surface as a long high vowel [i:], as in (67b). According to Newton, this environment can only arise as a result of an unstressed high vowel loss with subsequent *i*-epenthesis, shown in (68). Thus, examples in (67b) represent the loss of the onset *r* with CL of the following vowel.

(68) **Standard** **Samothraki**

rufó	i:fó	'I sip'
(via *rufó > *rfó > *rifó> i:fó)		
ruθúnia	i:θún'a	'nostrils'
(via *ruθúnia > *rθún'a > *riθún'a > i:θún'a)		

Word-finally, *r* is not lost, as exemplified in (69).

(69) **Standard** **Samothraki**

parakóri	parakór	'maid'
samári	samár	'pack-saddle'

As was discussed in chapter 2, Samothraki Greek poses a serious problem for moraic theory. The moraic approach predicts that the deletion of the onset *r* in (67b) should not result in CL, since *r* in these cases is clearly non-moraic. Since in order to be moraic *r* has to be in the coda, could it be possible that *r+vowel* sequences went through metathesis first?

For the sake of the argument, let us assume that *rV* sequences in Samothraki Greek underwent metathesis with the following *r*-deletion and vowel lengthening. This solution would be consistent with the moraic approach, but it creates a paradox in the ordering of the historical events, as demonstrated in (70).

(70) *r*-loss in Samothraki: possible scenarios

a.	rufó	xarti	prasinus	rúxa	samari	tirí
HighVloss	rfó	xarti	prasnus	rúxa	samar	trí
Metathesis	-	-	parsnus	-	-	-
i-epenthesis	rifó	xariti	parisnus	rúxa	samar	tirí
r-deletion	i:fó	xaiti	***paisnus**	ú:xa	samar	tií

b.	rufó	xarti	prasinus	rúxa	samari	tirí
HighVloss	rfó	xarti	prasnus	rúxa	samar	trí
i-epenthesis	rifó	xariti	prasnus	rúxa	samar	tirí
Metathesis	irfó	xariti	parsnus	úrxa	samar	tirí
r-deletion	i:fó	xaiti	pa:snus	ú:xa	***sama:**	tií

(70) shows that high vowel loss happened before *r*-deletion (intervocalic *r*'s got lost, but word-final *r*'s are preserved). High vowel epenthesis happened before the intervocalic *r*-loss *xarti* > *xariti* > *xaiti*. If metathesis happens before the loss and/or deletion of high vowels, it would result in the wrong outcome ***paisnus* < *prasinos*, instead of the correct *pa:snus*. If we order metathesis after the loss of high vowels, it would incorrectly predict *r*-loss with vowel lengthening, yielding incorrect ***sama:* as well as correct *pa:snus*, unless we stipulate that word-final coda *r*'s do not delete while word-medial coda *r*'s do, which is rather unusual: the reverse situation is expected.

We have just seen that CL in Greek is indeed caused by the deletion of an onset *r*, which is problematic for moraic theory. Newton suggests that it is phonetically plausible that *r* was first replaced by a vocalic element of a quality identical to that of the following vowel. He exemplifies this process by the example of replacement of postvocalic *r* in British English by a lengthening of the preceding vowel, as in [art] > [a:t]. However, the precise nature of the problem here is that it has been claimed by moraic theory that this kind of "replacement" can occur only postvocalically, that is, where *r* (or any other consonant) can be moraic.

I propose that the solution of the problem of CL through loss of onset *r* is connected with the acoustics of rhotics. *r* is vocalic enough to be reinterpreted as additional vowel length, or to exert lengthening effect on the following vowel and to be reinterpreted as a part of the vowel. It has the same properties when it is in the coda or in the onset, where it does not have to be moraic. Thus, *r* can be reinterpreted as additional length on preceding and following vowels. Glides have the same properties, and indeed

there are processes of onset glide vocalization attested in various languages, for example, in Mohawk (Bonneau 1988) and Swahili (Houlihan 1973). As was argued earlier for Turkish , the absence of lengthening with loss of intervocalic *r* can be attributed to a morpheme-structure constraint, prohibiting three-vowel sequences in Greek and thus inhibiting a possible reanalysis of a very long sequence of two vowels as a trimoraic one, once *r* is not heard. The examination of data indeed does not show any VVV sequences.

So, one can say, in spirit of the theory of evolutionary phonology (Blevins 1999) and Blevins & Garrett 1998) that CL originates in perceptual properties of speech and not in moraic structure.

3.4.3. Onondaga

Proto-Lake-Iroquoian **r* was lost in the three western Lake-Iroquoian languages: in Cayuga intervocalically and after a postvocalic laryngeal, and in all environments in Onondaga and Seneca. In Onondaga the loss of **r* preconsonantally (in the coda) was accompanied by CL. Preconsonantal (coda) *r*-deletion in Onondaga is exemplified in (71).

(71) Coda *r*-deletion with CL in Onondaga

Onondaga	**Proto-Lake-Iroquoian**	
wa?hk**a:**háthwa?	< *wa?kk**ar**hathw-	'I turned it (over, right side up)'
kató**:**je?s	< *kat**ór**je?s	'I am breathing'

r-loss in Onondaga is a very recent change, because we have historical records from as late as the mid-eighteen century that write *r* in all environments.

In all Lake-Iroquoian languages which lose the *r*, intervocalically it is lost without CL. According to Michelson (1988), in all three languages the loss of **r* between identical vowels produced long vowels that are treated as *disyllabic* VV sequences by the accent and vowel lengthening rules. Between non-identical vowels, "**r* became *w*

intervocalically if after rounded vowels, and **r* became the palatal glide *j* intervocalically after *i* and in a few cases *e*" (Michelson 1988: 169-171). However, it is hard to assess if Lake Iroquoian intervocalic **r* went through a stage of a glide, or if is was lost first and then subsequently the glide was inserted to resolve vowel hiatus. The **r* > *w* change is exemplified in (72).

(72) Intervocalic *r*-loss in Onondaga

teh**owe**hweta:ti	< teh**ore**hwetati	'he has made an opening'

Michelson (1988: 182) argues that the preconsonantal deletion of *r* in Onondaga "occurred under influence from Seneca, which has **Vrh* > *Vh* (but without compensatory lengthening)". If this interpretation is correct, this change has to be separate from the postconsonantal *r*-deletion.

Michelson (1986, 1988) describes CL through *r*-loss in Onondaga as a rather unusual case of CL, since the deletion of not only preconsonantal coda *r*, but also postconsonantal, onset *r*, is accompanied by the lengthening of the following vowel, as exemplified in (73).

(73) Onset *r*-loss with CL in Onondaga

Onondaga	**Proto-Lake-Iroquoian**	
tewake**:**hwetá:ti	< *tewak**re**hwetati	'I have made an opening'
ek**é:**hka	< *ek**re**hka	'I will gather'
k**a:**eta?ke	< *k**ra**eta?ke	'my heel'
ek**i:**hwatshe:ni?	< *ek**ri**hwatsheni?	'I want to discover the truth, know everything'

Woodbury (1981) proposed the following explanation for Onondaga CL through onset loss. In the 19th century dictionaries of Onondaga (Shea 1860, Horsford 1887), **Cr* is frequently represented by *Cer*, with the epenthetic *e*. Based on the fact that Mohawk

regularly breaks up **Cr* clusters with an epenthetic *e*, Woodbury treats Onondaga CL as a case of vowel epenthesis with the following deletion of intervocalic *r*, and vowel coalescence. The change proposed by Woodbury is shown in (74).

(74) $*V_1rV_2 > V: / C\ \_$ where V_1 is an epenthetic vowel, V_2 is nonepenthetic, and where *C* is an oral obstruent or *n* if V_1 is *e* and any consonant if it is *a*.

However, the coalescence shown in (74) applied to *eV* < **erV* vowel sequences only if *e* was epenthetic. Otherwise, if *e* represented an underlying vowel, there was no coalescence. The vowel hiatus either simply remained unresolved *(*erV > eV)*, or, less often, an epenthetic glide would surface between the vowels *(*erV > ejV)*. Additionally, there was a different epenthetic vowel *a*, which did not participate in coalescence, as in (75).

(75) wa?khnékaèhka? 'I collected water'
< *wa?+k+hnek+A+rehk+a?
factual+I+liquid+stem-joiner+collect+aspect

In the case of Onondaga, moraic theory would have to treat two types of epenthetic vowels differently: one has to be non-moraic, and the other bears weight. A possible way out of this puzzle is to say that in Onondaga, as in Samothraki Greek, onset *r* was not moraic, but vocalic enough to be reinterpreted as additional length on the following vowel. What Woodbury interpreted as epenthetic vowels in *consonant+r* sequences was actually a phonetic effect of *r* itself, perceived by listeners but not yet phonologized.

3.4.4. Summary

To sum up, to account for CL through onset deletion in Samothraki Greek and Onondaga I proposed that the explanation of the peculiar behavior of *r* is connected with the acoustics of rhotics. An approximant *r* has no sharp discontinuities in respect to the adjacent vowels and also is known for its ability to "color" adjacent vowels and to have syllabic variants (Ladefoged & Maddieson 1996); thus the parsing of this segment as prevocalic or postvocalic is difficult. For this reason the deletion of *r* prevocalically can cause CL of the following vowel, which implies that CL in this case is not dependent of the moraic status of a deleted segment. The case of CL through the deletion of the onset *l* in Romanesco Italian has similar phonetic origins and arguably remained in the grammar since it was morphologized.

3.5. Conclusions

In this chapter, I have developed a typology of CVC CL patterns in the languages of the world, focusing on the understudied area of segmental conditioning of CL. On the basis of a language sample of 55 languages which exhibit CL of *CVC > CV: type, I proposed a phonetically-based phonologization account of CVC CL. I demonstrated that loss of segments happens mainly in the environments where these segments are not heard (for example, nasals are very often lost before fricatives or voiceless stops, *h* is often misheard as a part of a vowel, especially if it is followed by a sonorant, etc.), and that vowel lengthening correlated with deletion of glides, liquids, nasals and fricatives in certain environments can be viewed as perceptually-based phonetic change, since vowels are usually phonetically longer in these environments.

In this chapter, I have also accounted for the undergeneration problems of the moraic approach pertaining to CVC CL. These problems are summarize in (76):

(76) Undergeneration
- independent weight requirement
- onset deletion

So far, we have seen that independent weight requirement is not an empirically valid generalization and have shown that it is not required by the phonologization model. CL through onset deletion, which is not predicted to occur by the moraic approach, is explained by the phonetic properties of liquids, the only segments participating in onset deletion.

To conclude, CL starts as a phonetic process which can become phonologized. When the "seeds" of a historical change are in question, very often it is unnecessary to talk about the notion of compensation or the moraic status of deleting segments since other mechanisms, like hypocorrection, are responsible for the CL change. That is, vowels whose phonetic duration in certain environments is longer than the duration of their counterparts can be reinterpreted as long with the loss of the environment conditioning the duration. However, as soon as such changes are phonologized, phonetic naturalness is not of importance any more. Phonetically natural CL processes can be extended to environments in which one would not expect vowel lengthening based on phonetic facts, as in the case of CL through degemination, or morphologized, obscuring phonetic naturalness of the processes in question. The cases of morphologization will be dealt with in Chapter 5.

Chapter 4.
Conditions on CVCV compensatory lengthening

4.1. Introduction

In this chapter, we turn to the historical development of CL through vowel loss. This type of CL can be represented schematically as a *CVCV > CV:C diachronic process whereby the second vowel in a CVCV sequence is lost with a subsequent lengthening of the preceding vowel. As discussed in chapter 2, this type of CL poses problems for the moraic approach, as well as for other strictly representational approaches, since it is non-local in a strict segmental sense: it creates typologically disfavored syllable structure, and, in some cases, crucially involves non-moraic onset consonants. In this chapter, I will show that these phenomena can be given a satisfactory phonetic account.

As discussed in earlier chapters, CL through vowel loss is not an uncommon historical development, although, it is not even remotely as common as CL through consonant loss, whose diachronic analysis was presented in chapter 3. Among the languages in the corpus which exhibit the effects of CVCV CL are various Slavic languages and dialects (see for example Topolińska 1974 for West Slavic, Langston 1998 for East Slavic, and Timberlake 1983a, 1983b for general discussion of CL in Slavic), as well as in Romance dialects, such as Friulian (Hualde 1990, Prieto 1992, Repetti 1992) and Milanese (Repetti 1992, Sanga 1988). Hock (1986) discusses CL through vowel loss in Germanic, specifically in Northern German dialects, such as Rhenish "Schärfungsgebiet" (Hanenberg 1915, Neuse 1915, Frings 1916), the dialect of the area of Dithmarschen and Stavenhagen (Grimme 1922), and Jutland Danish (Ringaard 1982).[50] CVCV CL is also documented in Finno-Ugric for Hungarian (Kálmán 1972,

[50] Contra Minkova (1982), Lass (1985), Hayes (1989), and Kim (1993), it is suggested by Hock (1986) and de Chene & Anderson (1979) and convincingly argued by Lahiri & Dresher (1999) that vowels in stressed syllables in Middle English were not lengthened as a result of CL caused by the loss of final schwa, but rather underwent a process of open syllable lengthening.

Sauvageot 1971), Estonian and Sámi, in Korean (Ramstedt 1939), in the Nilotic language Dinka (Andersen 1990), in the Voltaic language Baasaar (Rialland 1993), in the Gur language Lama (Ourso 1989, Ourso & Ulrich 1990), and in the Bantu language Runyoro-Rutooro (Rubongoya 1999).[51] CL through vowel loss was a diachronic development in all these languages, and lives on in some of them in the form of (mostly lexically or morphologically conditioned) synchronic alternations. In this chapter, we will be mainly concerned with diachronic aspects of CL in these languages.

(1-4) are representative examples of CVCV CL from Friulian (Romance), Serbo-Croatian (Slavic), Hungarian (Finno-Ugric), and Lama (Gur) respectively.

In Friulian (1), all unstressed vowels except the low vowel *a* were lost word-finally, giving rise to CL of accented preceding vowels. (1a) illustrates the correlation of vowel loss with vowel lengthening, (1b) shows an example of a non-deleting final *a*, and (1c) demonstrates that there is no lengthening of unstressed vowels with the loss of final vowels, that is, after the loss of *o* in **úmido*, *i* in [úmit] remains short.

(1) Friulian (Hualde 1990)

a.	*lóvu	>	lo:f	'wolf'
	*rúdu	>	ru:t	'pure'
	*méle	>	mi:l	'honey'
b.	*fémina	>	femina	'female'
c.	*úmido	>	úmit	'humid'

In Slavic (2), the ultra-short high vowels [ɪ] and [ʊ] (the so-called jers) were lost, and the vowels preceding them were lengthened.

[51] CVCV ~ CV:C alternations are present in the synchronic grammars of Trukese, and other Austronesian languages, but the historical source for the alternations in question is not *compensation* but rather a bimoraic minimal size condition, which will be discussed in Section 4.5.

(2)	**OCS**		**Serbo-Croatian**	
	boru	>	bo:r	'forest'
	rogu	>	ro:g	'horn'
	medu	>	me:d	'honey'

In Hungarian (3), short high vowels were also lost with CL of most preceding vowels ([o] did not participate in the change). Longer forms in (3a) illustrate that CL in Hungarian cannot be due to a minimal size condition.

(3) Hungarian (Kálmán 1972)

a.	*wizi	>	vi:z	'water'
	*tyzy	>	ty:z	'fire'
	*utu	>	u:t	'road'
	*ludu	>	lu:d	'goose'
	*neʒi	>	ne:ʒ	'four'
b.	*modoru	>	modo:r	'bird'
	*teheni	>	tehe:n	'cow'

In Lama (4), a schwa was lost word-finally, yielding a long vowel in the preceding syllable.

(4) Lama (Ourso 1989)[52]

*atorə	>	ato:r	'shallow hole'
*kpaterə	>	kpate:r	'bangle'
*mirə	>	mi:r	'nose'

Example (5) provides comparative data from two Nilotic languages, Päri and Dinka. On the basis of comparative reconstruction, Andersen (1990) argues that Dinka

[52] The evidence for reconstructing a historic schwa in Lama is very tentative and based solely on the information in Ourso (1989).

lost word-final plural suffixes (which have been retained in Päri as /ɔ/ and /o/) with subsequent lengthening of preceding vowels.[53]

(5) Dinka (Andersen 1990)

a.	**Päri**	**Dinka**	
	CVCV	CVVC	
	rìm-ɔ	riɛ̰ɛm[54]	'blood'
	tùŋ-ó	tu̟uŋ	'horn'
b.	**Päri**	**Dinka**	
	CVVCV	CVVVC	
	pàaj-ɔ	baa̰aj	'home'
	cíin-ó	ci̟in	'intestine'

As a result of final vowel loss, the reflexes of original short vowels (cf. Päri) surface as long in Dinka (5a), and original long vowels develop additional length, thus introducing a ternary length contrast in Dinka (5b).

In the rest of Chapter 4, I will discuss phonetic motivations and present the phonologization account of CVCV CL in Section 2. Two case studies of CVCV CL in Rhaeto-Romance and Slavic will be presented in Sections 3 and 4, and a conclusion will follow in Section 5.

[53] This situation is typologically unusual, since it is common that the shortest vowels get lost, which is exemplified by the first three examples of CVCV CL just discussed (jers are the shortest vowels in Common Slavic, schwa is the shortest vowel in Lama, and in Friulian only the low vowel, which is the longest, is immune to deletion). However, these vowels have possibly undergone lowering in Päri. There is not enough evidence, however, to claim this with any certainty.

[54] The vowel here is a long falling diphthong.

4.2. Phonetic motivations for CVCV compensatory lengthening: the phonologization model

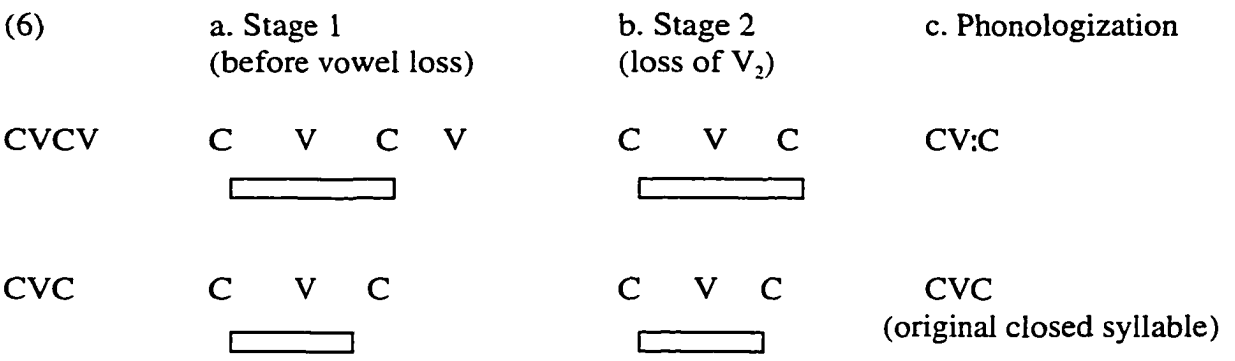
Recall that the phonologization model, presented in chapter 1 and applied in chapter 3 to CVC CL, holds that CL is a phonological reanalysis of inherent phonetic duration of vowels; increased phonetic duration in some contexts is reinterpreted as phonological length with the loss of the conditioning environment. The same basic insight holds for CVCV CL as well, as shown by Barnes & Kavitskaya (2000): with the loss of conditioning environment, the inherent phonetic duration of vowels is interpreted by listeners as phonemic, leading to phonologization of vowel length.

However, there are important differences between CL through consonant and vowel loss. As has been discussed in chapter 1, it is crucial that CL through vowel loss results in changes in syllable structure from an open to a closed syllable. Change in syllable structure is responsible for the reinterpretation of vowel duration as phonemic in the cases of CVCV CL.

The relevance of syllable structure to CL through vowel loss follows from an observation that vowel durations are dependent on syllable structure; vowels in open syllables are cross-linguistically longer than vowels in closed syllables (Maddieson 1985, Rietveld & Frauenfelder 1987, *etc.*).[55] This generalization concerning vowel durations and syllable structure allows us now to approach most examples of CVCV CL from the point of view of phonologization. Based on Barnes & Kavitskaya (2000), I propose that CL through vowel loss as a historical process does not in fact involve any transfer of length or weight. Rather, phonetic vowel durations found intrinsically in the CVCV environment are reinterpreted as phonologically significant upon a change in syllable structure.

[55] As was mentioned in Chapter 2, Turkish seems to be a counterexample to this claim; in Turkish vowels in closed syllables tend to be longer than vowel in open syllables (Barnes 2001).

In (6), I repeat a schematic illustration of the phonologization of vowel duration in CVCV CL presented in chapter 1.



(6) shows that, prior to the deletion of the final vowel, the longer vowel duration characteristic of open syllables is correctly parsed by listeners as a phonetic consequence of syllable structure in the first syllable of a CVCV sequence, and is discounted (6a). The vowel is interpreted as phonologically short, as is intended by the speaker. With the deletion of the final vowel (*i.e.* failure to detect the final vowel), however, the duration of the vowel in the newly-closed syllable becomes inexplicable, since it is longer than is expected in the closed syllable (6b). The listener therefore parses the longer duration as intended by the speaker, and reinterprets the vowel in question as phonologically long (6c).[56]

In the following sections, we will use the phonologization model to analyze in detail two cases of CVCV CL, Friulian and Slavic. The analysis of CL in Friulian will be

[56] In some languages with CVCV CL, e.g. in Friulian, the lengthening never applies across a consonant cluster. However, in Slavic and Hungarian (1'), there are cases of CL across an intervening consonant cluster where no change of syllable structure takes place, which constitute apparent counterexamples to the phonologization account just presented.

(1') *V-loss and lengthening* *epenthesis*
*lelki > *le:lk > le:lek 'soul'

It has been shown, however, that vowels are shorter in syllables with complex codas than in syllables with single codas (see, for example, Klatt 1975, O'Shaughnessy 1981). Thus, a change of syllable structure is still crucial for CL through vowel loss, but in the case of Hungarian, it involves not only the change from an open to a closed syllable, but also the change from a singleton to a complex coda.

presented in Section 4.3, and the Slavic data will be analyzed in Section 4.4, with specifics of segmental conditioning of Slavic CL discussed in Section 4.4.2.

4.3. Case study 1: compensatory lengthening in Friulian

4.3.1. Data

We will now turn to details of the data from Friulian and other Romance dialects which exhibit CL through vowel loss (Hualde 1990, Repetti 1992, Prieto 1992, Haiman & Benincà 1992). Friulian is one of the few Romance languages with contrastive vowel length[57]; indeed, CL is the sole source of length oppositions in Friulian, which thus constitutes one of a few counterexamples to the claim that CL is a structure-preserving sound change.[58]

In Friulian, seven vowel qualities (with vowel length) are contrastive in stressed syllables (Hualde 1990, Frau 1984):

(7)

i/i:		u/u:
e/e:		o/o:
ɛ/ɛ:		ɔ/ɔ:
	a/a:	

In unstressed positions, vowel-length distinctions are neutralized (with a few lexical exceptions), as are distinctions between open and closed mid vowels. Thus only five vowels /i e a o u/ are found in unstressed syllables.

As mentioned earlier, the distribution of long vowels in Friulian is restricted; long vowels are only exceptionally found in syllables other than the final stressed syllable in the word. There is a regular allomorphic alternation in Friulian roots: in the (suffixed) feminine form, the root has a short vowel and the final consonant is voiced, while in the

[57] Some Italian dialects of Romagna and Emilia also have contrastive vowel length, which has a more limited distribution than in Friulian (Hualde 1990: 31; Ugozzoni 1971, 1975).
[58] See the discussion of CL as a non-structure-preserving sound change in Chapter 2.

corresponding (unsuffixed) masculine form, the vowel is long (if stressed) and the final consonant is voiceless. These alternations are illustrated in (8) (with stress marked as an acute accent):

(8)	**fem**	**masc**	
	lóve	ló:f	'wolf'
	rístive	rísti:f	'obstinate'
	rúde	rú:t	'pure'
	fréde	fré:t	'cold'
	savúde	savú:t	'known'
	beáde	beá:t	'blessed'

According to Hualde (1990), "the principal environment where the opposition between long and short vowels is manifested in final tonic syllables closed by an obstruent." Hualde lists the following minimal pairs illustrating phonemic vowel length in Friulian:

(9)	kás	'bodice' (masc)	ká:s	'case' (masc)
	pás	'pace' (masc)	pá:s	'peace' (fem)
	lát	'milk' (masc)	lá:t	'gone' (masc)
	mút	'mute' (masc)	mú:t	'mode' (masc)

Before sonorants the distribution of long vowels is even more limited than before obstruents. For example, before an *r*, vowels are always long, as in (10), and before nasals vowels are always short, as in (11).

(10)	vé:r	'true'
	savó:r	'flavor'
	tó:r	'tower'

(11) pán 'bread'
fán 'hunger'
plén 'full'
kuzín 'cousin'
konvén 'it is convenient'

Among final sonorant consonants, vowel length is preserved only before *l*, as shown in (12).

(12) sa:l 'salt' val 'valley'
mi:l 'honey' mil 'a thousand'

(13) shows that regardless of the nature of the final consonant, if the final vowel of the stem is not stressed, the lengthening does not take place:

(13) a. **fem** **masc**
úmide úmit 'humid'

b. pévar 'pepper'
zínar 'son-in-law'

Historically, Friulian CL is a result of the loss of short non-low final vowels with lengthening of vowels in preceding syllables. Correspondences between Latin and Friulian are shown in (14) to illustrate vowel loss only.

(14)

Latin				**Friulian**	
lupum	>	*lupu	>	lo:f	'wolf' (masc.sg.)
novum	>	*novu	>	nu:f	'pure'
dekem	>	*detʃe	>	di:ʃ	'ten'
nivem	>	*nive	>	ne:f	'snow'

The low vowel [a] was not lost word-finally and underwent subsequent raising (**a* > *e*) in Friulian (15).

(15)

Classical Latin		**Friulian**	
kasa	>	kase	'house'
nova	>	nuve	'new' (fem.sg.)
lupa	>	lɔve	'wolf' (fem.sg.)

The minimal pairs in (16) illustrate the historical origins of the contrastiveness of vowel length before obstruents in Friulian. The forms which are synchronically contrastive only by virtue of their vowel length used to have contrast in the voicing of the last obstruent. Note that lengthening applied to forms with a voiced intervocalic obstruent (16a), but it did not affect vowels before voiceless obstruents (16b).

(16)

a.	*kazu	>	ka:s	'case'
	*mudu	>	mu:t	'mode'
b.	*kasu	>	kas	'bodice'
	*mutu	>	mut	'mute'

The factors which affect the outcome of CL in Friulian are summarized in (17).

(17) (i) the identity (voicing) of the intervening C_2 in a $C_1V_1C_2V_2$ sequence;
(ii) the stress on V_1 (the lengthening vowel).

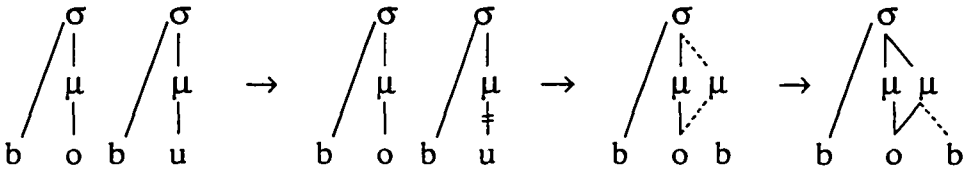
An analysis of these factors will be offered in the following section.

4.3.2. Phonologization of vowel length in Friulian

The phonologization model outlined in section 4.2 provides an explanation for the change of the type *CVCV > CV:C. With the loss of the second vowel, the first one can be reinterpreted as long by listeners, since the duration of the first vowel is excessive for a closed syllable. However, in Friulian, an additional factor plays a role in determining the outcome of CL: the realization of C_1VC_2V CL depends crucially on the identity of the intervening C_2.

As was discussed in chapter 2, conditions on CVCV CL in Friulian are theoretically significant with respect to the intervocalic onset consonant in a CVCV sequence, which is a domain of CL. Recall that to capture the appearance of a *transfer* of vowel length from one place in the string to another, moraic theorists propose that CL occurs when a mora-bearing segment is deleted, but its mora persists in the representation. This stray mora is then reassociated to a nearby vowel, making that vowel long, as shown in (18).

(18) A hypothetical CVCV CL case (after Hayes 1989 on Middle English)



Moraic theory thus makes the following prediction: since intervening onset consonants in CVCV CL are not associated to any prosodic structure at the time of the reassociation of the stray mora, they should have no way of interacting with the application of CL. In Friulian, however, intervening voiced obstruents permit CL to take place, and intervening voiceless obstruents appear to block it. The mora-reassignment account fails to derive the asymmetry of application of CL in these cases, as there is nothing in the representations which could be made to block the reassignment in some cases, while allowing it in others.

The asymmetry of CL application in Friulian can be explained by a reference to two uncontroversial phonetic factors. First, it is well-known that stressed vowels are very often longer than unstressed ones, and second, vowels tend in many languages to be longer before voiced consonants than before voiceless (e.g., Ščerba 1912, Chen 1970; Kluender, Diehl & Wright 1988). On the basis of these factors, we can assume that at the time of the loss of the final unstressed vowel, preceding vowels were phonetically longer

if they were stressed and if they were followed by voiced obstruents. Thus, only length in such newly closed syllables was reinterpreted as phonologically significant.

Consider the difference between (19) and (20), which schematically show the application of CVCV CL in forms with intervening voiced consonants (19) and non-application of CL in forms with intervening voiceless consonants (20).

(19)	a. Stage 1 (before vowel loss)	b. Stage 2 (loss of V_2)	c. Phonologization
CVDV	C V D V	C V D	CV:D
CVD	C V D	C V D	CVD (original closed syllable)

(20)	a. Stage 1 (before vowel loss)	b. Stage 2 (loss of V_2)	c. Phonologization
CVTV	C V T V	C V T	CVT
CVT	C V T	C V T	CVT (original closed syllable)

Vowels are longer before voiced consonants in both open and closed syllables, and in earlier work it was shown that at least in some languages, the difference in vowel duration between open and closed syllables in the case of voiced consonants (19) is greater than the difference in duration in the case of voiceless consonants (20) (Barnes & Kavitskaya 2000). We hypothesize that this relative difference in duration was interpreted as phonemic in Friulian, resulting in phonologization of vowel length.[59] Arguably, the

[59] I was unable to verify the validity of my claims for Friulian experimentally, but see section 4.4.2 for the experimental verification of a similar (but more complex) case of Slavic CL.

change only affected stressed vowels because the unstressed ones were much shorter and the relative difference in duration between open and closed syllables was not significant.

The fate of vowel length before sonorants in Friulian provides additional support for the phonologization account. Recall that before nasals and *r* vowel length is neutralized; before *r* vowels are always long, as in (21), and before nasals they are always short, as in (22).

(21) vé:r 'true'
savó:r 'flavor'
tó:r 'tower'

(22) pán 'bread'
fán 'hunger'
plén 'full'
kuzín 'cousin'
konvén 'it is convenient'

Recall also that among sonorants vowel length contrast is maintained only before *l*, as shown in (23).

(23) sa:l 'salt' val 'valley'
mi:l 'honey' mil 'a thousand'

The explanation of synchronic variable vowel length before laterals has its roots in diachrony. According to Vanelli (1979), Moretti (1985), and Hualde (1990), a vowel lengthens before a single lateral and stays short before a historical geminate, which is illustrated in (24):

(24) a. *palu > pa:l 'stick'
*male > ma:l 'badly'

b.	*mille	>	mil	'a thousand'
	*valle	>	val	'valley'

If degemination happened after vowel loss, the situation in (24) can be easily explained. The difference in the original duration of vowels before singleton onset vs. coda which constitutes the first half of a geminate could play an important role in the outcome of phonologization. Forms in (24b) were in a closed syllable originally, so the duration of vowels in (24b) was much shorter than in (24a). Thus, in words with geminate *ll* no grounds for reinterpretation of vowel duration and the phonologization of vowel length were present.

To account for the neutralization of vowel length before rhotics, Hualde (1990) assumes (after Moretti 1985) that the simplification of geminate rhotics preceded the simplification of other geminate consonants, in particular, liquids. As stated by Hualde (1990: 40), "the etymological distinction between single and geminate laterals is relevant for the process of vowel lengthening but the historical distinction between single and geminate rhotics does not play a role for this process".

The fact that vowels are always long before *r* is consistent with the CVCV CL phonologization model. The transitions from a vowel into an approximant *r* are very long, much longer than transitions from a vowel into an obstruent (see chapter 3 for discussion of CL through the loss of rhotics). With the loss of the final vowel, extra vowel duration in closed syllables was phonologized, and the additional length from vocalic transitions could be an additional factor in the phonologization process. In the case of the nasals, however, it is entirely plausible that vowel duration was attributed to nasalization and thus discounted.

4.3.3. An alternative account of Friulian compensatory lengthening as a sound change

Hualde (1990) suggests a different account of CL in Rhaeto-Romance, proposing the following chronology for Friulian. According to Hualde, first, there was a process of voicing of stops (25a), followed by loss of nonlow final vowels (25b), producing alternations like **finid* ~ **finida*, since final *a* was not lost. After that, phonetic lengthening of stressed vowels before final voiced obstruents took place (25c), followed by word-final devoicing (25d), at the time of which the greater duration of vowels preceding the consonants which underwent devoicing became phonologically relevant. Finally, a subsequent **a > e* change is responsible for **finida > finide*.

(25) a. Voicing of stops

*finitu > *finidu 'finished' (masc.)
*finita > *finida 'finished' (fem.)

b. Loss of low unstressed final vowels

*finidu > *finid vs. *finida > *finida

c. (Phonetic) lengthening of stressed vowels followed by a word-final voiced obstruent

*finid > *fini:d vs. *finida > *finida

d. Word-final devoicing (vowel length becomes phonologically relevant) and *a > e

*fini:d > fini:t
*finida > finide

There are several interesting issues raised by Hualde's analysis. Firstly, the analysis treats loss of final vowels and lengthening of vowels in penultimate syllables as unrelated events. As suggested by Andrew Garrett (*p.c.*), such an interpretation would be

entirely plausible if Friulian underwent open syllable lengthening with consequent loss of final vowels, as happened in Middle English (Lahiri & Dresher 1999). However, lengthening did not affect words which ended on the low vowel *a*, which shows that vowel loss and lengthening are related in Friulian.

Secondly, Hualde argues that the loss of final vowels in Friulian happened before phonetic lengthening of vowels followed by word-final voiced consonants, which were subsequently devoiced. Thus, his analysis simply stipulates that lengthening happened only before word-final voiced obstruents and did not occur in other positions in the word where vowels were followed by voiced obstruents as well.[60]

As I argued before, the phonologization of the inherent vowel duration happened upon the change in syllable structure and not upon the change in obstruent voicing. This

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[60] A seemingly similar situation is found in a northern dialect of Italian, Milanese (Repetti 1992). The examples in (2') reconstruct to original CVCV forms, in which the final vowels except the low vowel *a* were lost with lengthening of the vowels in preceding syllables.

(2') Milanese (Repetti 1992: 174)

a.	pilu	>	pe:l	'hair'
	krutʃe	>	kru:s	'cross'
	fotʃu	>	fo:k	'fire'
b.	gula	>	gula	'throat'
	skola	>	skola	'school'

The crucial difference between Milanese and Friulian is that in Milanese the process of word-final devoicing is optional, so voiced and voiceless obstruents freely alternate in word-final position, as shown in (3').

(3')	di:t ~ di:d	'finger'
	lɑ:k ~ lɑ:g	'lake'
	nɑ:s ~ nɑ:z	'nose'

The data in (3') arguably show that the stage of word-final devoicing does not have to be considered crucial in the phonologization of vowel length. However, this is uncertain because in Milanese vowel lengthening is also attested before voiced consonants in open syllables (Nicoli 1983: 50), as shown in (4').

(4')	piza	'Pisa'
	speza	'expense'

At this point, I cannot determine the source of the vowel length in (4'); it is entirely possible that in Milanese vowels underwent lengthening in open syllables followed by voiced consonants. If this is correct, it would render Repetti's (1992) account unsatisfactory and withdraw Milanese data from the list of objections to Hualde's account of CL in Friulian.

analysis does not have to stipulate that phonetic duration of vowels was increased only before word-final voiced obstruents. Vowels before any voiced obstruents (regardless of their position in a syllable or in a word) were longer than before voiceless obstruents. This difference in phonetic duration became phonologized in Friulian and Milanese at the time of the loss of final vowels, because the conditioning environment for the phonetic duration of vowels (open syllable, exaggerated by the voiced consonant) was lost.

4.4. Case Study 2: compensatory lengthening in Late Common Slavic

4.4.1. Conditions on Slavic compensatory lengthening

In the previous section we discussed CL in Friulian which was constrained both segmentally and prosodically. Segmentally, CL only applied across voiced obstruents and liquids, and prosodically it was restricted to penultimate stressed vowels which became final after the loss of final short vowels. In this section we consider CL in Slavic which is also segmentally and prosodically restricted, but the conditions are of greater complexity than in Friulian.

Slavic CL was brought to life at the end of the Common Slavic period, when the two short lax high vowels known as *jers* deleted in certain positions, giving rise to lengthening of the vowel in the preceding syllable. *Jers* are reflexes of the original short high vowels *i* and *u*. In the general phonological literature, jers are usually represented by the symbols [ĭ] and [ŭ]. Slavists traditionally use symbols 'ь' for a front jer and 'ъ' for a back jer, but in this study I will use [ʊ] and [ɪ] to denote the front and the back jer respectively.

Yet another common division of both front and back jers is into *strong* and *weak*. While weak jers are lost in the history of Slavic, the reflexes of strong jers are full-fledged vowels. These two processes are known respectively as the *fall* and the *vocalization* of the jers. The rule of jer-deletion in Slavic was first stated by Havlík

(1889). This rule was later canonized as *Havlík's Law* in the literature on Slavic linguistics. The usual simplified formulation of Havlík's Law can be formulated as follows: "Word-final jers and jers in syllables followed by vowels other than jers become weak. Weak jers are dropped. Jers in syllables followed by a weak jer become strong. Strong jers merge with one or several of the 'non-reduced' vowels" (Isačenko 1970: 73).

In other words, Havlík's Law simply states that, counting from the right edge (the end) of a word, the first jer will be weak, and the following one will be strong, and the next one will be weak again, and so on.[61] If a different vowel interferes, the count is reset, so the first jer to the left of this vowel will be weak. Havlík's Law and the notion of weak and strong jers are illustrated in (26).

(26)

	LCS	**Russian**	
a.	*rʊtʊ	rot	'mouth'
b.	*dɪnɪ	den^{j}	'day'
c.	*kʊniʒɪka	kniʒka	'book' (nom.sg., dim.)
d.	*kʊniʒɪkʊ	kniʒek	'book' (gen.pl., dim.)

In (26a-b), there are two jers in a word. The rightmost jer is weak, so it is lost, while the one to its left is strong, so it undergoes *vocalization*, merging with a full vowel. The reflex of a back jer in Russian is [o], and the reflex of a front jer is [e] (reflexes of strong jers differ from one Slavic languages to another). Jers in (26c) are not preceded by other jers, so they are weak and thus they disappear. In (26d), the rightmost jer is lost, and the one which precedes it vocalizes. Since there is a vowel to its left, the count restarts, and the leftmost jer is also lost.

Data from Upper Sorbian which illustrates the basic mechanism of Slavic CL is shown in (27). Upper Sorbian represents the simplest case of Slavic CL through the loss of jers. Note that the reflexes of Pre-Upper-Sorbian **o* are different in in the Upper

[61] Jer strengthening is analyzed as an instance of CL by Timberlake (1983a,b).

Sorbian genitive singular and nominative singular forms, [ɔ] vs. [o]. This shows that CL applied in the nominative where a jer was lost, and did not apply in the genitive, where the ending was a full vowel.

(27) Upper Sorbian ((Schuster-)Šewc 1968)

a.	**Upper Sorbian**		**Pre-Upper-Sorbian**[62]	**Gloss**
	gen.sg.	**nom.sg.**	**nom.sg.**	
	wɔz-a	woz	*vȍzu	'carriage'
	nɔs-a	nos	*nȍsu	'nose'
	rɔd-a	rod	*rȍdu	'kin'
	plɔt-a	plot	*plotù	'raft'
	dwɔr-a	dwor	*dvorù	'yard'
	kɔnj-a	konj	*konjɪ	'horse'

b.	**Upper Sorbian**	**Pre-Upper-Sorbian**	**Gloss**
	hrozba	*grozìba	'threat'
	horki	*gorìkujɪ	'bitter'[63]

I chose to exemplify Slavic CL with alternations in Upper Sorbian, where CL applied across the board, regardless of the intervening consonant, accent, or position in the word. However, CL is notoriously complex in many other Slavic dialects, since the outcome of CL depends on a number of various factors which interact with each other (Timberlake 1983a, b; 1988, 1993). The factors which may affect CL in different Slavic languages are summarized in (28):

[62] Two types of accent (short falling and short rising) are shown for the reconstructed forms in this example to illustrate that accentuation was irrelevant for the purposes of CL in Upper Sorbian. Slavic accentuation will be discussed in detail in Section 4.4.3.

[63] The reflex of the last two vowels in 'bitter' arose by coalescence. This, however, is orthogonal to the discussion of CL.

(28) (i) the identity of the intervening C_2 in a $C_1V_1C_2V_2$ sequence;
(ii) the identity of the target (lengthening) vowel V_1 in a $C_1V_1C_2V_2$ sequence;
(iii) prosody (in particular, the accent of the strong (lengthening) vowel);
(iv) position of the disyllabic $C_1V_1C_2V_2$ unit in the word (final vs. non-final);
(v) the identity of a trigger (deleting) segment V_2 (front or back jer) in a $C_1V_1C_2V_2$ sequence.

Since the conditions on Slavic CL are so complex and intertwined, they may seem to present problems for the historical phonologization model proposed above. In fact, however, I will argue that they support the hypothesis that CL arises from the phonologization of intrinsic duration. To illustrate these points I will use mostly data taken from Timberlake (1983a) unless otherwise specified.

Slavic is subdivided into three subgroups, West, East and South Slavic. For the purposes of characterizing Slavic CL, Timberlake (1983a,b) distinguishes four dialectal zones which were affected by CL, as shown in (29):

(29) Slavic dialectal zones affected by CL

- West Slavic (WSl)
  1. South-West Slavic (S-WSl): Slovak, Czech, Upper Sorbian
  2. North-West Slavic (N-WSl): Polish, Kashubian-Slovincian
- South Slavic (SSl)
  3. North-Western South Slavic (NW-SSl): northwestern Slovenian, Serbo-Croatian (Štokavian and Čakavian dialects only)
- East Slavic (ESl)
  4. South-Western East Slavic (SW-ESl): southwestern Ukrainian, southern Belorussian

The conditions on CL in Slavic are summarized in Table 1. Since the conditions intricately interact, some languages will be repeated more than once in the table, to demonstrate the interaction.

Table 1 is to be interpreted in the following manner. For instance, there are two rows for Czech in Table 1. In both rows, the position of the CVCV unit undergoing CL in the word and the identity of the trigger and the target are the same: CL in Czech does not depend on position in the word, it applies to mid vowels, and it is triggered by the loss of both jers. Note, however, that under a new rising accent (NAct = neo-acute), CL in Czech applies across any intervening consonant, while under old rising and falling accents (Act = acute, Cmflx = circumflex) CL in Czech is more constrained and applies only across sonorants and voiced fricatives. This difference is what requires two entries for Czech in Table 1.

Language	**Intervening C (N,Z,D)**	**Accent (Act, NAct, Cmflx)**	**Position (internal, final)**	**V_1 (i,e,a,o,u)**	**V_2 ([ɪ], [ʊ])**
Southern West Slavic					
Slovak	any	NAct	any	*e,o	ɪ, ʊ
Czech	any	NAct	any	*e,o	ɪ, ʊ
Czech	N,Z	Act,Cmflx	any	*e,o	ɪ, ʊ
Upper Sorbian	any	any	initial syl	*e,o	ɪ, ʊ
Northern West Slavic					
(Old) Polish	any	NAct	any	any	ɪ, ʊ
(Old) Polish	N,Z,D	Act,Cmflx	final	any	ɪ, ʊ
Kashubian	any	NAct	any	any	ɪ, ʊ
Kashubian	N,Z,D	Act,Cmflx	final	any	ɪ, ʊ
Northwestern South Slavic					
Slovenian	any	Act, NAct	internal	*e,o	ɪ, ʊ
Slovenian	any	Cmflx	any	*e,o	ɪ, ʊ
Štokavian (except Posavian)	y	Act, NAct	final	*e,o	ɪ, ʊ
Štokavian (except Posavian)	N	Act, NAct	internal	*e,o	ɪ, ʊ
Štokavian (except Posavian)	any	Cmflx	any	*e,o	ɪ, ʊ
Posavian	N	Act, NAct	any	*e,o	ɪ, ʊ

Language	Intervening C (N,Z,D)	Accent (Act, NAct, Cmflx)	Position (internal, final)	V_1 (i,e,a,o,u)	V_2 (back/ front jer)
Posavian	any	Cmflx	any	*e,o	ɪ, ʊ
North Čakavian	N	Act, NAct	any	*e,o	ɪ, ʊ
North Čakavian	any	Cmflx	any	*e,o	ɪ, ʊ
South Čakavian	N,Z,D	Act, NAct	any	*e,o	ɪ, ʊ
South Čakavian	any	Cmflx	any	*e,o	ɪ, ʊ
Southwestern East Slavic					
Ukrainian	any	any	any	*o	ɪ, ʊ
Ukrainian	any	NAct	any	*e	ʊ
Ukrainian	any	any	any	*e	ɪ
(Southern dialects of) Belorussian	any	any	any	*o	ɪ, ʊ
(Southern dialects of) Belorussian	any	NAct	any	*e	ʊ
(Southern dialects of) Belorussian	any	any	any	*e	ɪ

N = any sonorant
Z = any voiced fricative
D = any voiced stop

Table 1. Conditions on Slavic CL

I claim that the conditions on Slavic CL are not random, but comprise a system with hierarchical organization, and that their interaction is predicted by the phonologization model. Since according to the model, CL is the phonologization of inherent duration of vowels with the loss of conditioning environment, the cut-off point for each dialect is different but is still in compliance with the durational effects induced by each condition separately and the sum of their interactions. To develop this argument, we will analyze the details of conditions on Slavic CL in the rest of Section 4.4.

4.4.2. Segmental conditions

I will start with segmental conditioning on CVCV CL in Slavic. In this section, we want to understand the effects of three conditioning factors on Slavic CL: the nature of the intervening consonant, the identity of the target, and the identity of the trigger of CL. Section 4.4.2.1 will concentrate on the issues connected with the nature of the intervening consonant. In section 4.4.2.2 we will address the question of why it is mostly mid vowels which undergo lengthening in Slavic.[64] Section 4.4.2.3 will address an issue of reinterpreting newly-closed syllables as long in Slavic which did not have closed syllables at the time of jer-loss, and section 4.4.2.4 will conclude the study of segmental conditioning of Slavic CL.

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[64] In Ukrainian and southern dialects of Belorussian, CL appears to occur more regularly before a front jer than before a back jer, and **o* lengthens more regularly than **e*. **o* in these dialects lengthens unconditionally (before any consonant, before either jer, both finally and internally, and under the falling and new rising accents). **e* is lengthened before a front jer regardless of accent (5'a), but before a back jer, **e* generally does not lengthen under the the falling (5'b), but CL is regular under the new rising accent (5'c).

(5')					
	a.	*pěčɪ	>	pič	'stove'
		*kā̆menɪ	>	kámin^{j}	'stone'
		*vesèlɪje	>	vesillja	'joy'
	b.	*mē̆dʊ	>	med	'honey'
		*klē̆nʊ	>	klen	'maple-tree'
	c.	*selʊ̀	>	sil	'village' gen.pl.
		*lebedʊ̀ka	>	lebídka	'swan' fem.
		*neslʊ̀	>	nis	'he carried'

The problem of the outcome of CL in these dialects is far from resolved. Many researchers interpret the **o,e > i* change as a consequence of CL (Timberlake 1983a,b; Langston 1998, but see Shevelov 1985, and Garde 1974 for an opposite view). Timberlake (1983a) argues that the asymmetry in CL due to the nature of jers is the result of the chronology of the sound change in question. Thus, the nature of the trigger of CL will not be our concern in this study.

4.4.2.1. Intervening consonants

Data

The first condition to be discussed is the effect of the identity of the intervening consonant on CL in Slavic. In many dialects, CL takes place only if the intervening consonant (C_2) in a C_1VC_2V sequence is above a certain threshold in the hierarchy shown in (30). Different Slavic dialects set this threshold at different points in that hierarchy (Timberlake 1983a,b, 1993).

(30) Hierarchy of the intervening segments in CL in Slavic

[j]	sonorants	voiced fricatives	voiced stops	voiceless fricatives and voiceless stops
Štokavian				
	Posavian North Čakavian			
		Czech		
			Polish South Čakavian	
				Ukrainian Upper Sorbian

The following examples illustrate the hierarchy stated in (30). Posavian and North Čakavian dialects of Serbo-Croatian permit CL only when the consonant intervening between the deleting vowel and the target is a sonorant, as in (31a), and does not permit it otherwise (31b).

(31) North Čakavian: CL only before sonorants

a. *daru	>	dar	'gift'
b. *pragu	>	prag	'threshold'
*maku	>	mak	'poppy'

In Czech CL occurs when the intervening consonant is either a sonorant or a voiced fricative, as in (32a). No vowel lengthening happens if the intervening consonant is a stop, either voiced or voiceless (32b).

(32) Czech: CL before sonorants and voiced fricatives

a.	*domu	>	du:m	'house'
	*bogu > *boɣu >	*boɦu >	bu:χ	'god'
b.	*rodu	>	rod	'kin'
	*nosu	>	nos	'nose'

Polish allows CL across sonorants, voiced fricatives, and voiced stops, as shown in (33a), but does not allow it before voiceless consonants (33b).

(33) Polish: CL before sonorants, voiced fricatives and voiced stops

a. *domu >	do:m	'house' (Old Polish)
*dõbu >	da:b	'oak'
*vozu >	wo:z	'cart'
b. *soku >	sok	'juice'

More permissive still are Ukrainian and Upper Sorbian (shown above), in which CL takes place regardless of the identity of the intervening consonant.

The table in (30) certainly resembles the sonority hierarchy, and it would match the standard sonority hierarchy were the sonorancy of the intervening consonants the only factor affecting the outcome of CL. It has been debated, however, if voicing is relevant for sonority (see Cho 1991 and Zec 1988, 1995 against the relevance of voicing for sonority), and thus, as it requires reference to voicing, the hierarchy in (30) diverges from the standard sonority hierarchy.

Phonologization and the nature of intervening consonants

Complicated though the situation might appear, the phonologization model can account for the nature of the intervening consonants in Slavic CVCV CL. Recall that to account for CL in Friulian, we relied on a typological observation that vowels tend in many languages to be longer before voiced consonants than before voiceless (Hualde 1990 on CL in Friulian, Kluender, Diehl & Wright 1988, among others). We can extend this idea to the more fine-grained situation in Slavic.

Noticing the implicational relationship between consonant sonority[65] and participation in CL processes in Slavic, we claim that vowel durations might be greater not only before voiced obstruents than before voiceless, but that this generalization might represent only the bottom end of a hierarchy of vowel duration differences along a larger scale (cf. Ščerba 1912). Were it the case that vowel duration, at least in LCS (and potentially more generally), was longer before consonants toward the left edge of the scale in (30), and shorter before consonants toward the right edge, then the picture we sketch of Slavic CL becomes markedly clearer.

To wit, Proto-Slavic had disyllables of the form CV_1CV_2, in which V_1 was phonetically the longest before sonorants, but also longer before voiced fricatives than before voiced stops, and the shortest before voiceless stops. With the loss of the second vowel, the language acquired a set of newly-closed syllables. The inherited phonetic duration of the vowel in these yielded in some cases closed syllables with vowels uncharacteristically long for their phonetic environment. This length, previously phonetically conditioned, was now reinterpreted as phonological, producing, in effect CL. Below a certain point in the hierarchy discussed above, however, the aberrant duration was perceptually insignificant and was not phonologized. Different Slavic dialects set this

[65] Taking *sonority* in a loose sense as a way of referring to the tendency for certain groups of consonants to behave as classes along a generally accepted sonority scale (*i.e.* as in Blevins 1995: 211), and not to any specific phonetic features of those classes.

cut-off point for lengthening in different places, resulting in CL before some consonants, and none before others.

An Experiment[66]

To demonstrate that the state of affairs described for Late Common Slavic (LCS) is plausible, it would be desirable to locate a similar set of phonetic facts as yet unphonologized in a living language. To this end, I conducted and experiment with the vowels of Contemporary Standard Russian (CSR), in which I examined vowel durations in closed and open syllables before a variety of consonants. Russian was chosen for the experiment since it is a Slavic language which has no vowel length contrast synchronically and did not undergo CL diachronically. The hypothesis was that phonetic realization of vowel length in Russian is close enough to vowel length in dialects of Slavic which underwent CL, so we could attempt to locate possible "seeds" of the CL sound change in this language.

Methodology

Subjects were three native speakers of CSR. They were asked to read a list of 78 real Russian words of at least two syllables each. Each word was repeated three times, of which repetitions only the first two were analyzed.[67] Analog recordings were made in a sound booth, and the recordings were digitized and spectrograms and waveforms were produced using CSL. Standard measuring techniques were used to determine vowel durations.

The data set was constructed in the following way. All tokens were real disyllabic words with initial stress. Only durations of the first (stressed) vowels /o/ and /a/ in open

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[66] This experiment was done in collaboration with Jonathan Barnes (see Barnes and Kavitskaya 2000 for an earlier version of this work).

[67] Features of list intonation gave the third repetition of each word both lower amplitude and pitch, and shorter duration, making it less amenable to analysis.

and closed syllables were analyzed. Intervening consonants were voiceless stops, voiceless fricatives, voiced stops, voiced fricatives, nasals and liquids. (36) shows some examples of tokens taken from the experiment. For example, to compare the duration of stressed /a/ in open and closed syllables, the words *papa* 'dad', and *papka* 'folder' were used.

(34)

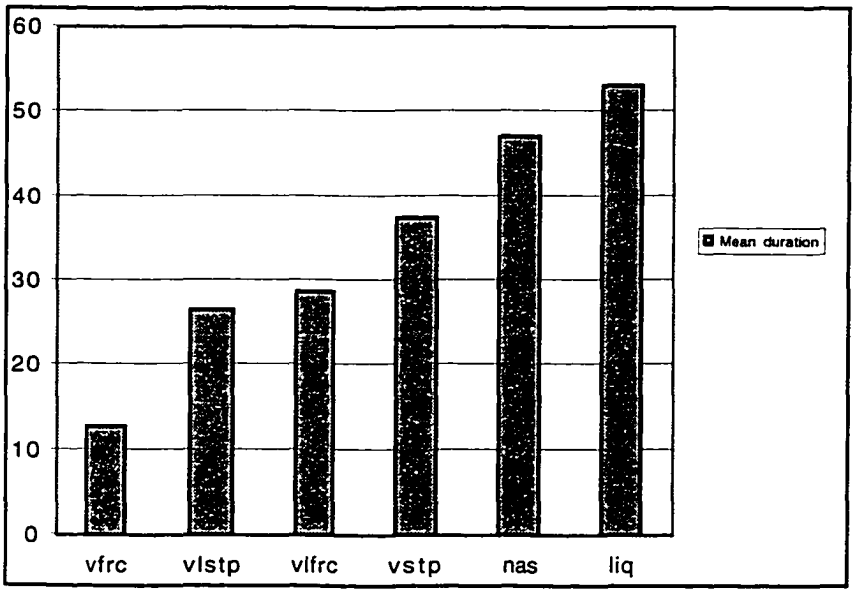
CVCV		**CVCCV**	
papa	'father'	papka	'folder'
vata	'cotton wool'	vatka	'small wad of cotton wool'
proba	'test'	lobzik	'fretsaw'
noʃa	'load'	noʃka	'little foot'
saʒa	'soot'	ʒaʒda	'thirst'
mama	'mother'	mamka	'mother' (coll.)
ʃkola	'school'	xolka	'withers' (equestr.)

Results

To interpret the results we obtained, we subjected the mean differences in vowel duration between open and closed syllables to pairwise comparisons for each following consonant. This preliminary statistical analysis using ANOVA tests suggested that further analysis of the data with consonants grouped together into the classes discussed above would be statistically significant. Variation between speakers was seen to be insignificant. Note that the crucial measurement for our purposes must be not the durations of the vowels themselves in various preconsonantal environments, but precisely the *differences* between those durations in closed and open syllables. Vowel durations might well be longer before sonorants than before obstruents, but if they were equally longer in both closed and open syllables, there would be no basis for a reinterpretation to take place upon loss of the vowel in the second syllable.

The graph in (35) shows that in comparison of vowel duration differences in open and closed syllables, consonant class is indeed significant. Mean differences in vowel durations between open and closed syllables are greatest for liquids, followed by nasals, voiced stops, voiceless stops, voiceless fricatives, and finally if somewhat mysteriously, voiced fricatives. If for the moment we discount these latter, this corresponds to the hierarchy of consonant interaction found in Slavic CL.

(35) Mean differences between open (O) and closed (C) syllables for both vowels



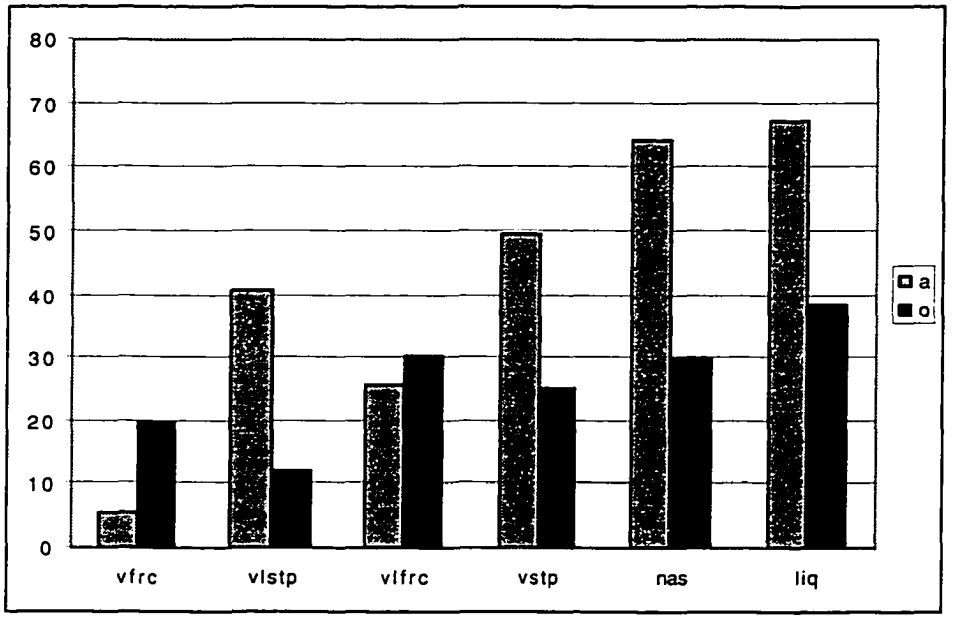
liq = liquids
vfrc = voiced fricatives
vstp = voiced stops
nas = nasals
vlfrc = voiceless fricatives
vlstp = voiceless stops

The results pertaining to the voiced fricatives are unexpected. For these the differences between open and closed syllables were either very small, or even negative for at least one speaker. A possible explanation for this lies in the peculiarities of Russian syllabification patterns. Specifically, because Russian has both voicing assimilation in consonant clusters and word-final devoicing, it is difficult to find uncontroversial

examples of voiced fricatives as codas. It is entirely possible, indeed perhaps even likely, that the voiced fricatives in our "closed syllable" examples are in fact syllabified as onsets (*no-zdri* 'nostrils', rather than *noz-dri).* If this is true, then all the relevant vowel durations were taken from open syllables, and the lack of any appreciable difference in durations is explained.

The graph in (36) shows the mean differences in vowel durations in open and closed syllables with the effects of both consonant class and vowel height. While a larger sample might have helped to eliminate a certain amount of statistical noise, one can nevertheless see the same pattern emerging in CSR as there was in LCS.

(36) Mean differences with effects of class and vowel displayed



liq = liquids
nas = nasals
vfrc = voiced fricatives
vlfrc = voiceless fricatives
vstp = voiced stops
vlstp = voiceless stops

4.4.2.2. The identity of the lengthened vowel

In addition to the identity of the intervening consonant, the second factor which plays a role in Slavic CL is the identity of the target vowel (V_1) in a CV_1CV_2 sequence. In general, only mid vowels (**e* and **o*) lengthen under CL in Slavic. Note that exceptions to this generalization do exist, though they are rare. For example, North West Slavic dialects, such as Old Polish and Kashubian have distinct qualitative reflexes of high vowels, which reflect the application of CL (Timberlake 1983a: 215). In (37), there are some examples from Kashubian to illustrate that CL indeed applied to high vowels.

(37) Kashubian

Gen.sg.	**Nom.sg.**	
gřəba	gři:b	'mushroom'
səna	si:n	'son'
ləda	lu:d	'people'

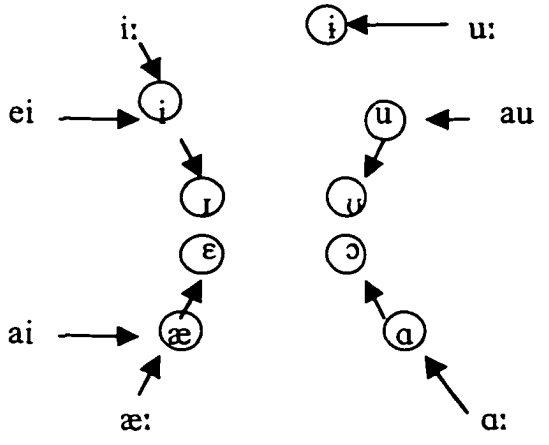
The long vowels in the Kashubian nominative singular forms are the original high vowels. The length in the nominative singular is the outcome of CL, while the vowel of the genitive singular ending was not a jer and thus it is preserved with no lengthening of the preceding vowel. Short high vowels underwent a later lowering to a schwa.

I propose that the reason why mid vowels should often undergo CL more often than either high or low vowels is to be found in the synchronic facts of the LCS vowel system. In LCS, all high and low vowels are reflexes of earlier distinctively long vowels. All non-peripheral vowels are reflexes of originally short vowels. (38) shows the vowel systems of Common Slavic (CS) and LCS, and (39) illustrates the changes from the former systems to the latter.

(38) **Common Slavic** > **Late Common Slavic**

ei			au				
ɪ:	ĭ		ŭ	u:			
					i	i̯	u
					ɪ		ʊ
					ɛ		ɔ
	æ:	æ̆		ɑ̆ ɑ:		æ	ɑ
	ai						

(39) Changes in vowel system from CS to LCS

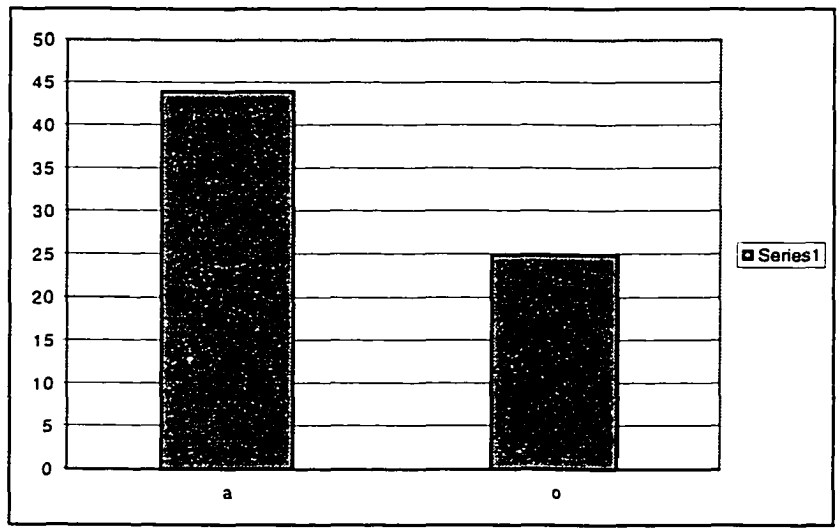


Note that the schema in (39) is not recursive; the vowels from which the arrows start belong to the former system of CS, and the vowels where the arrows end (these vowels are also circled) represent the new vowel system of LCS.

If at the time of the change peripheral vowels still retained their inherited duration, then they might have been substantially longer at this point than non-peripheral vowels. Thus, even if the difference between the durations of peripheral vowels in open and closed syllables was greater than that difference for non-peripheral vowels, this difference would nonetheless be a smaller proportion of the total duration of those vowels. Simply put, 20 ms is a much less significant chunk of a 200 ms vowel than it is of a 100 ms vowel. It is therefore less likely to be noticed and reinterpreted.

Of course, the facts of the synchronic vowel system of LCS are irrelevant in the case of Russian. Indeed, when the mean differences between the durations of mid vowels before all consonants in closed and open syllables were compared to the mean differences for other vowels in Russian, the results were significantly different from what would be expected in LCS. The graph in (40) illustrates these results.

(40) Mean differences between closed and open syllables for all consonants



(40) shows that in Russian the differences in duration between open and closed syllables for /a/ are much more dramatic than for /o/. This could be due to the fact that low vowels are usually longer than non-low ones.

4.4.2.3. Jers and closed syllables

The fact that at the time of the restructuring of its vowel system, LCS did not possess any closed syllables raises an interesting question which may become a potential objection to the analysis just presented. I have just argued that in dialects with CL, vowels in the newly closed syllables were reinterpreted as long since their duration was excessive for a closed syllables. However, if the dialects in question had no inherited closed syllables,

how would speakers determine that the mid-vowels in their newly-closed syllables were "too long"?

The answer might be connected with the outcome of the CL of jers. In the previous sections, we have seen many examples of lengthening of vowels in syllables which preceded lost jers. This scenario is somewhat more complex, however, since when the vowel in the syllable before a deleting jer is also a jer, it does not delete but rather merges with a short vowel. The identity of this vowel varies from dialect to dialect.

In (41), we schematically illustrate the differences between the loss of jers with lengthening of preceding full vowels vs. the loss of jers with 'vocalization' of preceding jers, that is, the merger of jers with the inherited mid vowels.

(41) CL and jer vocalization[68]

Time 1:	CoTъ	CoDъ	CoRъ
	CъTъ	CъDъ	CъRъ
Time 2:	$Co^{Long}T$	$Co^{Long+1}D$	$Co^{Long+2}R$
	$Co^{Short}T$	$Co^{Short}D$	$Co^{Short}R$

Thus, at the time of CL, there were two types of newly-closed syllables in Slavic: those with inherited mid vowels, and those with new mid vowels which are the reflexes of strong jers.

It is generally excepted that jers were ultra-short high vowels. It has been also shown that high vowels may not show the same consonant-dependent durational asymmetries as mid and low vowels (see, for example, Lehiste (1970: 36) on variability of duration for distinctively long and short vowels). If this is true, then the vowel in $Co^{Long}T$ is slightly longer than *all* instances of /o/ < ъ in closed syllables. In $Co^{Long+1}D$ the difference is even greater, and in $Co^{Long+2}R$ the difference is greatest of all. We would

[68] Superscripts refer to schematic *phonetic* durations only. T is a voiceless obstruent, D is a voiced obstruent, and R is a sonorant.

argue, thus, that the existence of these new, uniformly shorter mid vowels in closed syllables provides the point of reference for the reanalysis of certain inherited mid vowels in closed syllables as long.

4.4.2.4. Local conclusion

In Section 4.4.2, I examined segmental facts of CL phenomena from the history of Slavic (which was a similar but a more complex case than CL in Friulian discussed in 4.3). I showed that the phonologization model is capable of accounting for the segmental factors of the Slavic CL. The plausibility of this explanation is supported by a phonetic study of vowel duration conducted for Russian. We now move on to examining prosodic conditions on CL in Slavic dialects.

4.4.3. Prosodic conditions

Two more factors which determine the outcome of CL in Slavic dialects are accent type, as well as the position of the disyllabic unit undergoing CL in the word. Since these conditions turn out to be crucially connected, both of them will be discussed in the following section.

Accentuation plays a role in the majority of CL cases in Slavic. Timberlake (1983b: 306) states that accent divides Slavic CL into two large areas: Northwestern South Slavic (Slovenian and dialects of Serbo-Croatian) on the one hand and Southwestern East Slavic (Ukrainian and Belorussian dialects) and West Slavic (Slovak, Czech, Upper Sorbian, Polish, and Kashubian) on the other. In Northwestern South Slavic, CL applies in more environments and is sensitive to fewer additional conditioning factors under the circumflex (falling accent) than under the acute or neo-acute (rising accents), while in both Southwestern East Slavic and all of West Slavic, CL is subject to fewer conditioning factors under the neo-acute (the new rising accent resulting from

accent shift) than under either the circumflex or the acute (old accents). Interestingly, the accentuation condition on CL is connected with the position of the disyllabic unit of CL in a word. In many cases, the position in a word (final or internal) is irrelevant, but when it becomes relevant, favoring the final position coincides with CL more consistently under the new rising accent than under the old falling and rising accents, and on the opposite, CL under the old accents seems to happen more regularly in a word-medial position.

Since the effect of prosody on the outcome of CL is not uniform (see discussion in Timberlake 1983b: 304-305), and in certain dialects prosodic conditions under which CL has fewer restrictions are the opposite to those in other dialects, these data present a problem for a phonetic diachronic analysis. In section 4.4.3.2, I will argue that vowels under the falling accent were phonetically longer than vowels under the rising accent which predicts that CL should apply with less restrictions in the falling accent environments. I will proceed to show in section 4.4.3.3 that where the opposite situation is true (CL applies in the superset of the possible environments under the rising accent), the account crucially depends on chronology of the sound changes in question and does not constitute a counterexample to the predictions of the phonologization model.

4.4.3.1. Slavic accentuation

Prosody is probably the most intricate condition which affected the outcome of CL in Slavic dialects. In 1926 N.S. Trubetzkoy wrote to Roman Jakobson that "in general Slavic accentology is a completely hopeless enterprise" (Jakobson 1975). At times Slavic CL seems to be one of the best illustrations of this rather desperate statement, but much work has been done since the time the letter was written to clarify at least some issues pertaining to the connection of CL and accentuation in Slavic (cf. Jakobson 1929/1971,

1931/1971, 1963, Stang 1957, Kurylowicz 1958, Garde 1976, Dybo 1981, Timberlake 1983a,b, Stankiewicz 1993, Bethin 1998, among others).

An excursus into the facts of the original Slavic accentuation might be useful before we consider various types of accent, their phonetic and phonological meaning, and their relevance to CL. As was previously discussed, before the dawn of Late Common Slavic[69], the Common Slavic vowel system was one based on quantity. Common Slavic had the phonemes /i, æ, ɑ, u/.[70] In addition to this distinctive length, Common Slavic prosody was characterized by a pitch-accent system, traditionally described as consisting of four distinct accents (see, for example, Carlton 1990 for details):

(42) Accents of Common Slavic

Name	Symbol	Distribution
Circumflex (long falling)	^	Restricted to initial syllables[71]
Short falling	˜	Initial syllables only. Often conflated with short rising as one accent, because of complementary distribution.
Acute (long rising)	´	Unrestricted
Short rising	ˋ	Non-initial syllables only.

Old rising and falling accent: a reanalysis

For the purposes of the present study it is more convenient to think about accents in Slavic as of different configurations of High tone. There is no complete agreement in the literature on the analysis of pitch-accent in Slavic, but here I choose to adopt the

[69] Generally said to have existed some time around the ninth century AD, in the period just prior to the disintegration of the Slavic family into its respective branches. Some of this disintegration, however, even at this time, was already underway dialectally.

[70] Diphthongs, liquid diphthongs, and nasalized vowels will not concern us here.

[71] See Timberlake 1993 for discussion of indirect evidence for non-initial circumflexes in certain oxytone verbal paradigms.

approach widespread in recent work which assumes that pitch-accent in Slavic can be interpreted as combination of tone and quantity and suggests that pitch contour in fundamental to accent (Shevelov 1965, Timberlake 1993).[72] In terms of tone, Kurylowicz (1931) and later researchers (e.g. Trubetzkoy 1939/1967, Kiparsky 1973) derive pitch accent from the location of High tone, or "culminative prominence" within a sequence of phonological units or moras.

One of the most recent analyses of Slavic accent in terms of High tone is that of Bethin (1998). According to Bethin, a short rising accent can be represented as a High tone on a single mora (43a), and a short falling accent – as an absence of tone (43c). Long accents can be distinguished by the location of the High on the second mora (43b) for the long rising accent or on the first mora of a bimoraic sequence (43d).

(43) Bethin's system of Slavic accentuation

Acute	a. short rising	b. long rising
	H | μ	H | μ μ
Circumflex	c. short falling	d. long falling
	μ	H | μ μ

Notice that within Bethin's system, a vowel with a short falling accent is indistinguishable from an unaccented short vowel, which is descriptively unsatisfactory. Additionally, Bethin's analysis of Slavic accentuation treats the fact that falling accents occur (with a few potential exceptions) only on initial syllables as completely accidental.

[72] Bethin (1998: 114) defines pitch accent as a combination of tone, quantity, and stress, and Feldstein (1990) refers to it as "stress" and as "ictus", but since stress is usually defined in terms of tone and quantity, I will not treat it as defining pitch accent.

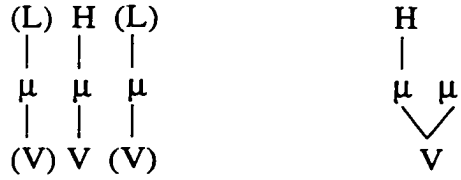
To address these problems, as well as to provide an account of vowel reduction in Slavic, we propose a different system of accentuation in Slavic (cf. Barnes & Kavitskaya 1998).

We hypothesize that rising accents in Common Slavic were realized over two moras, just as it is motivated for the case of modern Slavic dialects with pitch accent, such as dialects of Serbo-Croatian (Inkelas & Zec 1988). According to our model, a short rising accent is centered by definition over a monomoraic vowel. The second mora of high tone necessary to a rising accent is thus realized on the preceding syllable. So, at least with the short rising accent, and probably also with the long rising accent (Timberlake 1993), the pre-tonic syllable participated in the pitch contour of the accent, containing the upward slope to the peak held over the duration of the tonic syllable. Whereas this may have been incidental to the long-rising acute, the fact that the short rising accent never occurs initially (i.e., without a pre-tonic) implies that the pre-tonic syllable was necessary for the realization of this accentual contour. The revised system of accent in Slavic is shown in (44).

(44) Slavic accentuation (Kavitskaya & Barnes 1998)

Acute a. short rising b. long rising

Circumflex c. short falling d. long falling



Data from contemporary Slavic languages provides evidence that the analysis just presented is indeed correct. In order to show this, we need an excursus in a morphological distribution of Slavic accent. Accent in Slavic is manifested in three types of accentual paradigms, known in the literature as *Type-a*, *Type-b*, and *Type-c* (see Carlton 1991 and references wherein). *Type-a* represents a fixed rising accent (acute) on the stem. This type of stress or accent in modern Slavic languages is reconstructed to the earlier rising accent (acute). In *Type-b*, the rising accent is fixed in a post-root position, and *Type-c* shows morphologically conditioned alternations between a falling accent on the final syllable and a rising accent on the initial syllable.

To illustrate the accentuation patterns reconstructed for Slavic I will use data from the three accentual paradigms. In the examples below, I will show reconstructions as well as data from contemporary Russian where the place of stress reflects the place of accent in the reconstructed forms, and from Serbo-Croatian (specifically, the Novi dialect of Čakavian (Belić 1910)) which preserves Slavic pitch accent as short falling [˜], long falling [ˆ], and rising [´].[73] I use the symbol [´] to mark stress in the examples from Russian.

The following examples illustrate *Type-a* and *Type-c* accentual paradigms with the examples of nominative and dative case in Russian and Čakavian; *Type-b* will be illustrated in the next section. This data is relevant to the understanding of the phonetics of rising and falling accents in Slavic since liquid diphthongs have a different pattern of behavior in East Slavic (Russian) and South Slavic (Čakavian). While in Čakavian the original Slavic accents remain on the same vowel, in Russian the Slavic liquid diphthong is realized differently depending on the accent (all liquid diphthongs are considered bimoraic here). In the paradigm where the original accent was rising (*Type-a* in (45)), stress in Russian surfaces on the second vowel of the /oro/ sequence, as in **mořzu* >

[73] Čakavian has shortened the stem rising accent, and thus long rising and short rising accents are not lexically contrastive in Novi.

moróz 'frost', **kor̃va > koróva 'cow'*, suggesting that the long rising accent traditionally called "acute" in the Slavic literature was indeed a pitch accent realized on the second mora, rather than on the first.[74]

(45) Fixed rising accent (*Type-a* paradigm) in Slavic[75]

				Russian	**Čakavian**	**Gloss**
Type-a. *cv̋c-						
a. *mor̃zu LHL	masc.	sg.	nom.	moróz	mrȁz	'frost'
			dat.	moróz-u	mrȁz-u	
		pl.	nom.	moróz-i	mrȁz-i	
			dat.	moróz-am	mrȁz-ōn	
b. *kor̃va LHL	fem.	sg.	nom.	koróv-a	krȁv-a	'cow'
			dat.	koróv-e	krȁv-i	
		pl.	nom.	koróv-i	krȁv-e	
			dat.	koróv-am	krȁv-ān	

In the paradigm with the original falling accent (*Type-c* in (46)) the opposite situation in attested in Russian. Stress, which is a correlate of the Slavic accent, surfaces on the first vowel of /oro/, as in **gôrdu > górod* 'city'. This suggests that the long falling (circumflex) accent was realized phonetically on the second mora, rather than on the first.

[74] Note that in reconstructed liquid diphthongs in the *Type-a* paradigm, accent falls on the second part of the diphthong.

[75] In all following examples in the sections on accentuation I will use both traditional accentuation marks and High and Low (HL) notation to refer to accent.

(46) Mobile falling accent (Type-c paradigm) in Slavic

				Russian	**Čakavian**	**Gloss**
Type-c. CV̂C-V ~ CVC-V̀						
a. *gôrdŭ HLL	masc.	sg.	nom.	górod	grâd	'city'
			dat.	górod-u	grâd-u	
		pl.	nom.	gorod-á	grâd-i	
			dat.	gorod-ám	grâd-on	
b. *golvà HLL	fem.	sg.	nom.	golov-á	glāv-à	'head'
			dat.	golov-é	glāv-ì	
		pl.	nom.	gólov-ɨ	glâv-e	
			dat.	golov-ám	glāv-án	

New rising accent

In addition to the falling and rising pitch contours just discussed, Timberlake (1983a) recognizes "neo-acute", the new rising accent[76], as a distinct accent at the time of CL. The neo-acute (49) arose by accent retraction from the lost vowel to the vowel in the previous syllable (Stang 1957, Jakobson 1963). Notice that the notational convention is the same for short acute and neo-acute.

(47) Notational convention for neo-acute

	neo-acute (NAct)
short	ˋ
long	ˊ

[76] Rather a phenomenon of accentual shift than a real accent (Alan Timberlake, *p.c.*).

We will now look at the genitive plural suffixes reconstructed as *-v̀, which provide evidence for the neo-acute accent retraction. Shifting stress in the boxed examples of genitive plural nouns illustrates the new rising accent in Slavic.

(48) New rising accent in Slavic: Type-b paradigm

				Russian	**Čakavian**	**Gloss**
Type-b. *CVC-v̀						
	fem.	sg.	nom.	borozd-á	brāzdȁ	'furrow'
			gen.	borozd-í	brāzdé	
		pl.	nom.	bórozd-i	brāzdȅ	
*borzdù LHH			gen.	borózd	brázd	

(49) New rising accent in Slavic: Type-c paradigm

				Russian	**Čakavian**	**Gloss**
Type-c. CV̂C-V ~ CVC-v̀						
	fem.	sg.	nom.	golov-á	glāv-ȁ	'head'
			gen.	golov-í	glāv-é	
		pl.	nom.	gólov-i	glâv-e	
*golvù LHH			gen.	golóv	gláv	

The data in (48) and (49) show that in East Slavic (Russian) the new rising accent has merged with the old rising accent, as can be clearly seen from the comparison of **golvù* > *golóv* 'head' (gen.pl.) with **mořzu* > *moróz* 'frost' (nom.sg.) we have seen earlier. In Čakavian, however, there was no merger, which is evident from the fact that the accentuation differs in Čakavian forms which are reflexes of words with the new rising

[77] This form represents a later stress shift; originally, borozdí.

accent which remained rising, as in **golvȕ* > *gláv* 'head' (gen.pl.), and the old rising accent which became the short falling, as in **moř̋zu* > *mràz* 'frost' (nom.sg.).

4.4.3.2. Compensatory lengthening under the falling accent

With the facts of Section 4.4.3.1 in mind, we can now turn to the analysis of the accentuation as a factor in CL in Slavic. First, we will look at the instances of CL where the segmental environments for CL under the falling accent are superset of the environments in which CL occurs under the rising accent. This is the case in a few North-Western South Slavic dialects.

Data

In Slovenian vowels under the short falling accent are lengthened (50a), but final vowels under the rising accents (acute and neo-acute) (50b) are not (Timberlake 1983b: 296).

(50)	**LCS**		**Slovenian**	
a.	*bȍgu HL	>	bo:g	'god'
	*kȍstu HL	>	ko:st	'bone'
b.	*konjɪ HH	>	kònj	'horse'

In Serbo-Croatian, CL happens under all accents, but it is more restricted under the rising accents, where it is sensitive both to the nature of the intervening consonant and occasionally to the position of the disyllabic CL unit in a word (Timberlake 1983a: 222). For example, in Štokavian dialects (except Posavian) under the rising accents CL in final position occurs only before a palatal glide *j* (51a) and not before other sonorants (51b). However, internally CL occurs before all sonorants, as in (52).

(51) Štokavian CL word-finally

	Northwestern South Slavic[78]		**Štokavian**	
a.	*krȁjɪ HL	>	krâ:j	'place'
	*rȁjɪ HL	>	râ:j	'heaven'
b.	*konjɪ HH	>	kȍnj	'horse'
	*dȉmu HL	>	dȉm	'smoke'

(52) Štokavian CL word-internally

*stȁrɪtsa HLL	>	stâ:rtsa	'old man'
*pȁlɪtsa HLL	>	pâ:ltsa	'finger'

Analysis

Recall that both long and short falling accents are restricted to the initial syllable of words lacking a rising accent (Jakobson 1963; for a few potential exceptions see Timberlake 1993), so if CL has less restrictions under the falling accent, it will necessarily have less restrictions in non-final position in a word. Indeed, in South Slavic CL is sensitive to fewer additional conditions in word-internal rather than in word-final position. The question remains, however, why the falling accents would ever be more prone to be interpreted as additional length than the rising ones.

The development of the rising accents in North-Western South Slavic can shed light on the outcome of CL under different accents in the dialects of this zone. According to Ivić (1958), in North-Western South Slavic the long rising accent (the original acute)

[78] This reconstruction represents the stage after the shortening of the new rising accent in Northwestern South Slavic: krã:jɪ (HHL) > krȁjɪ (HL).

had been shortened, and the new rising accent (the neo-acute) merged with the shortened original rising accent. Timberlake (1983b: 308) describes this situation as follows:

> "In NW-SSl, the original Act on tense vowels had been allophonically shortened. The NAct could develop either onto lax vowels (redundantly short) or onto tense vowels (maintained as long pretonically). When the NAct developed, the NAct on lax vowels was evidently identified with the shortened Act, to judge by the fact that they have the same behavior under CL. That is, the development of the NAct created an opposition of phonemic quantity for the merged Act/NAct accent: length from the NAct onto a tense vowel, brevity from NAct onto a lax vowel or shortened Act on tense vowel. Quantity was also phonemicized for the Cmflx: length from the Cmflx on a tense vowel (allophonically maintained as long), brevity from the Cmflx on a lax vowel."

In other words, the development of accent in North-Western South Slavic can be described as follows. A series of mergers created a situation when lax vowels *e* and *o*, that is, the vowels which were the only undergoers of CL in most dialects of Slavic including North-Western South Slavic, could be only short under the rising accent. If the shortening of rising accents happened before the shortening of the falling accents in these dialects, as suggested in Timberlake (1983b: 311), it can be argued that at some point in the history of Slavic (which coincided with the fall of jers), only vowels under the falling accent could be long in North-Western South Slavic dialects. It is entirely plausible that North-Western South Slavic maintained the allophonic length of the falling accent longer than the length of the rising accent. Thus, I propose that vowels under the falling accent were phonetically longer than vowels under the rising accent, which was an additional factor in the phonologization of vowel duration as length.

This explanation is admittedly circular, since the story of the development of the accent in North-Western South Slavic dialects is largely based on the facts of CL in the same dialects. However, for the lack of a better option, we will keep this account as a working model.

4.4.3.3. Compensatory lengthening under the new rising accent

The situation in Southern West Slavic is the opposite of that of North-Western South Slavic just discussed. Although it has been claimed that the new rising accent "favored" CL (Timberlake 1983 and references wherein), I will argue that the neo-acute retraction in West Slavic resulted in vowel lengthening with no contextual restrictions.

Data

Slovak has CL of **e, o* "only under the NAct, and then across any consonant and in any word position" (Timberlake 1983b: 295), as shown in (53a), but does not occur under the old falling or rising accents (53b).

(53) Slovak

a.	*ʒenù	HH >	ʒe:n	'wife' gen.pl.
	*vedlù	HH >	ve:dol	'to lead' past participle
	*noʒìka	HHL >	no:ʒka	'leg' dim.
b.	*mèdu	HL >	med	'honey'
	*màtuka	HLL >	matka	'mother'

In Northern West Slavic (Polish and Kashubian), in addition to regular reflexes of length before sonorants and voiced obstruents (this condition on CL in Southern West Slavic was discussed in Section 4.4.2), there are occasional examples of long vowels before voiceless obstruents in Polish dialects and in Old Polish (Timberlake 1983a: 216).

All these reflexes involve the new rising accentuation rather than the old falling or rising accents (54).

(54) Old Polish or Polish dialects

nom.sg.	**gen.pl.**				
stopa	sto:p	<	stopù	HH	'foot'
kosa	ko:s	<	kosù	HH	'braid'
osa	o:s	<	osù	HH	'wasp'

(54) shows that in Polish CL under the new rising accent developed regardless of the identity of the intervening consonant, but under other accents it applied only before sonorants and voiced obstruents, and not before voiceless obstruents, as was mentioned before.

This allows us to conclude that while CL in West Slavic was sensitive to the nature of the intervening consonants under the old falling and rising accents, the lengthening applied across the board under the new rising accent. The following section presents an account of this generalization.

Analysis

The connection between accentuation and CL in North-Western South Slavic is the opposite of the one described for West Slavic dialects and requires a different explanation. Earlier in this chapter we argued that the phonologization of length in CVCV CL crucially depends on changes in syllable structure. A vowel which originally was in an open syllable is found in a closed syllable upon the loss of the following vowel. The phonetic duration of such a vowel is excessive for a closed syllable, so it can be reinterpreted as phonologically long. Other factors, such as the effect of a following consonant on the duration of the vowel discussed in the previous section, can also play a

role as additional conditions which determine the phonologization of inherent duration. However, since LCS was a pitch-accent system, accents could hardly require any durational cues (e.g., in Modern Serbo-Croatian, which is a pitch-accent language, there are no durational cues for accent).

We have just seen that in Northern West Slavic dialects CL favors the new rising accent, that is, lengthening applies across any consonant if the lengthened vowel has the new-acute accent. Recall that the neo-acute accent arises after the retraction of the original rising acute from lost jers to the preceding vowels, as illustrated in (55).

(55) * H > H
μ μ]$_w$ μ (μ)]$_w$
V V V

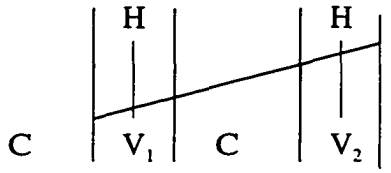
In most dialects, the new rising accent is realized on long vowels only (Carlton 1991: 198), unless it shortens and merges with the old short rising accent, which will be discussed later. There is a disagreement in the literature on where the neo-acute length comes from, but at least some researchers believe that the neo-acute lengthening was a separate process which applied after jers were sufficiently reduced to cause the retraction of accent, but were not yet lost (Carlton 1991 among others).

We have argued in Section 4.4.3.1 that the short rising tone requires the second mora of the High tone to be realized on the preceding vowel, as repeated in (56).

(56) Acute a. short rising b. long rising

Thus, it is quite plausible that the old short rising tone was phonetically manifested as a pitch rise over two vowels. (57) shows this state of affairs before the loss of a final short rising accent.

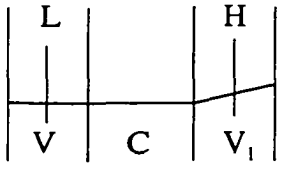
(57) Short rising accent realized over two vowels



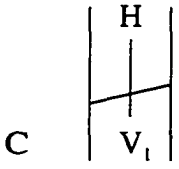
With the reduction of the second vowel, the first vowel could be interpreted as prominent, and a rising slope on the first one could be easily reinterpreted as a new rising tone. Since there was no rising slope on the vowel preceding the newly accented vowel if the original word was long than two syllables (58a) or the newly accented vowel was in the first syllable in a word (58b), the whole entirety of the rising pitch contour was now realized over a monomoraic vowel.

(58) Short rising accent realized over two vowels

a.



b.



However, in LCS, rising accents were required to be realized over two moras, leading to the circumstance in West Slavic languages, such as Slovak, dialects of Polish, and Kashubian, the newly accented vowel was reinterpreted as long.

This analysis treats the neo-acute retraction and CL as unrelated events and provides an explanation of why the lengthening of vowels under the new rising accent happened across the board in West Slavic dialects in question. While CL was sensitive to the nature of the intervening consonant for the reasons explained above, the neo-acute lengthening applied in all cases when the accent on a lost jer was originally rising.

The position of the disyllabic $C_1V_1C_2V_2$ unit in the word is interconnected with the neo-acute lengthening in some dialects of West Slavic, but not in all of them. For example, in Polish CL happens more readily in word-final position $(CVCV]_w$), while Slovak shows evidence for CL regardless of the position in the word. We can note here that the neo-acute retraction condition might coincide with the preference for word-final position only incidentally. As is indicated by the recurrent diachronic loss of final vowels, these is a cross-linguistic tendency for final vowels to be shorter than non-final vowels. Thus, final vowels are more likely to be reduced, lose their prominence, and then disappear completely, thus triggering the neo-acute lengthening and CL more readily.

4.4.5. Concluding remarks for the Slavic case study

To conclude the part of this study which concerns CVCV CL in Slavic, we can state that both our analysis and the experimental results suggest that the phonetic situation we reconstruct for Late Common Slavic is plausible indeed, and provides an explanation for CVCV CL in Slavic. The extent to which the hierarchy we find there represents a cross-linguistic generalization concerning the interaction of syllable structure, segmental and prosodic conditions remains to be seen. While the moraic approach may well be a desirable notational device for the description of synchronic alternations, it not particularly insightful with regard to the origin and typological variation observed for CVCV CL in general, and has nothing at all to say concerning the additional complications found in the Late Common Slavic dialects. The phonologization approach,

on the other hand, accounts for the facts of Slavic using only the facts of phonetic vowel duration and syllable structure and requires no additional formal machinery.

4.5. Directionality and CVCV: apparent counterexamples

It follows from the diachronic model of CVCV CL developed in Chapter 4 that the deletion of a vowel can only result in lengthening of the preceding vowel since only in this case it results in the change of syllable structure. In other words, deletion of V_2 in a CV_1CV_2 sequence is predicted to be able to cause lengthening of V_1, while the opposite situation when deletion of V_1 causes lengthening of V_2 is predicted not to occur. In the following sections, we will discuss to apparent counterexamples to this claim. In Section 4.5.1 we will look at a diachronic development which includes the loss of the first vowel and the lengthening of the second one in a CVCV sequence. In Section 4.5.2 we will consider a case of synchronic alternations exhibiting similar properties; the first vowel in a CVCV sequence deletes and the second one lengthens. I will show that, even though the cases in 4.5.1 and 4.5.2 are reminiscent of CL, they acquire vowel length through non-compensatory processes, minimal size condition and iambic lengthening respectively.

4.5.1. Minimal size condition

Consider Utsat (Austronesian) forms in (59) which look like they could be described as a result of a CL process of the type which is predicted not to occur.

(59) Utsat (Thurgood 1999, Maddieson p.c.)

Proto-Austronesian	**Utsat**	
*lima	ma:	'five'
*matah	ta:	'eye'

From the data in (59), it is conceivable that the deletion of the first vowel in **lima* triggered lengthening of the second vowel, resulting in the Utsat [ma:] 'five', which would constitute a counterexample to the phonologization account presented earlier.

In fact, however, the diachronic development of vowel length in Utsat is due to a completely different phenomena, and the connection between the lost and the lengthened vowels is superficial. It has been shown that initial and final consonants were lost in Chamic, so a development like **lima* > *lma* > *ma:* appears plausible. After the loss of the first vowel, the bimoraic minimal size condition in Utsat is responsible for the lengthening of the second vowel (*ma > ma:) (Maddieson, *p.c.*).[79] It is evident, thus, that Utsat does not present a problem for the phonologization model.

4.5.2. Rhythmic vowel deletion

Another apparent counterexample to the directionality prediction comes from instances of rhythmic vowel deletion. Consider, for instance, examples of rhythmic syncope with vowel lengthening in Macushi Carib:

(60) Macushi Carib (Kager 1997)

/pata/	(pˀtá:)	'place'
/wanamari/	(wnà:).(mrí:)	'mirror'
/u-wanamari-ɨ/	(wà:).(nmà:).(rɾɨ́:)	'my mirror'

The relevance of the example in (60) is that it shows vowel lengthening and vowel reduction/deletion applying in iambic feet. The alternations in (60) can be analyzed as a process whereby the second vowel lengthens in compensation for the loss of the first one: [CV.CV] -> [CCV:].

[79] On minimal size requirements see McCarthy & Prince (1986), Ito (1986), Hayes (1995) and references therein.

However, vowel lengthening in Macushi Carib happens regardless of syncope. The forms in (61) exhibit lengthening of final vowels even though the preceding vowel is stressed and thus is not subject to syncope.

(61) Macushi Carib (Kager 1997)

/piripi/	(prì:).(pí:)	'spindle'
/waimuyamɨ/	(wài).(myà:).(mɨ́:)	'rats'

(61) suggests that vowel length alternations in Macushi Carib cannot be treated as compensatory and are the result of iambic vowel lengthening independent of vowel deletion. This analysis is supported by the data from languages like Choctaw (62) where iambic lengthening applies without vowel deletion.

(62) Choctaw (Nicklas 1975, Buckley 1998)

a.	/habina/	(habi:).na	's/he receives a present'
	/tʃi-habina-li/	(tʃiha:).(bina:).li	'I receive a present from you'
b.	/pisa-li/	(pisa:).li	'I see'
	/tʃi-pisa/	(tʃipi:).sa	's/he sees you'
	/tʃi-pisa-tʃi-li/	(tʃipi:).(satʃi:).li	'I cause you to see'

We conclude that rhythmic syncope and lengthening in Macushi Carib are not compensatory and should be attributed to the properties of iambic systems. Thus, rhythmic vowel deletion does not constitute a counterexample to the phonologization model.

4.6. Conclusions

To summarize, in chapters 3 and 4 we surveyed CL through consonant and vowel loss and showed that the phonologization model outlined in chapter 1 can account for the

sound changes involved in these processes. According to this model, both types of CL arise from phonologization of the inherent duration of vowels. Thus, we can conclude that CL through vowel loss as a historical change of the type *CVCV > CV:C is compensatory only in a very broad sense whereby lengthening of one segment is connected with the loss of the other. CL through vowel loss involves no compensation in the direct sense of this word, such as transfer of phonetic duration or phonological weight. In chapter 5, we will turn to CL alternations present in synchronic grammars.

Chapter 5.
Synchronic compensatory lengthening: an analysis and implications

5.1. CL through consonant and vowel loss: a synchronic asymmetry

This chapter introduces a generalization which has not been previously noticed but emerges when we consider CL through consonant and vowel loss as separate types. I demonstrated in the previous chapters that diachronic processes of CL through consonant and vowel loss are phonetically similar; both types of CL arise through the phonologization of the inherent duration of vowels. In this chapter, I show that CVC and CVCV CL behave asymmetrically in synchronic grammars. CL through consonant loss can be handled by (usually phonetically natural) phonological rule, occasionally with some slight morphological conditioning, and can be modeled as optimization of syllable structure. Unlike CL through consonant loss, CL through vowel loss rarely stays transparent, often must be handled with suppletive allomorphy, and when it is rule-governed, is often governed by a morphologically conditioned or phonetically unnatural rule. As long as its historical trigger is not recoverable synchronically, CL through vowel loss cannot be modeled as a compensatory process; it is usually lexicalized or bound to specific morphological alternations which are non-optimizing.

What does it mean for a process to be phonological, as opposed to morphologized? A purely phonological process depend only on phonological contexts, regardless of the morphological status of the morphemes participating in the alternations. Sometimes the phonological alternations are transparent and exceptionless, sometimes they are opaque, that is, not conditioned by markedness and well-formedness constraints on surface structure. However, they can always be defined purely in terms of phonological environments. By contrast, a morphologized process is not conditioned by purely phonological contexts. They require reference to grammatical structures, and can

only be described in terms of suppletive allomorphy. If suppletive allomorphs need to be defined for roots, we call such phonetic differences between allomorphs *lexically specified.* Keeping in mind the distinctions between the two types of alternations just discussed, we summarize general properties of CVC and CVCV CL in (1).

(1) Typical characteristics of CL-related allomorphy

CL TYPE	TRIGGER	PHONOLOGY/MORPHOLOGY	OPTIMIZATION
CVC	recoverable	phonologically conditioned	optimizing
CVCV	1. recoverable	phonologically conditioned	optimizing
	2. not recoverable	a. lexically specified b. morphologically conditioned	non-optimizing

We will now proceed to discuss the types of CL-induced allomorphy shown in (1), beginning with an example of purely phonologically conditioned, rule-governed allomorphy resulting from CL in Komi Ižma (Uralic). As expected, these alternations are of the CVC type.

In Komi Ižma, stem-final *l* deletes before any C-initial suffix and word-finally. Its loss is accompanied by lengthening of the preceding vowel, a typical case of CVC CL. Representative consonant-initial and vowel-initial suffixes are illustrated in (2) and (3). (2) shows verbal suffixes (the 1st singular past suffix /-i/ and the infinitive suffix /-ni/), and (3) shows nominal suffixes (the elative /-ys/ and the nominative /Ø/).

(2) Komi Ižma (Batalova 1982)

	stem	**V-initial suffix 1st sg. past**	**C-initial suffix infinitive**	
a.	liy-	liy-i	liy-ni	'shoot'
	mun-	mun-i	mun-ni	'go'
b.	kil-	kil-i	ki:-ni	'hear'
	sulal-	sulal-i	sulo:-ni	'stand'

(3)	**stem**	**V-initial suffix elative sg.**	**C-initial suffix nom.sg.**	
a.	gort-	gort-ys	gort-Ø	'house'
b.	vøl-	vøl-ys	vø:-Ø	'horse'
	nyl-	nyl-ys	ny:-Ø	'daughter'

(2a) and (3a) demonstrate that stems which end in consonants other than *l* do not alternate regardless of the type of suffix (if any) that they precede. However, stems ending in l do display alternatiosn. When preceding a V-initial suffix, the *l* surfaces; otherwise, i.e. when followed by no suffix or by a C-initial suffix, the *l* deletes, accompanied by CL, as shown in (2b) and (3b). Clearly *l* is deleting when it would syllabify as a coda.

CL alternations in Komi are phonologically transparent and phonetically natural; they apply in all relevant phonological contexts and are completely productive. There is no need to refer to the specific identity of the suffixes conditioning *l* deletion (and vowel lengthening).

A very different situation occurs in Hungarian (Kálmán 1972, Lotz 1988). Vowel length alternations in Hungarian are not phonologically transparent like the ones just seen in Komi Ižma. They do not apply across the board; rather, they affect only a subclass of stems which cannot be identified by any independent phonological criteria.

In Hungarian, there are three types of noun stems in respect to vowel length. These are illustrated, with nominal stems, in (4). In the first type, vowel length is non-alternating, and vowels are always short (4a). In the second type, vowel length is non-alternating, but vowels are always long (4b). In the third class of nouns, however, we find CVC ~ CV:C alternations conditioned by the following suffix. When a vowel-initial suffix is added to one of these alternating stems, the stem has a short vowel, as shown by the plural forms in (4c). If, however, a consonant-initial suffix is added to such a stem, or if the stem constitutes a prosodic word on its own, the last vowel of the stem is long. This is illustrated by the singular forms in (4c). The generalization is that in alternating stems, vowels are long in closed syllables and short in open syllables.

(4) Hungarian (Kálmán 1972, Lotz 1988)

	plural	**singular**	
a.	ember-ek	ember	'man'
	ørøm-øk	ørøm	'friend'
b.	hu:ʃ-ok	hu:ʃ	'meat'
	ha:z-ak	ha:z	'house'
c.	tyz-ek	ty:z	'fire'
	lud-ok	lu:d	'goose'
	madar-ak	mada:r	'bird'
	tehen-ek	tehe:n	'cow'

Historically, non-alternating stems are very often the result of analogical extension of length in a paradigm. This is claimed to be the case for the stems in (4a-b) (Kálmán 1972). Synchronically, however, the only possible way to distinguish the alternating from the non-alternating stems is to mark the latter as such in the lexicon. CVCV CL alternations in Hungarian are opaque (in the sense of Kiparsky 1973); rather than being purely phonologically conditioned, like the CVC CL alternations in Komi, the

Hungarian alternations require extra-phonological conditioning. The question of how exactly to model the facts in (4c) will be discussed in section 5.4.2.

5.2. Recoverability

The question to address at this point is why CVC and CVCV CL differ in the ways just discussed, the former being in general phonologically productive, exceptionless, and optimizing (as in Komi, seen above, as well as the discussed in chapter 3, e.g. in Turkish, Greek, Lithuanian, etc.), and the latter being mostly morphologized and arbitrary (as in Hungarian and the languages discussed in chapter 4, e.g. in Dinka, Czech, etc.). In the following two sections I compare CVC and CVCV CL and argue that the two types of CL differ along the dimension of trigger recoverability.

5.2.1. CVC CL: trigger is recoverable

One important difference between CVC and CVCV CL that contributes to the split behavior we have seen is that in CL through consonant loss, lost segments are likely to be *recoverable*, while in CL through vowel loss, this is typically not the case. Recoverability of the trigger of CL is a necessary condition for purely phonological conditioning of alternations (whether the alternation itself is transparent or opaque) and contributes significantly to the transparency and productivity of the associated process of vowel lengthening. Consider, for instance, CL through the loss of coda nasals in Latvian (Baltic), a language in which CVC CL is a purely phonological (i.e. non-morphologized) process:

(5) Latvian (Mathiassen 1997)

a.	*m**in**-t > m**i:**-t	'to tread'
b.	**present (1st sg.)**	**infinitive**
	m**in**-u	m**i:**t

In Latvian, *n* was lost historically when preconsonantal or word-final, giving rise to lengthening of the preceding vowel, as illustrated in (5a). This diachronic change has resulted in synchronic alternations in which morpheme-final *n* surfaces only when prevocalic. Therefore, in Latvian the synchronic alternations mirror the diachronic sound change closely, and thus the alternations are transparent as well as phonetically natural (see chapter 3 for the discussion of the phonetic origins of CL through the loss of nasals). The trigger of CL has not been lost to history.

Representative data from Lithuanian and Komi further illustrate the fact that whenever the deleting consonant surfaces in some contexts and is thus recoverable, CVC ~ CV: alternations remain phonologically productive. In Lithuanian, a Baltic language, closely related to Latvian, the *n* is lost with CL word-finally, e.g. in the accusative singular, as in (6a), and before fricatives, e.g., before the infinitive ending /-stɪ/, as in (6b), but retained otherwise. (6c) shows that the final *n* is not lost before affricates (before the 3rd person suffixes).

(6) Lithuanian (Mathiassen 1996)

a.	/a:ki/	[a:kʲi]	'eye' nom.sg.
	/a:**ki-n**/	[a:kʲ**i:**]	'eye' acc.sg.
b.	/spræ**n**-stɪ/	[sʲpʲrʲæ:sʲtʲɪ]	'to decide'
	/**su**n-stɪ/	[sʲ**u:**sʲtʲɪ]	'to send'
c.	/spræ**n**-dʒa/	[sʲpʲrʲ**end**ʒʲa]	'decides'
	/**su**n-tʃɛ/	[sʲ**ʊnt**ʃʲɛ]	'sends'

Recall from section 1 that in Komi Ižma coda *l*'s delete with the lengthening of the preceding vowel. Whenever the *l* is syllabified as an onset, as in elative examples, no deletion and no CL take place, as repeated in (7) and (8).

(7) Komi Ižma (Batalova 1982)

	stem	**V-initial suffix 1st sg. past**	**C-initial suffix infinitive**	
	kɨl-	kɨl-i	kɨ:-nɨ	'hear'
	sulal-	sulal-i	sulo:-nɨ	'stand'

(8)

	stem	**V-initial suffix elative sg.**	**C-initial suffix nom.sg.**	
	vøl-	vøl-ys	vø:-Ø	'horse'
	nyl-	nyl-ys	ny:-Ø	'daughter'

(7) and (8) illustrate that in cases where the trigger of CL is synchronically recoverable, in derived environments CVC CL creates regular alternations. Both in Komi Ižma and in Lithuanian, stem-final *l* and *n* delete whenever an appropriate phonological environments is created by an addition of any suffix (consonant-initial in the case of Komi Ižma, and fricative-initial in the case of Lithuanian).

Note that in non-derived environments, that is, stem-internally, there are no alternations, and thus there is no length contrast before the historically lost consonant in either Lithuanian (9a) or Komi Ižma (9b). The vowel which preceded the historically lost segment is always long.

(9) Neutralization of length in non-derived environments

a. Lithuanian

*ʒansis	>	ʒa:sis	'goose'

b. Komi Ižma

*palgyny	>	pa:gyny	'to throw on'
*tulsol	>	tu:so:	'spring' adj.

Recoverability of the trigger does not guarantee that the alternation is transparent; Huallaga Quechua is a case in which the trigger of CL is recoverable but the alternation has become morphologized to some degree nonetheless. Huallaga Quechua exhibits synchronic alternations resulting from the *CVC > CV: sound change (*q > *χ > Ø). Synchronically, CL occurs whenever coda *q* deletes (10a,b) unless *q* is word-final (10b).

(10) Huallaga Quechua (Weber 1989: 469-470)

a.	/nuqa-**paq**-pis/ me-for-too	[noɣapa**ː**pis]	'for me too'
b.	/ima-**paq**-taq/ what-for-Q	[imapa**ː**ta]	'what for?'

Despite this apparent transparency, CL in Huallaga Quechua cannot be described by reference purely to phonological environments. The complicating factor is that some morphemes can be used as suffixes or as roots. As suffixes they are subject to CL, but when they act as roots, vowel length does not alternate. This is illustrated in (11) with the example of *kaq* 'definite'. In (11a), the second instance of *kaq* is a suffix, undergoing *q* deletion and CL when followed by the consonant-initial topic suffix. But the first *kaq* in (11a), as well as the only instance of *kaq* in (11b), are acting as roots. When root-final, *q* undergoes fricativization, and not deletion, in the same phonological environment.

(11) Huallaga Quechua (Weber 1989: 469-470)

a.	/tʃajtʃaw **kaq-kaq**-qa/ DEF-DEF-TOP	[tʃajtʃaw **kaχkaː**ɣa]	'those that were there'
b.	/kutitʃimuʃan **kaq**-pita/ DEF-ABL	[kaχpita]	'from the place to which they were returned'

Thus, in Huallaga Quechua the deletion of coda *q* is morphologically conditioned and CL is sensitive not only to the position of *q* (coda vs. onset), but also to the

morphological status of the morpheme which contains the *q*. We conclude that CL alternations in Huallaga Quechua have to refer to grammatical information as to the morphological status of the morphemes in question. But despite the morphological conditioning that has crept into the Quechua CL alternation, the trigger of CL *when it does apply* is always recoverable; for each morpheme that is subject to vowel lengthening, there is a surface allomorph in which the triggering *q* surfaces. Thus in both Quechua and Komi, as in all the other cases of CVC CL in my database, the phonological rule relating the CL-related allomorphs is learnable.

We conclude that CVC ~ CV: alternations at least in some of the languages in our corpus remain productive phonologically. In Komi Ižma and Lithuanian (as well as in English, Kabardian, Latvian, Leti, Luganda, and other languages with synchronic CVC CL alternations discussed in chapter 3), whenever morphology creates the phonological environment required for a given alternation, the alternations are exceptionless. We will argue later that this persistent property of synchronic CVC CL is connected with its optimizing nature.

5.2.2. CVCV CL: trigger is not recoverable

Unlike the examples of CL through consonant loss, the trigger of lengthening in CL through vowel loss processes – i.e. CVCV CL – is usually *unrecoverable*. Thus, processes which result diachronically from a *CVCV > CV:C change appear synchronically simply as vowel length alternations of CVC ~ CV:C type. As a result it is difficult to relate them by any phonetically motivated phonological alternation. The following example from Slovak (West Slavic) illustrates these points. In (12a) vowel length in the genitive plural form of 'wife' is the result of the diachronic loss of the high back vowel in the Late Common Slavic. In contemporary Slovak, however, the lost [ʊ] never surfaces, so the vowel length cannot be seen synchronically as compensatory.

(12) Slovak (Carlton 1990)

a.	**LCS**		**Slovak**	
	*ʒenʊ	>	ʒeːn	'wife' gen.pl.
b.	ʒen-a	'wife' nom.sg.		
	ʒeːn	'wife' gen.pl.		

There are alternations in contemporary Slovak, as seen in the two forms of the root (*ʒen-* and *ʒeːn-)*; however, the synchronic alternations do not mirror the historical *CVCV > CV:C process. The high back vowel which triggered lengthening historically does not exist in Slovak; its nonrecoverability makes it impossible to formulate a phonetically natural synchronic phonological rule to account for the V ~ V: alternations.

It is precisely for this reason – unrecoverability of the trigger – that V ~V: alternations of this type are so commonly lexicalized or morphologized. In Slovak and other similar cases, the historical development of CVCV CL results in suppletive root allomorphs which may (though need not) have a phonological distribution. As I will argue below, even when the allomorphs do have a phonological distribution, as in Slovak, this distribution is not phonologically natural or optimizing.

Thus, alternations which arise through CVCV CL significantly differ from the alternations which are the result of CVC CL. CVC ~ CV: alternations are the result of CL through vowel loss, and are usually phonologically conditioned due to the synchronic recoverability of their diachronic trigger. Contrary to alternations created by CVC CL, CVC ~ CV:C alternations, which are the result of CL through vowel loss, are very often lexicalized or morphologically conditioned which is connected with the fact that the trigger of such alternations is not synchronically recoverable. CVC ~ CV:C alternations are present in Hungarian (discussed above), Friulian, Lama, Korean, and various Slavic

languages, such as Czech, dialects of Serbo-Croatian, Sorbian, etc. In the following sections we will look at representative examples from languages with CVCV CL.

Friulian

Descriptively, in Friulian stressed vowels are long in closed syllables before voiceless consonants and short in open syllables before voiced consonants. The alternations can be observed, for instance, in the masculine/feminine pairs in (13). Before the feminine suffix /-e/, final stem vowels are always short. In the masculine, however, final stem vowels regularly lengthen whenever the word-final consonant of the stem is voiced underlyingly.

(13) Friulian (Hualde 1990)

fem	**masc**[80]	
lov-e	lo:f	'wolf'
rud-e	ru:t	'pure'
famoz-e	famo:s	'famous'
ristiv-e	risti:f	'obstinate'
fred-e	fre:t	'cold'
savud-e	savu:t	'known'
bead-e	bea:t	'blessed'

Whenever the final obstruent of the stem is not voiced, there are no vowel length alternations (14).

(14)

fem	**masc**	
ros-e	ros	'red'
mat-e	mat	'crazy'

[80] Word-final devoicing of obstruents is exceptionless in Friulian.

We have seen in chapter 4 that vowel length alternations in Friulian arose through the loss of non-low final vowels correlated with the lengthening of the preceding vowels (word-final devoicing was a later sound change), as in (15).

(15)	*lov-u	>	lo:v	>	lo:f	'wolf'
	*rud-u	>	ru:d	>	ru:t	'pure'

The low vowel *a* was not lost word-finally (and subsequently underwent raising to *e*), which created alternations in (15).

As stated by Hualde (1990: 34), "a great number of words with long vowels before an obstruent are morphologically related to other words where the obstruent is not in final position (the environment of devoicing) and appears to be voiced". The alternations, thus, can be observed not only in masculine/feminine pairs, but also in other morphologically conditioned forms (16).

(16)	redʒ-i:	'to reign'	re:tʃ	'he reigns'
	nav-iga:	'to navigate'	na:f	'ship'
	nev-ea:	'to snow'	ne:f	'snow'
	plav-ot	'person from Piave'	pla:f	'Piave'
	lag-une	'lagoon'	la:k	'lake'

Here it will suffice to notice that the diachronic trigger of vowel length alternations in Friulian never surfaces synchronically and is not recoverable. An analysis of the Friulian alternations will be presented in later sections.

Czech

(17) illustrates vowel length alternations between genitive and nominative singular in Czech and demonstrates that in Czech, as in Hungarian, vowel length alternates only within a subclass of stems. The alternations in Czech can be described as regular if stem-

final vowels are analyzed as underlyingly short and long. As a result of this representational choice, the following statement is descriptively true of the alternations in (17): the long stem-final [u:] undergo shortening alternating with the short [o] if the stem is followed by a vowel-initial suffix (17a), while short vowels do not alternate (17b).

(17) Czech[81]

	gen.sg.	**nom.sg.**	
a.	dom-a	du:m	'house'
	kon^{j}-e	ku:n^{j}	'horse'
	noʒ-e	nu:ʃ	'knife'
b.	rod-a	rot	'kin'
	nos-a	nos	'nose'

We have seen in chapter 4 that vowel length alternations in Czech are the result of the loss of high ultra-short vowels, as recapitulated in (18). Since the lost vowels are not recoverable synchronically, they do not participate in the alternations, and vowels which have different historical reflexes can be conceptualized as "covering up" for the lost triggers.

(18) CL in Czech (Timberlake 1983a,b)

a. *domʊ	>	du:m	'house'
*boɦʊ	>	bu:χ	'god'
b. *rodʊ	>	rot	'kin'
*nosʊ	>	nos	'nose'

Recall that historically CL in Czech applied across sonorants and voiced fricatives, which explains the absence of length alternations before voiced stops and

[81] In Czech, vowel raising in the nominative singular and general word-final devoicing are separate later sound changes orthogonal to CL.

voiceless fricatives in (18b). Synchronic alternations preserve this pattern, even though it not as exceptionless, as in Friulian. Paradigm leveling is responsible for the absence of alternations in the exceptional form in (19).

(19) zbor-a zbor 'body, committee'

Also problematic are the forms in (20). Final vowels of stems are short before a vowel-initial nominative singular suffix, and long before a consonant-initial diminutive.

(20)

nom.sg.	**diminutive**[82]	
jezer-o	jezi:r-k-o	'lake'
semen-o	semi:n-k-o	'seed'

However, stem vowels in the words in (20) are long not only before nominative singular diminutive forms, but also before genitive plural diminutive forms, shown in (21), regardless of the fact that in this case the stems are followed by a surface vowel.[83]

(21)

nom.sg.	**gen.pl.**	
jezi:r-k-o	jezi:r-ek	'lake' dim.
rami:n-k-o	rami:n-ek	'shoulder' dim.

We conclude then that in Czech certain types of root are lexically specified for long final vowels. Within this lexical class, vowel length alternations are phonologically conditioned and regular, and thus call for a synchronic account.

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[82] Historically, *e: > i:.

[83] Notice that the presence or absence of a vowel (an underlying jer) in the examples in (21) does not affect CL, even though jers were triggers of vowel length alternations historically. This is consistent with synchronic analyses which treat jers as underlyingly moraless segments (Rubach 1986) or as ghost vowels with empty root nodes (Zoll 1994).

Dinka

In the previous sections we discussed lexically specified alternations and showed that in Friulian, Hungarian, and Czech, vowel length alternations were present only to a subclass of stems, but within this lexically marked stem class, the alternations were phonologically conditioned. A different type of outcome of the CVCV CL change is represented by vowel length alternations in Dinka (Nilotic)[84] which are shown in (22a) with the example of singular/plural noun forms, and in (22b) with the example of a verbal paradigm.

(22) Dinka (Andersen 1990)

a.	**singular** *creaky*	**plural** *breathy*	
	dɔ̰m	dṵum	'field'
	rɔ̰w	rɔ̤ot̤	'hippopotamus'
	mɛ̰t̤	mɪ̤it̤	'child'
b.		Class II[85]	'to roll'
	PRE	lɛ̰er	
	NF	leɛ̰er	
	1sg	leɛ̰̀er	
	2sg	lɛ̰̂er	
	3sg	leɛ̰̀er	

Examples in (22) illustrate that in contrast with lexically specified but phonologically conditioned allomorphy, vowel length alternations in Dinka have become independent of syllable structure and fully morphologized as vowel length alternations, such as short/long (V ~ V:), as in (22a), or long/super-long (V: ~ V::), as in (22b).

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[84] Dinka has a voice quality contrast between creaky voice /V/ and breathy voice /V/, which is phonetically reminiscent of the distinction between –ATR and +ATR in Pari (Dixon 1990: 10) and an elaborate tonal system. I show Dinka tones here for completeness, but for the full analysis of the tonal system of Dinka see, for example, Denning (1990).

[85] PRE = verb stem with a preposed subject; NF = non-finite (terminology from Andersen 1990).

Recall from chapter 4, that in Dinka vowel length arose through the loss of word-final suffix vowels (which have been retained in a closely related Päri as /ɔ/ and /o/), as shown in (23).

(23)	*tùŋó	>	tu̱uŋ	'horn'
	*pàajɔ	>	baa̱aj	'home'

The lost vowels which gave rise to alternations in Dinka are not only unrecoverable synchronically, but vowel length which arose through the loss of vocalic suffixes is reanalyzed as dependent on breathiness, as illustrated in (24).

(24)	**singular**	**plural**	
a.	***creaky***	***breathy***	
	dɔ̰m	dṵum	'field'
	mɛ̰t	mi̤i̤t̤	'child'
b.	***breathy***	***creaky***	
	le̤e̤c	lɛ̰c	'tooth'
	t̤i̤n	t̰ḭn	'breast'

(24) provides evidence to the fact that vowel length alternations in Dinka are fully morphologized. Number inflection in Dinka became what Anderson & Browne (1973) call "exchange rules"[86] when a short vowel in the singular corresponds to a long vowel in the plural, and a long vowel in the singular corresponds to a short vowel in the plural.[87]

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[86] The term was introduced in Chomsky & Halle (1968).

[87] Andersen (1990: 18-19) hypothesizes that a historical explanation for the rise of "exchange" rules in Dinka could be as follows: "Since the voice quality contrast is historically identical with the ATR contrast, and since +ATR vowels are liable to harmonize -ATR vowels in languages with ATR contrast, the most likely explanation of the voice quality alternation is that either the plural, ... or the singular, ... once had a +ATR suffix vowel which harmonized a root with a -ATR vowel. This hypothesis is corroborated by the fact that the vowel of the breathy stem is often longer and apparently very rarely shorter than the vowel of the creaky stem."

Lama

In Lama (Gur) we find one of the two cases of synchronic CVCV CL alternations which is not only phonologically conditioned, but also transparent and not lexicalized.[88] I contend that this property of CVCV ~ CV:C alternations in Lama is due to the fact that the trigger of the historical vowel lengthening is synchronically recoverable.

Ourso (1989) and Ourso & Ulrich (1990) describe two contrastive central schwa-like vowels in Lama, a +ATR schwa (which I will transcribe as [ə̟]), and a –ATR schwa (which I will transcribe as [ə]). According to Ourso (1989), both schwas delete word-finally with CL of a preceding vowel after a sonorant, but not after an obstruent. The deletion of schwas after sonorants is illustrated with the examples of two sonorant-initial suffixes, /ɽə/ NOUNCLASS7 (25a) and /ɳə/ NOUNCLASS4 (25b). In both suffixes, schwas delete exceptionlessly with the lengthening of the preceding vowel when these suffixes follow vowel-final stems.

(25) Lama (Gur) (Ourso 1989, Ourso & Ulrich 1990)

a.	/ɽə/ NOUNCLASS7		
	/hạ̟-ɽə/	hạ̟:ɽ	'benefactor'
	/se-ɽə/	se:ɽ	'runner'
	/sẹ̟-ɽə/	sẹ̟:ɽ	'field mouse'
	/cema-ɽə/	cema:ɽ	'pottery'
	/acamkpo-ɽə/	acamkpo:ɽ	'bachelor'
b.	/ɳə/ NOUNCLASS4		
	/ɳi-ɳə/	ɳi:ɳ	'heads'
	/wa-ɳə/	wa:ɳ	'palm trees'

[88] Arguably transparent synchronic CL alternations through the deletion of word-final [u] are also present in Baasaar (Podi 1987, Rialland 1993).

(26) illustrates the fact that there is no schwa-deletion after obstruents, after a voiceless stop in the NOUNCLASS9 suffix /tə/ (26a) and after a voiceless fricative in the NOUNCLASS6 suffix /sə/ (26b).

(26) Lama (Gur)

a.	/tə/ NOUNCLASS9		
	/je-tə/	jetə	'father-in-law'
	/tu-tə/	tutə	'food'
	/caha-tə/	cahatə	'sour vegetable'
b.	/sə/ NOUNCLASS6		
	/wi̤-sə/	wi̤sə̤	'children'
	/ase-sə/	asesə	'rabbits'
	/wəta-sə/	wətasə	'words'

The data in (27) provides some justification for positing the NOUNCLASS7 suffix as underlyingly /ɽə/, with a synchronically recoverable schwa.

(27)	/kan-ɽə/	kanɖə	'lamp'
	/jem-ɽə/	jenɖə	'hippo'

Ourso (1989: 54) proposes a rule of the retroflex sonorant /ɽ/ hardening to a stop after a non-palatal sonorant. Although the data which would constitute independent evidence for the posited rule is not present Ourso (1989), if we accept it as a working hypothesis, the alternations in Lama are arguably phonologically transparent.

A plausible phonetic explanation of why word-final schwas are lost only after sonorants is as follows. As schwa is very short and has indeterminate spectral characteristics, it can be easily misheard as a part of a sonorant. In the case of consonants, at least after stops the burst of the released stop reinforces the perceptibility of schwa, thus preventing its loss.

The recoverability of the schwa in Lama is crucially connected with the fact that its deletion is segmentally conditioned, that is, that it deletes only after sonorants. The dependency of the vowel deletion on the segmental environment resulted in the recoverability of the vowel and thus created transparent vowel length alternations.

Summary

To summarize, we have seen three types of alternations which result from CL through vowel loss. When the trigger of CL is no longer recoverable, the historical process of vowel loss and lengthening results in allomorphy synchronically. In Hungarian, Friulian, and Czech, allomorphy is lexically determined, but synchronic vowel length alternations are phonologically conditioned even if not phonetically natural, while in Dinka, the alternations are not phonologically conditioned and completely morphologized. When the trigger of CL is recoverable and vowel length alternations arise through a segmentally conditioned sound change, as in Lama, the alternations remain phonologically conditioned and transparent. The following section is devoted to the discussion of why triggers are typically preserved in CVC CL but lost in CVCV CL.

5.2.3. Segmental properties of CL and recoverability

We have just seen that the trigger of CVC CL is always synchronically recoverable, while the trigger of CVCV CL tends not to be (from 22 cases of CVCV CL in our database, in only two languages, Lama and Baasaar, the trigger of CL is arguably recoverable). Why should this be the case? In this section I propose that the recoverability of the trigger in alternations arising via CVC CL vs. its unrecoverability as a result of CVCV CL can be attributed to systematically differing conditions on segment loss across these two types of CL. The essential parameter is whether segment loss (the

consonant loss of CVC CL, or the vowel loss of CVCV CL) is conditioned or unconditioned in a given syllable context.

When consonant or vowel loss is *completely* unconditioned, no alternations arise. For example, if a language lost all high vowels stem-internally with lengthening of the vowels in a preceding syllable, this would result in the absence of high vowels and in uniformly long vowels in stems which are reflexes of original CVCV sequences, but would not produce any alternations. Similarly, the loss of all codas in a language would result in a system with only open syllables and no alternations. This would happen only if for any given consonant in any given morpheme, that consonant always occupies a constant syllable position (always onset or always coda).

However, usually the loss of segments is determined by a specific syllabic and/or segmental environment. For consonants, this environment is usually segmental (but surely syllable position is crucial – by definition, in CVC CL), that is, the loss of consonants depends on the properties of surrounding consonants and/or vowels (see chapter 3 for full discussion of segmental conditioning of CVC CL), while the loss of vowels more often depends on their prosodic properties (stress/accent, position in a word, the level of reduction in a specific prosodic position, etc.) or on the segmental properties of vowels themselves (e.g., duration) regardless of the environment. Vowel loss is rarely conditioned by consonantal context.

When the trigger of CL through consonant loss is not lost unconditionally, the process may result in transparent synchronic alternations. In the previous chapters we have seen that consonants which trigger CL always participate in such alternations. This property of CVC CL alternations can be attributed to the fact that in these alternations the deletion of consonants and the lengthening of vowels is determined segmentally. While the historical segmental trigger/target relationship between a consonant and a vowel

participating in CL is preserved in alternations, they remain phonologically conditioned and can be modeled synchronically as a compensation process.

In contrast with the situation true of most examples of CL through consonant loss, in most examples of CL through vowel loss, the vowel whose deletion triggered lengthening of the preceding one is not recoverable synchronically. The loss of the vowel creates suppletive allomorphs differing in vowel length. We saw an example of such alternations in Hungarian in earlier sections, and more cases of synchronic vowel length alternations, phonologically conditioned, as in Lama, lexicalized, as in Friulian or Slavic, or morphologized, as in Dinka.

It is most important that the unrecoverability of the trigger makes the CVCV ~ CV:C alternations opaque. Opacity of such alternations is significant in two ways. First, purely phonetic accounts will not be sufficient to model synchronic alternations which involve CL through vowel loss. To model the opacity of such alternations, a phonological account is called for. Second, it is entirely plausible that opaque alternations should be subject to paradigmatic leveling more frequently than transparent ones. Thus, such alternations are very often preserved only through morphologization.

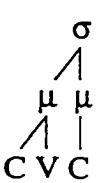
We can now turn to the precise nature of the conditions on CL which result in recoverability vs. non-recoverability. While CL through consonant loss is usually a prosodically independent change caused by the segmental properties of deleting segments, CL through vowel loss is a phonologization of inherent duration of vowels which depends on the change in syllable structure. Thus, diachronically, syllable structure poses an additional constraint on CL through vowel loss. Synchronically, this results in a different set of conditions which govern CVCV CL as opposed to CVC CL.

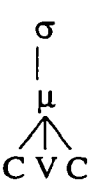
In the following sections we will turn to the discussion of asymmetries just exemplified and to the analyses of the synchronic CL alternations.

5.3. Optimization

In this section we consider differences between CL through consonant and vowel loss from the point of view of optimization of syllable structure. If we compare CVC and CVCV CL, we will see that while the first type of alternations results in optimization in syllable structure and can be fairly easily modeled in OT, the other one is problematic for a phonological optimization account.

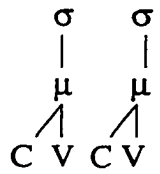
We have seen before that while CL through consonant loss is quite common, CL through vowel loss is relatively rare. Only in a few languages the loss of vowels results in CL. Interestingly, the rarity of the CVCV CL in comparison to CVC CL is paradoxical from the point of view of the moraic approach. In order for CVC CL to occur, a language is required to have closed syllables and moraic codas. This already constrains the systems where CVC CL is predicted to occur in two ways. Firstly, while open syllables are present in all languages, not all languages have closed syllables. Secondly, even if a language has codas, coda consonants are not always moraic, and their moraicity is language-specific. So, only in languages where closed syllables are heavy (that is, where coda consonants are moraic) can the loss of a coda consonant trigger CL (28a). If closed syllables are treated as light (28b), CL is predicted not to occur.

(28) CVC syllables a. Heavy 

b. Light 

There is no such restriction imposed on CL through vowel loss. Vowels are generally thought of as moraic in all languages, as schematized in (29), so moraic theory predicts that the loss of a vowel should always result in CL.

(29) CVCV



Contrary to this prediction, CL through consonant loss happens much more often than CL through vowel loss. Even though vowel deletion word-medially (syncope) and word-finally (apocope) is rampantly common, it results in lengthening only in a miniscule percentage of languages which have it as a sound change (For syncope and apocope without lengthening, see, for example, Hock 1991 on Germanic, Baltic, and Greek; Dixon 1977 on Yidiɲ).[89]

I would like to argue that the reason for the paradox, that is, for the typological rarity of CVCV ~ CV:C alternations, lies in language-specific biases against certain syllable structures. CVCV ~ CV:C alternations always result in syllable structure which is non-optimal. It is generally accepted on the basis of typological data that the universally preferred scale of syllable types is as in (30).

(30) CV » CV:, CVC » CVVC

It is not clear if CVC is less preferred than CV: cross-linguistically. Language-specific constraints on long vowels or possible codas are usually responsible for resolving this issue one way or the other. However, it is uncontroversial that closed syllables with long vowels are cross-linguistically dispreferred. Gordon's (1999) excellent survey of weight and weight-related phenomena in 396 languages shows that from these languages 35 have no codas, 110 have no long vowels (from these, 9 have neither codas nor long vowels), and 170 disallow CV:C syllables, as summarized in (31).

[89] See also Kager (1997, 1999) for an OT analysis of rhythmic syncope in Macushi (Carib) and Southeastern Tepehuan (Uto-Aztecan).

(31) Gordon's (1999) survey

Languages	**396**
*CVC	35
*CV:	110
*CV:C	170

170 languages from the survey with the absence of the CVVC syllable template include languages with no coda consonants and no long vowels. However, there are still 25 languages in which both long vowels and coda consonants are allowed, but CV:C syllables are still dispreferred.

In the case of CVCV ~ CV:C alternations, which are the result of CL through vowel loss, no optimization of syllable structure takes place. From a sequence of two open syllables with short vowels which are the most common typologically, a (super)-heavy closed syllable with a long vowel is produced.

On the assumption that optimizing changes are more common (Kiparsky 1996 *et passim*, Vennemann 1988), two typological predictions/expectations follow from the fact that CL through vowel loss is not optimal. Firstly, this type of CL should be more rare than the CVC → CV: type, and secondly, CVCV ~ CV:C alternations should be even more rare in languages with moraic codas, since superheavy syllables are even less preferred cross-linguistically than closed syllables with long vowels.

Although my corpus is small, the prediction nonetheless is borne out. Table 1 gives an exhaustive list of languages and dialects I was able to find so far that had a vowel loss with lengthening as a sound change. Among these languages, there are only 2, Estonian and Sámi, which undoubtedly have trimoraic syllables. These two languages happen to have ternary length distinctions as well.

FAMILY/LANGUAGE	TRIMORAIC SYLLABLES	
Finno-Ugric		
Estonian	yes	
Sámi	yes	
Hungarian	no evidence	
Indo-European		
Germanic	evidence from CVC CL	(see Hayes 1989)
Rhenish "Schärbungsgebiet"		
Dithmarschen		
Jutland Danish		
Old French	no evidence	
Slavic	no evidence	
Czech		
Slovak		
Upper Sorbian		
(Old) Polish		
Kashubian		
Slovenian		
Serbo-Croatian		
Ukrainian		
Belorussian		
Romance	no evidence	
Friulian		
Milanese		
Korean	no evidence	
Nilotic		
Dinka	no evidence	
Gur Lama	no evidence	
Baasaar		
Voltaic	no evidence	
Bantu		
Runyoro-Rutooro	no evidence	

Table 1. Moraicity of codas in languages with historical CVCV CL

Since there are not many cases of CVCV CL known to us, this survey is far from conclusive, but it shows that languages which treat CV:C syllables as trimoraic and have historical CL through vowel loss are indeed rare, and the treatment of the coda of a closed syllable with a long vowel as non-moraic is cross-linguistically preferred.

5.4. Implications of recoverability and optimization asymmetries

From the considerations in this section, we conclude that on one hand, in synchronic C_1VC_2 ~ CV: alternations, phonology mirrors phonetics since the trigger (C_2) directly affects duration of the target (V). Thus, CVC CL remains a "phonological" (that is, automatic exceptionless) pattern (Dressler 1985, Spencer 1991, Kiparsky 1993, Garrett & Blevins to appear, among others). In section 2 of this chapter I will show that CVC CL involves preservation of syllable weight synchronically. Since CVC CL alternations are arguably optimizing, the optimality theory (OT) framework should be able to model these alternations without insurmountable difficulties, so I will use OT as a formal device to illustrate the main points of a synchronic phonological analysis of CL.

On the other hand, in synchronic CVC ~ CV:C alternations, the diachronic trigger is not recoverable and thus evidently does not have a direct effect on the duration of the target. Thus, diachronic CVCV CL results a morphophonological pattern which is either lexically restricted or morphologized. In such a case, alternations which are the outcome of a diachronic vowel lengthening process cannot be treated as instances of lengthening synchronically.

5.4.1. CVC CL as moraic conservation within the syllable

Many recent theories rely on the idea of optimization to account for various phonological phenomena. Optimality theory (OT) (Prince & Smolensky 1993) is the first explicit theoretical framework to develop the concept of optimization as a constraint-based model. However, the idea of optimization is far from recent in phonological literature. It is closely related to the idea of *markedness* in respect to neutralization patterns, as developed, for example, in Trubetzkoy (1939) and in later work. Various researchers have argued that certain processes involved optimization (e.g., Chomsky & Halle 1968, Vennemann 1988, among others).

The output of synchronic CL through consonant loss (CVC → CV:) can potentially be more optimal than the input. It is unclear if CV: syllables are typologically more or less *marked* than CVC syllables, however, in some languages, syllables of CV: type are allowed unconditionally, while CVC syllables are restricted (e.g. in Japanese, the only possible codas are nasals and first parts of geminates, while no restrictions apply to long vowels in open syllables) (see Sherer 1994, Gordon 1999 for examples and discussion). So, if CL through consonant loss can in principle be viewed as optimization of syllable structure, it should be possible to model it in OT, which is a framework created with an emphasis on optimization.

Once our theory allows reference to syllabification of a string in question, an optimization account of CVC CL becomes straightforward. In (32) and (33), there are definitions of the two general families of constraints on deletion and insertion proposed by McCarthy & Prince (1994, 1995). These constraints are crucial for characterization of any optimizing process.

(32) MAX
Every element of the input has a correspondent in the output.
(no deletion)

(33) DEP
Every element of the output has a correspondent in the input.
(no insertion)

In the case of CL, the relevant constraint of the MAX family has to demand Input/Output correspondence at the moraic level (see Blevins 1997, Kager 1999 and references therein).[90] The MAX-μ constraint is stated in (34).[91]

(34) MAX-μ
Every mora in the input has a correspondent in the output.

[90] See Chapter 2 for discussion of non-moraic approaches to CL.
[91] DEP-μ would be the "anti-lengthening" constraint, prohibiting insertion of moras.

Additionally, the *Weight-by-Position* principle (Hayes 1989) needs to be formulated as a constraint (Sherer 1994). Since languages differ on what consonants are moraic in codas, the WEIGHT-BY-POSITION constraint requires language-specific modifications.

(35) WEIGHT-BY-POSITION
Coda consonants are moraic

In modeling CL, language-specific constraints on possible codas are required as well, to express prohibition of certain segments in codas. For example, to express the fact that coda *l* is not allowed in Komi, a general constraint in (36) can be modified as (37).

(36) NOCODA
*C $]_{\sigma}$ Syllables are open

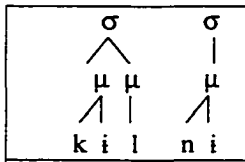
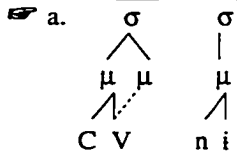
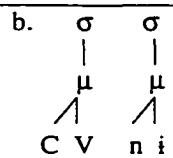
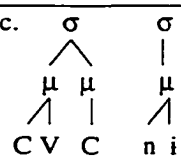
(37) NOCODA-L
*l $]_{\sigma}$ *l* is not allowed in codas

A more specific incarnation of MAX-μ is required to express the idea of the preservation of weight within a syllable. MAX-μ(σ) is formulated in (38).

(38) MAX-μ(σ)
Every mora in the input (or an intermediate representation) has a correspondent within the same syllable in the output.

A simplified tableau showing CL through *l*-deletion in Komi is shown in (39). In (39), I use a fully syllabified input since, as we will see in the following section, the choice of a version of OT responsible for syllabification is orthogonal to the analysis just presented.

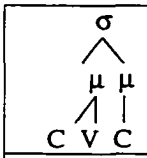
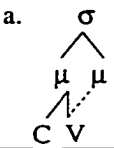
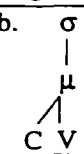
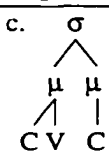
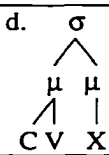
(39) Komi CVC CL

	MAX-μ(σ)	No-Coda-l
		
☞ a. 		
b. 	*!	
c. 		*!

Note that the candidate (39a) can only be the winner if the constraint against long vowels (*V:) is not active in the language in question, that is, if that language has phonological long vowels synchronically. This leads to an interesting, though perhaps circular, interpretation of the claim made by de Chene & Anderson (1979) that CL is always structure-preserving. The only expectation from a system from the point of view of optimization is that CL has to be structure-preserving only in order to have synchronic alternations.

Given the idea of rankability and violability of constraints, which is one of the main postulates of OT, the analysis of CL outlined so far allows for an existence of a language in which the most optimal repair strategy would be to insert a different consonant instead of a dispreferred coda. However, there is no motivation for such a repair diachronically, and synchronically we can model the existing state of affairs by the high ranking of DEP, so no insertion of segments is allowed (40).

(40) CVC CL (schematic)

	DEP-seg	MAX-μ(σ)	No-Coda-C
			
☞ a. 			
b. 		*!	
c. 			*!
d. 	*!		

If DEP-seg is ranked below MAX-μ(σ) and NO-CODA-C, and a well-motivated constraint prohibiting long vowels (*V:) is ranked high, a repair just suggested becomes possible. Nonetheless, this type of repair never happens, which represents either an accidental typological gap or requires a fixed ranking of constraints. This question has a direct relevance to the idea of *factorial typology* in OT. OT vastly overgenerates, since from a factorial typology constructed of any large enough system of constraints, a significant part of the generated possibilities is usually unattested (e.g. in Crosswhite 1999, the most generous conceivable interpretation of the factorial typology of vowel systems in respect to vowel reduction still generates 181 unattested languages to only 71 attested). While some researchers believe that language change is directly represented by the reranking of constraints (Jakobs 1995 among others), others argue that sound change is always phonetically motivated and the reranking of constraints happens as an end-

result of the change, and not as the driving force (Holt 1997, Anttila & Cho 1998). Thus, if there is no diachronic source for certain alternations, there is no reason to expect that a constraint reranking will exist, and a gap in a factorial typology will not be filled, even though in principle the possibility of filling the gap is present in the grammar.

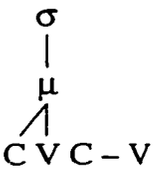
5.4.1.1. The opacity problem

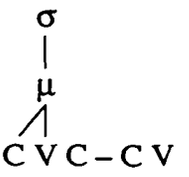
I showed that alternations triggered by CVC CL are transparent insofar as the trigger of this type of CL is always recoverable. On the other hand, however, CL through consonant loss is inherently opaque[92], since CVC ~ CV: alternations are not conditioned purely by markedness and well-formedness conditions on surface structure and crucially require reference to an intermediate stage. This situation is easily modeled as a serial derivation: firstly, the coda consonant deletes; secondly, the deletion of the consonant results in a stray mora, and finally, the stray mora is subsequently filled by spreading from the preceding vowel. However, modeling CVC CL is problematic for any two-level OT analysis, since constraints responsible for CL need to be able to distinguish between moraic and non-moraic consonants, that is, to be able to refer to specific positions in the syllable. This, in turn, means that to evaluate the candidate correctly the constraints have to have access to syllabification of input strings.[93]

Several solutions to the opacity problem have been offered in the recent OT literature. An obvious type of solution is to assume some syllabification of the input. It has been argued, however, that predictable metrical structure (as well as any predictable material) should not be specified in the input (e.g. Kiparsky 1982, 1993, Archangeli & Pulleyblank 1989, Sprouse 1997). Inkelas (1994) argues that lexicon optimization results

[92] See Kiparsky (1971, 1973) for discussion of phonological opacity.
[93] This type of opacity does not present any problems for rule-based approaches. Interestingly, this problem does not arise in the case of CL through vowel loss in OT either, since it is the general consensus that vowels are always moraic in the input.

at least in partial syllabification of the input, unless syllabification of an input string is alternating and predictable, which is exemplified in (41).

(41) CVC- a. 

b. 

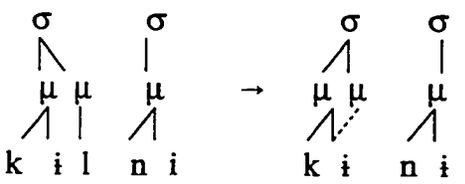
(41) shows that according to the *archiphonemic underspecification* approach of Inkelas (1994), in an input string consisting of a CVC root and a suffix, only the first CV in the string in invariably syllabified. The syllabification of the last consonant of the root is alternating and predictable, so it will be underspecified as a consequence of lexicon optimization. If a vowel-initial suffix is added to the CVC- root (41a), the last consonant of the root will be syllabified as an onset, and if a consonant-initial suffix is added (41b), the last consonant of the root will be syllabified as a coda.

In examples of CVC CL, the segment in question is always alternating and its syllabification is always predictable. Recall, for instance, an example of CVC CL through *l*-deletion in Komi Ižma (42).

(42) a.

	stem	**1 sg. past**	**infinitive**	
	kɨl-	kɨli	kɨ:nɨ	'to hear'

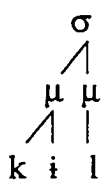
b. kɨl- 

c. 

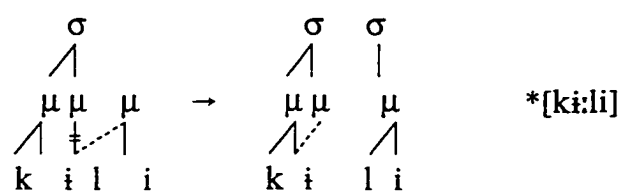
Lexicon optimization predicts that since the syllabification of the final consonant of a CVC stem is alternating and fully predictable (it will be syllabified as an onset if followed by a vowel-initial suffix, and as a coda if followed by a consonant initial suffix), the stem in (42a) will always be syllabified as in (42b), with the last consonant of the stem underspecified for metrical structure. That metrical structure is crucially required to predict the output of CL, as shown in (42c). We conclude thus that the lexicon optimization approach does not resolve the opacity problem.

It is, of course, possible to stipulate that the input is always fully syllabified. The idea of fully syllabified inputs is generally dispreferred, because syllabification is entirely predictable in most cases, so it does not have to be present in the output. More seriously, this solution makes a wrong prediction. For example, if the syllabification of a CVC root is as in (43a), it predicts CL from resyllabification as in (43b), which never happens.

(43) a.



b.



*[ki:li]

There are several possible solutions to the problem of opacity of CL within OT. As we have seen earlier, one type of solution is to refer to segmental rather than to prosodic identity of the material involved in CL. One such analysis is that of Sumner (1999).

In an analysis of CL in Tehrani Farsi[94], Sumner (1999) treats CL as coalescence rather than deletion of segments. In order to account for vowel length from CL, Sumner proposes a constraint BIPOSITION which requires that "an output segment representing two input segments (denoted by subscripts) must be linked to two prosodic positions". MAX_{SEG} is a constraint which disallows deletion of segmental material.

A sample tableau from Sumner (1999: 538) is shown in (44).

(44) μ
|
Input: /$r_1o_2b_3ʔ_4$/

	BIPOSITION	MAX_{SEG}
→ a. μ μ \ / | $r_1o_{2,4}b_3$		
b. μ | $r_1o_2b_3$		*!
c. μ | $r_1o_{2,4}b_3$	*!	

The problem with the BIPOSITION constraint is that it simply stipulates the presence of moraic structure (and thus, the length of a consonant which is the result of CL) in the winner candidate. The second mora of the vowel is not present in the input, and its insertion in the output in not independently motivated. It is also problematic for OT-internal reasons that BIPOSITION states an arbitrary correspondence relation of the unlikes, whereby a segmental position of the input corresponds to a prosodic position (a mora) in the output, and therefore, this constraint is basically a rule in disguise.[95]

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[94] See Chapter 3 of this dissertation for an alternative analysis.

[95] A more general argument against treating CL as coalescence comes from typology of coalescence processes. According to Casali (1997), hiatus resolution often results in coalescence, but it never produces long vowels. Additionally, Casali shows that in hiatus contexts, both elision of V_1 and V_2 are possible, but elision of V_1 is more common and productive than V_2.

Additionally, Sumner's account runs into the same problem that Lee (1996) does, but Sumner is careful enough to notice that under the constraint ranking she proposes for Farsi, onset deletion is predicted to result in CL. A constraint IDENTWI which requires identity of word-initial segments in the input and output appears to solve the problem only in the case of deletion of initial onsets. To prevent CL from deletion of word-medial onsets, Sumner has to introduce a WEIGHT-BY-POSITION constraint, which refers to syllabification. Since the details of Sumner's account of onset deletion are not worked out, it is hard to assess how such a constraint would work in a model where syllabification in not present in the input.

There are several versions of OT which are capable of solving the opacity problem. One is to propose an intermediate state (but not an intermediate stage since these theories are non-derivational at least in spirit) where everything is already syllabified but the evaluation is not in force yet (e.g., Sprouse's 1997 Enriched Inputs theory). It is also possible to derive CL by using an OT version of intra-paradigmatic relations, such as output-output correspondence (Benua 1995), the sympathy theory extension to OT (McCarthy 1999, but see discussion of problems of the sympathy account of CL by Kager 1999), or the theory of turbidity (Goldrick 2000).[96] In principle, which discrete version of OT we use to account for CL is orthogonal to the purposes of this study. All we need is a mechanism which allows us to refer to the syllabification of the string in question.

[96] Zec (1998) uses the containment version of OT (Prince & Smolensky 1993, McCarthy & Prince 1993) to account for CL of consonants on the basis of study of gemination in Pali, Japanese, and Piro. Under Zec's analysis, an unparsed segment is capable of projecting a moraic position which can be filled by a parsed segment, leading to CL. See Kager (1999) for arguments against mora projection.

5.4.2. CVCV CL: an analysis

5.4.2.1. CVCV CL as moraic preservation within a foot

We have just seen that CVCV ~ CV:C alternations cannot be accounted for as an optimization of syllable structure. This is not surprising, since a disyllabic sequence is crucially involved in the alternation. Another possible optimization strategy for CVCV CL could be stated as moraic preservation within the foot (for foot-optimization see Prince 1990, Prince & Smolensky 1993, Hayes 1995, Kager 1997, 1999 among others). Since we account for CVC CL by invoking moraic preservation within the syllable (MAX-μ(σ)), it might seem logical to seek an explanation for the second kind of CL by the reference to a higher prosodic constituent – a foot. We have already seen that CL through vowel loss is dependent on prosody and is necessarily confined to a disyllabic unit highly reminiscent of a foot. Such a stipulation would yield a unified account of synchronic CL as mora maintenance within a prosodic constituent, as in (45).

(45)

mora		
syllable	←	CVC CL
foot	←	CVCV CL
prosodic word		

Indeed, it is possible to account for vowel length alternations by invoking moraic conservation within a foot at least in one language in our CVCV CL corpus. Recall that in Lama, word-final schwa deletes after sonorants with lengthening of the preceding vowel, as recapitulated in (46).

(46) Lama (Gur) (Ourso 1989, Ourso & Ulrich 1990)

/hạ-ɽə/	haːɽ	'benefactor'
/cema-ɽə/	cemaːɽ	'pottery'
/acamkpo-ɽə/	acamkpoːɽ	'bachelor'
/ŋi-ŋə/	ŋiːŋ	'heads'
/wa-ŋə/	waːŋ	'palm trees'

We have seen that in Lama CL is phonologically conditioned, exceptionless and thus transparent. Assuming that feet in Lama are built right-to-left, a (MAX-μ(foot)) constraint will pick the correct output, given higher ranking of constraints on word-final schwa after sonorants.[97]

However, there exists data which does not yield to a foot-based analysis. Consider examples of vowel length alternations in Czech in (47).

(47)

nom.sg.	**diminutive**	
jezer-o	jezi:r-k-o	'lake'
semen-o	semi:n-k-o	'seed'
ramen-o	rami:n-k-o	'shoulder'
jablon^{j}	jablu:n^{j}-k-a	'apple tree'

(47) shows stems whose last vowels surface as long before a consonant-initial suffix, in this case, the diminutive /-k/, and as short before a vowel-initial suffix. Historically, the length arose from the deletion of the high back vowel (the back jer), as shown in (48).

(48) jezi:rko < *jeziruko
rami:nko < *raminuko

Recall that the descriptive generalization for the alternations in (47) is that the last vowel of the stem is long if a consonant-initial suffix is added, and it is short before a vowel-initial suffix. A class of stems which participate in similar alternations is present in Hungarian (49).

[97] As very little data is available on vowel length alternations and footing in Lama, this analysis will remain a sketch which I will not develop any further.

(49) Hungarian (Kálmán 1972)

tyz-ek	ty:z	'fire'
madar-ak	mada:r	'bird'
tehen-ek	tehe:n	'cow'

Examples from Czech and Hungarian given in (47) and (49) present a problem for a foot-based account of CL. Once moraic conservation is posited to be active within a foot, in order for the floating mora of the diminutive suffix to lengthen a vowel, the foot-structure in Czech and Hungarian is predicted to be as in (50a). However, since both Czech and Hungarian have initial stress and are analyzed as syllabic trochee languages (Hayes 1995), a reasonable foot-structure (if we assume binary feet as most researchers do) for such a language is shown in (50b). This mismatch alone presents an insurmountable problem for extending the moraic conservation within the foot hypothesis to either Czech or Hungarian.

(50) a. je[zir-ko]$_{foot}$
ma[dar-ak]$_{foot}$

b. [jezir]$_{foot}$-ko
[mada]$_{foot}$[rak]$_{foot}$

Secondary stress in Czech presents further problems for a foot-based analysis. In addition to the fixed main stress on the first syllable, Czech has alternating secondary stress which surfaces on even syllables starting from the third syllable from the left (Hála 1962), as shown in (51).

(51) Alternating secondary stress in Czech (Bethin 1998: 176)

[fílo][lògi][tskì] 'philological'

(s				w)
(s	w)			
(s	w)	(s	w)	(s)
σ	σ	σ	σ	σ
fi	lo	lo	fi	tski

The alternation pattern of the secondary stress also suggests that the Czech rhythmic structure is trochaic and left-aligned (Gebauer 1894/1963, Jakobson 1923, 1926/1971), thus rendering the moraic preservation within the foot as an untenable option in some cases.

5.4.2.2. CVCV CL: lexically marked alternations

Hungarian

Recall that in order to characterize vowel length alternations in Hungarian, three types of stem-final vowels need to be distinguished. These types are non-alternating short vowels, as in (52a), non-alternating long vowels, as in (52b), and alternating vowels, as in (52c).

(52) Hungarian

	plural	**singular**	
a.	ember-ek	ember	'man'
	ørøm-øk	ørøm	'friend'
b.	hu:s-ok	hu:s	'meat'
	ha:z-ak	ha:z	'house'
c.	tyz-ek	ty:z	'fire'
	madar-ak	mada:r	'bird'
	tehen-ek	tehe:n	'cow'

When vowels do not alternate, the choice of the input forms is determined by lexicon optimization (Prince & Smolensky 1993, Inkelas 1994, among others). Thus, non-alternating short vowels will be monomoraic (53a), and non-alternating long vowels will be bimoraic in the input (53b).

(53) a. μ μ
| |
e m b e r

b. μ μ
\ /
h a z

Given that alternating vowels need to be distinguished from both types of non-alternating vowels listed in (53), they require a different representation. Alternating vowels occur within an unpredictable subset of stems which does not possess any phonological properties distinguishing it from non-alternating stems, so stems with alternating vowels have to be marked in the lexicon. I propose that alternating vowels in Hungarian are represented as in (54).

(54) μ μ
/\
t u z

The representation in (54) captures the generalizations about alternating stems, firstly, that the vowel of the stem can be either long or short, and secondly, that the length of the vowel is crucially connected with the syllabic status of the following consonant.[98]

If the alternating stem is lexically marked, an OT account can be constructed for the vowel length alternations in Hungarian. We need the constraints in (55) and (56) to provide a working model of the alternations in question.

(55) ONSET
*$[_{\sigma}$ V
Syllables must have onsets

(56) IDENT-μ
Correspondent segments have identical moraic associations.

The tableau in (57) illustrates a principled possibility to model Hungarian vowel shortening in OT:

---

[98] I contend that lexically marked stems which participate in seemingly arbitrary CV:C ~ CVC alternations are more prone to morphological leveling than non-alternating stems. The leveling can proceed in the direction of a long or a short allomorph, as illustrated by the Hungarian example.

(57) Vowel shortening in Hungarian

μ μ μ \ / | t u z e k	DEP ONSET	IDENT-μ	MAX-μ
a. μ μ μ \ / / \ t u z e k		*!	
b. μ μ / \ / \ t u z e k	*!		
☞ c. μ μ / / \ t u z e k			*
d. μ μ / / \ t u z e k		*!	

IDENT-μ punishes any deletions or insertions of segmental-to-moraic associations, ruling out candidates (57a) and (57d), and ONSET rules out candidate (57b) which is identical to the input.

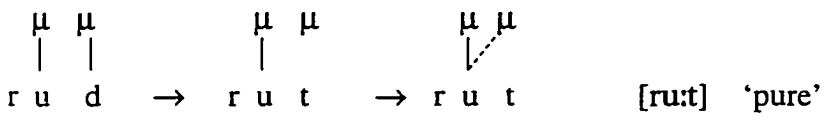
Friulian

Friulian alternations yield to a lexical prespecification account similar to that proposed for Hungarian. However, in Friulian the class of alternating stems is determinable phonologically. Vowel length alternations are present only in stems which end on voiced consonants. Hualde's (1990) proposes that in Friulian only voiced segments in a rhyme can bear moras. When such voiced consonants undergo word-final devoicing, the mora delinks from a voiceless consonants and docks on the preceding vowel, causing lengthening, as illustrated in (58). Voiceless codas do not bear moras underlyingly, word-final devoicing is vacuous in this case, and the lengthening of the preceding vowel does not happen.

(58)

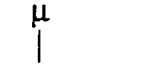
		masc	fem	
a.	/rud/	ru:t	rude	'pure'
	/ros/	ros	rose	'red'

b.



[ru:t] 'pure'

c.



[ros] 'red'

There are several problems with Hualde's account of synchronic CL in Friulian. Lombardi (1991), Cho (1991), and Zec (1988, 1995) explicitly argue that voicing is not relevant for sonority. Additionally, in a sizeable survey of weight typology of Gordon (1999), there appears to be no examples of languages in which the moraicity of the coda depends on its voicing. Thus, under Hualde's account, Friulian would be the only case where devoicing of an obstruent would result in lower sonority.

5.4.3. Comparison of proposed analysis to past approaches

In chapter 2, we have divided problems of the moraic approach in two groups: undergenerating and overgenerating. Undergeneration in moraic theory was addressed in chapters 3 and 4 where we have argued that the undergeneration problems do not need a synchronic account since they belong to the realm of diachrony. In this section, we have addressed the problems of overgeneration which the moraic approach faces. These problems are listed in (59).

(59) Overgeneration

- adjacency problem
- directionality problem

We have accounted for the adjacency problem in the case of phonologically conditioned CL by modeling CVC CL alternations as mora preservation within the syllable, and CVCV CL alternations as mora preservation within the foot. This account predicts that, in the case of synchronic alternations, the deletion of a consonant can only cause lengthening of a tautosyllabic vowel. We have modeled the only case of CL through vowel loss resulting in transparent phonological alternations of the CVCV ~ CV:C type (Lama) as moraic conservation within a foot. This extends the notion of moraic conservation within a syllable to a higher prosodic constituent.

Note that the problem of adjacency does not arise for lexicalized and/or morphologized CVC ~ CV:C alternations which are the outcome of CVCV CL. Since these alternations crucially involve reference to allomorphy, they are constrained by subcategorization frames required by morphological constituents, which makes the adjacency issue vacuous.

The right-to-left directionality of CL follows naturally from the prosodic account. In the case of CVC CL, the directionality is superfluous, since in a syllable only a moraic coda can delete with lengthening of the vowel. Thus, the directionality does not have to be stipulated and does not require a separate account. In the case of CVCV CL, however, the situation is different. Since we model synchronic CVCV CL with a recoverable trigger as moraic conservation within a foot, we predict that the deletion of any vowel within a foot can result in lengthening of the neighboring vowel in the same foot. However, though this is predicted synchronically, we have seen in chapter 4 that diachronically this situation is not prone to arise: diachronic loss of the first vowel in a CVCV sequence does not entail a change in syllable structure, and thus the reanalysis of vowel length is not likely to happen.

5.5. Conclusions

In this chapter, I have argued that alternations resulting from CL through consonant loss and vowel loss require different synchronic treatments. Consonant loss in CVC CL is usually transparent, since it is always segmentally conditioned, assuring synchronic recoverability of its trigger and permitting synchronic CVC CL alternations to be modeled as moraic conservation within the syllable. By contrast, CVCV CL is rarely segmentally conditioned. In most cases the trigger of CVCV CL is not recoverable synchronically, and thus vowel length alternations become lexicalized or morphologized and do not result in synchronic compensatory processes. In those few cases where the loss of the trigger of CVCV CL is segmentally conditioned and thus synchronically recoverable, CVCV CL alternations remain transparent and formally comparable to CVC CL alternations.

Chapter 6.
Summary and conclusions

This study shows the value in differentiating synchronic alternations from diachronic sound changes. Though the latter often result in the former, their motivations are often quite different. Formal analyses of one do not necessarily transfer to the other. In this dissertation I have focused on CL of vowels, which has operated as a sound change in many languages; in a subset of these languages the CL change is still reflected in (often limited) synchronic alternations.

On the basis of a typological survey of 56 languages possessing CL through consonant loss and 22 languages and dialects with CL through vowel loss, I have shown that phonetically, CL processes affecting vowels have a common origin: both arise through phonologization of inherent duration of vowels. To account for the diachronic source of CL, I developed a phonologization model based on a listener-oriented view of sound change: intrinsic phonetic properties of the speech signal are misparsed and reinterpreted, yielding phonologization (Ohala 1981, 1992, 1995).

The phonologization model of CL is based on the assumption that the vowel duration is present in the string in question at all times and is reanalyzed as phonemic length upon changes in its environment. Thus, CL as a historical process does not in fact involve any transfer of length or weight. Rather, intrinsic phonetic vowel durations are reinterpreted as phonologically significant upon a change in the conditioning environment or syllable structure. In the cases of diachronic CL through consonant loss, vowels which are phonetically longer in the environment of neighboring consonants are realized as phonemically long with the loss of conditioning environment. In the cases of CL through vowel loss, vowels in open syllables which are typically realized cross-

linguistically longer than vowels in closed syllables are reinterpreted as long with the change in syllable structure.

Synchronically, however, the manifestation of CL is not always phonetically motivated; it is also not uniform across the two basic types of CL that I have identified. I propose that the nature of the split is due to a difference in the relationship between trigger and target for the two types of CL. Consonant loss in CVC CL is usually transparent, since it is always segmentally conditioned, assuring synchronic recoverability of its trigger and permitting synchronic CVC CL alternations to be modeled as moraic conservation within the syllable. By contrast, CVCV CL is rarely segmentally conditioned. In most cases the trigger of CVCV CL is not recoverable synchronically, and thus vowel length alternations become lexicalized or morphologized and do not result in synchronic compensatory processes. In those few cases where the loss of the trigger of CVCV CL is segmentally conditioned and thus synchronically recoverable, CVCV CL alternations remain transparent and formally comparable to CVC CL alternations.

Previous approaches have offered a single analysis of CL (most influentially as mora conservation), and have not distinguished between synchronic alternations and diachronic sound changes, or between CL triggered by vowel loss and CL triggered by consonant loss. The attempt to account for diachronic developments within the moraic approach lead to wrong predictions. First, the moraic approach predicts that, since only the deletion of a weight-bearing segment can trigger lengthening, a language has to have an independently established weight distinction in order to have CL. We have seen, however, that languages with no evidence for the moraic status of consonants (e.g. Piro or Ngajan) still exhibit CL. Second, the moraic approach predicts the deletion of onsets not to cause CL, since onsets cannot bear weight. However, there are cases of CL through onset deletion in Samothraki Greek, Onondaga, and Romanesco Italian. Third, according

to the moraic approach, only weight-bearing segments can be relevant in CL processes. However, in Slavic, the nature of non-moraic intervening *onset* segments affects the outcome of CL. In addition, modeling the adjacency of the trigger and the target of CL, as well as accounting for the right-to-left directionality of the compensatory processes discussed, presents a challenge for the moraic approach.

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Appendix 1.
Languages with CVC CL

Language	Language family	Segments whose loss causes CL					Comments	References
		glide	*liq*	*nas*	*fric*	*stop*		
Abkhaz	North-West Caucasian	j, w					əj -> i: əw -> u: but not /a/ a -> o: /_w a -> e: /_j	Hewitt 1979
Akkadian	Semitic	j, w				?		Ungnad 1992
Ambialet Occitan	IE; Romance				s			Morin 1992
Bella Coola	Salish					?	CV?C > 1. CV:C 2. CVC[?]	Bagemihl 1991, Cook 1994
Bengali	IE; Indic			gemi nates		gemi nates		Chatterji 1970, Mojumder 1972
Cayuga	Iroquoian		r					Michelson 1988
CiBemba[99]	Bantu			n			prenasaliz-ation	Hyman 1992
Chitimacha	Gulf				h			Swadesh 1946
Choktaw	Muskogean					?		Ulrich 1993
Diegueño	Hokan					?		Langdon 1970
English (dialectal)	IE; Germanic		ɹ					Finegan 1990
Farsi (Tehrani)	IE				h	?		Darzi 1991, Lazard 1992
French	IE; Romance		l	nasal s	s > h			Bichakjian 1986, Pope 1952
Friulian	IE; Romance	j, w						Prieto 1992
Greek	IE	j, w		n	s > h			Allen 1968, 1973, Buck 1963, Lejeune 1987, Sihler, 1995, Steriade 1982, Hock 1986, Viredaz 1983, Wetzels 1986

[99] Most, if not all, Bantu languages exhibit this pattern. Here, I list just the most discussed ones.

Language	Language family	Segments whose loss causes CL					Comments	References
		glide	*liq*	*nas*	*fric*	*stop*		
Greek (Samothraki)	IE		r				onset deletion	Newton 1972
Gurage	Afro-Asiatic		l, r		phary ngeal s			Leslau 1992
Hebrew (Tiberian)	Semitic						morphologic-al (templatic) alternations	Lowenstamm & Kaye 1986
Irish	IE; Germanic				h			Ó Siadhail 1989, Ní Chiosáin 1990
Irish (Tyrone)	IE; Germanic				vls fric > h		onset deletion; a stage of "segmental reduction" (Hock 1986)	Hock 1986, Morin 1992
Italian (Romanesco)	IE; Romance		l				onset deletion; morpholog-ical	Loporcaro 1991
Kabardian	Northwest Caucasian	j, w			h			Colarusso 1992
Kasem	Voltaic		r					Rialland 1993
Ket	Isolate language of Siberia (Paleo-siberian)					?		Dulzon 1964
Klamath	Penutian					?		Barker 1964
Komi Iźma	Uralic		l					de Chene & Anderson 1979, Collinder 1960, Harms 1968
Latin	IE			n	s > h			Bichakjian 1986, Buck 1963, Pope 1952, Sihler 1995
Latvian	IE; Baltic			nasal s				Mathiassen 1997
Leti	Austronesian					?		Hume, Muller & van Engelenhoven 1997
Lillooet	Salish	j w			ʕ ʕʷ		synchronic variation	van Eijk 1997

Language	Language family	Segments whose loss causes CL					Comments	References
		glide	*liq*	*nas*	*fric*	*stop*		
Lithuanian	IE; Baltic			nasal s				Mathiassen 1996
LuGanda	Bantu			n			prenasaliz-ation	Clements 1986, Hubbard 1993a,b, 1995a,b, Hyman 1992, Maddieson 1993
Mohawk	Iroquoian	w			h	ʔ	*Vwy > V:y	Bonneau 1988, Michelson 1988
Ngajan (Dyirbal)	Australian	j	l, r					Dixon 1990
Old English	IE; Germanic			nasal s				Prokosch 1939
Old Frisian				nasal s				Hock 1986
Old Irish	IE; Germanic			n				Prokosch 1939
Old Norse	IE; Germanic			n				Prokosch 1939
Old Saxon	IE; Germanic			nasal s				Prokosch 1939
Oneida	Iroquoian				h			Michelson 1988
Onondaga	Iroquoian		r					Michelson 1986, 1988
Oromo	Cushitic					ɗ		Lloret 1988, Sprouse 1997
Pali (Prakrit)	IE; Indic			gemi nates		gemi nates		Hock 1986, Pischel 1965
Pomo, Eastern	Hokan			n				McLendon 1975
Pomo, Kashaya	Hokan		l	n				Buckley 1994
Quechua, Huallaga	Quechuan					q > χ		Weber 1989
Runyambo	Bantu			n			prenasaliz-ation	Hubbard 1995b
Ruwund	Bantu			n			prenasaliz-ation; also vowels lengthens before geminate nasals	Nash 1992
Sanskrit (Classical)	IE; Indic		r		s, h			Whitney 1886
Sanskrit (Vedic)	IE; Indic				s > h			Wackernagel 1957

Language	Language family	Segments whose loss causes CL					Comments	References
		glide	*liq*	*nas*	*fric*	*stop*		
Spanish (Andalusian)	IE; Romance				s > h		no prior length contrast	Hock 1986:453n2
Sukuma	Bantu			n			prenasaliz-ation	Maddieson 1993
Turkish	Turkic	j, w			h	g > ɣ		Kornfilt 1997, Sezer 1986
Veps (South)	Uralic		l					Zaitseva 1981
Wanka Quechua	Quechuan					ʔ		Floyd 1991
West Saxon	IE; Germanic					g > ɣ		Prokosch 1939
Yurok	Algic				h			Robins 1958

Appendix 2.
Languages with CVCV CL

Language	Language Family	Intervening Segments	Synchronic Alternations Yes/No	Comments	References
Rhenish 'Schärfungs-gebiet'	IE; Germanic	any	no		Hanenberg 1915, Neuse 1915, Frings 1916, Hock 1986
Dithmarschen/ Stavenhagen	IE; Germanic	any	no		Grimme 1922, Hock 1986
Jutland Danish	IE; Germanic	any	no		Ringaard 1982, Hock 1986
Old French	IE; Romance	none	no	trigger: post-tonic schwa target: stressed /ɛi/	Morin 1994
Friulian	IE; Romance	voiced stops, liquids	yes	target: stressed vowels	Repetti 1992, 1994, Prieto 1992, Hualde 1990
Milanese	IE; Romance		yes		Repetti 1992, Sanga 1988
Polish	IE; West[(x)] Slavic		no (Old Polish only)	triggered by loss of jers	Timberlake 1983a,b
Czech	IE; West Slavic		yes	triggered by loss of jers	Timberlake 1983a,b
Upper Sorbian	IE; West Slavic		yes	triggered by loss of jers	Timberlake 1983a,b
Ukrainian	IE; East Slavic		no	triggered by loss of jers	Timberlake 1983a,b
North Čakavian	IE; South Slavic		yes	triggered by loss of jers	Timberlake 1983a,b
South Čakavian	IE; South Slavic		yes	triggered by loss of jers	Timberlake 1983a,b
Posavian	IE; South Slavic		yes	triggered by loss of jers	Timberlake 1983a,b
Estonian	Finno-Ugric		no		Tauli 1954
Hungarian	Finno-Ugric		yes	trigger: short high vowels	Benko & Imre 1972

[(x)] On the conditions on CL in Slavic see Table 1 in chapter 4.

Language	Language Family	Intervening Segments	Synchronic Alternations Yes/No	Comments	References
Sámi	Finno-Ugric		no	phonetic effects?	McRobbie 1990
Lama	Gur	sonorants	yes	trigger: word-final schwa	Ourso 1989, Ourso & Ulrich 1990
Korean			yes	target: inter-sonorant /i/	Kang 1991
Runyoro-Rutooro	Bantu		yes	one morpheme only	Rubongoya 1999
Baasaar	Voltaic	any	yes		Podi 1987, Rialland 1993
Dinka	Nilotic	any	yes (vowel length only)		Andersen 1990