Vocalic Feature Assimilation in Cairene Arabic and Buchan Scots

Contrast and Phonological Activity in the Parallel Structures Model of Feature Geometry

by

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Abstract

This thesis examines two phonological processes in which vocalic features assimilate to neighboring segments with complex consonant-vowel interactions, namely emphasis spread in Cairene Arabic and lowered larynx assimilation in Buchan Scots. I propose a non-linear analysis in the framework of the Parallel Structures Model (PSM) of feature geometry (Morén 2003). This model provides a unified account of the assimilation facts based on the complete phonemic inventories of the respective languages. In this theory, feature specifications are justified primarily on phonologically contrastive behavior. The analysis provided shows that a restrictive model such as the PSM attains a more succinct description of the phonological patterns as well as enhances greater empirical coverage with fewer resources.

The main objective of this study is, therefore, three-fold. The first is to establish the contrastive inventories of Cairene Arabic and Buchan Scots with respect to which segments are phonologically active. The second is to provide full feature specifications of their contrastive segments in the Parallel Structures Model. The third is to describe and account for assimilation processes in these languages and describe the parallels between them in terms of application and feature analysis.

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List of Symbols and Abbreviations

[ ]	boundaries of phonetic forms
/ /	boundaries of surface forms
// //	boundaries of underlying representations
{ }	domain of emphasis spread
>>	dominates
$\sigma^{ʕ}$	pharyngealized syllable
adj.	adjective
ATR	Advanced Tongue Root
$C^{ʕ}$	pharyngealized consonant
$C_{[LL]}$	[Lowered Larynx] consonant
dim.	diminutive
ES	emphasis spread
Eval	evaluator function in Optimality Theory
f.	feminine
IPA	International Phonetic Alphabet
LL	Lowered Larynx
m.	masculine
n.	noun
OT	Optimality Theory
PF	phonetic form
pl.	plural
PSM	Parallel Structures Model
ROTB	Richness of the Base
SF	surface form
sg.	singular
SPE	Sound Pattern of English
UR	underlying representation
v.	verb
V́	Stressed vowel
$V^{ʕ}$	pharyngealized vowel
$V_{[LL]}$	[Lowered Larynx] vowel
voi	voice
VOT	Voice Onset Time

For transcriptions IPA 1993 has been used.

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Introduction

Phoneme inventories are structured in terms of universal elementary components called distinctive features. Within feature geometric models, distinctive features are represented in the form of hierarchical relations. The Parallel Structures Model of feature geometry (Morén 2003) is one such representational framework that allows us to capture segment inventories and their phonological interactions in an elegant, straightforward, and economical manner. The main advantage of this approach is that it recognizes a minimal number of features which combine maximally, resulting in a very restrictive model of segment-internal structure.

The issue of restrictiveness in representational models is central to language learning. The subset principle dictates that the learning strategy of the child selects the more restrictive of a number of competing grammars. From a featural perspective, children are assumed to have limited features in their systems and a number of mechanisms to combine them. Assuming a limited hypothesis space to which children are constrained helps to account for the process of language acquisition, given the huge number of options. A restrictive representational model, therefore, provides the basis to characterize a universal linguistic theory that a child develops to deal with the evidence presented to her. In the generative tradition, this is referred to as *explanatory adequacy*. Chomsky (1965) asserts that in order to advance linguistic theory in the direction of explanatory adequacy, we should attempt to refine the evaluation measure for grammars.

The Parallel Structures Model (PSM) provides a useful tool that reaches beyond the description of language-particular sound patterns to the comprehension of the underlying similarities among them that are characteristic of the language system as a whole and the universal mechanisms that a child utilizes to acquire them. In order to evaluate the adequacy of this tool, therefore, we should examine its ability to account for inventory facts and phonological interactions across languages. The current study goes some way to achieving this goal by applying the PSM to the inventories and phonological processes of Cairene Arabic and Buchan Scots. These languages were selected for two reasons. First, they are typologically unrelated, thus parallel behavior can be seen as robust evidence in favor of the uniformity of the model. Second, they exhibit two phonological processes that can be insightfully described using the geometry of vocalic features, namely emphasis spread and lowered larynx assimilation.

The two patterns in question can be grouped under the term *assimilation*, the most widely recurrent type of phonological behavior. Assimilation can be defined in terms of feature copying (Rose and Walker 2004), i.e. one segment becoming similar or identical to a neighboring segment by duplicating a feature from that segment. Other models, e.g. (Clements and Hume 1995), regard assimilation as the sharing of a feature among different segments. In dealing with assimilation patterns, it is useful to classify segments into four classes according to their roles and behavior. Following Walker (1998), the first category is *trigger* segments; these are segments that initiate the spreading of the relevant feature. The second is the category of *target* segments, which acquire this additional feature through spreading. The third is the category of *blocking* or *opaque* segments, which remain unaffected and block spreading through them. Last is the category of *transparent* segments, which also remain unaffected but allow spreading to continue. As in other aspects of assimilation, the presence or absence of opaque and transparent segments is subject to language-specific conditions and constraints.

This study investigates the unique properties of emphasis spread and lowered larynx assimilation to the end of showing parallels in the behavior of participating segments, despite apparent differences in their descriptions. In order to provide a comprehensive analysis of these patterns, I will explore the relevant interactions in light of the complete phonemic systems of contrast of the respective languages. My analysis employs the Parallel Structures Model of feature geometry (Morén 2003) which denies a one-to-one mapping between phonetic realizations and phonological representations. Therefore, the use of particular features must be justified on the basis of overt phonological evidence. This is a way of analyzing the acquisition process "bottom-up", knowing that the child employs overt evidence to formulate features and rules. By arguing that assimilation processes are featurally motivated in this way, I support the premises of autosegmental phonology (Goldsmith 1976) and the need for structural representations in a constraint-based grammar like Optimality Theory (McCarthy and Prince 1993a; Prince and Smolensky 2004).

The thesis is organized as follows. Chapter 1 briefly outlines the Parallel Structures Model, which might be unfamiliar to the reader. Chapters 2 and 3 introduce the contrastive phonemic systems and provide new accounts of the assimilation processes in Cairene Arabic and Buchan Scots respectively. Chapter 4 concludes the thesis with focus on the implications of this feature geometric model on the uniformity of different assimilation processes across languages.

Chapter 1

The Parallel Structures Model

1.1 Background: Distinctive Features

Current scholarship in feature geometry centers upon the classification of features, the minimal distinctive units of language. The term “distinctive features” was developed to characterize the elements which distinguish phonemes from each other. The original set was proposed by Jakobson, Fant, and Halle (1952) and later extended in the Sound Pattern of English (Chomsky and Halle 1968). Although these features were claimed to have concrete acoustic and articulatory correlates in their original formulation, more current models characterize them in relatively abstract terms. The use of distinctive features in phonology enables us to classify natural classes of segments and, by extension, to generalize regularly occurring phenomena and to formulate predictions about the behavior of class members (Tatham 1999). To formulate correct predictions, a model of feature geometry should be restricted only to those features which exhibit phonologically contrastive behavior in language, i.e. distinctive features.

If certain contrasts are never observed to coexist within one language, then they may be interpreted as mere variants of a single phoneme (Jakobson, Halle et al. 1952:7). This kind of *allophonic* behavior is usually referred to as *redundancy*. One of the main themes of feature geometric theory is to eliminate redundancy from phonological representations. However, redundant property in a certain language may surface as a distinctive feature in another language. To illustrate this, let us consider the case of plain and velarized laterals: [l] vs. $[l^{\gamma}]$. In English, these two variants exist in complementary distribution depending on their position in the syllable; they are phonetic allophones. In Russian, though, the velarized lateral contrasts phonologically with palatalized consonants (Padgett 2001). We conclude that the relevant feature for velarized laterals is distinctive in Russian, but redundant in English. And we need only indicate distinctive feature markings in the phonology of a particular language.

The distinction between redundant and distinctive features brings about the important distinction between phonetics and phonology in a model of feature geometry. I argue that only features which are contrastive somewhere should be mentioned in the grammar. By doing so, the analysis of language into an economic and exhaustive set of features is achieved. The resulting set of distinctive features is then able to uniquely define natural classes of segments, which are responsible for all kinds of phonological behavior in language.

1.2 The PSM: General Outline

The SPE introduced a representational model of distinctive features which are entirely associated with single segments. As a result of this model's inability to account for suprasegmental phenomena and non-local interactions, an autosegmental model of segment interactions was developed (Goldsmith 1976). In this framework, features are treated as autosegments in that they reside on individual tiers and behave independently of their respective segments. Autosegmental phonology later provided the stimulus for the resurgence of new feature geometric models which organize features hierarchically into natural classes. Furthermore, the notion of *class nodes*, non-terminal elements which lack any featural content, was developed to define which features behave together as a group (Uffmann 2005).

An influential contribution in feature geometry is the Unified Feature Theory (Clements 1991; Clements and Hume 1995). This model proposes the unification of consonant place (C-place) and vowel place (V-place) features, which greatly economizes the feature system. For example, the feature [labial] can be associated with a C-place node or a V-place node, and the V-place node is dependent on the C-place node. While the work of Clements makes use of the same features and basic structures for both consonant and vowel place, a more restrictive theory entails the use of similar consonant and vowel structures for place, manner, and laryngeal features.

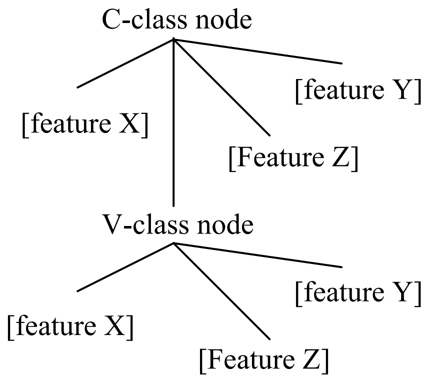
The Parallel Structures Model (Morén 2003) is a new restrictive model of feature geometry in which consonants and vowels exhibit parallel structures for place, manner, and laryngeal features. This unification of consonant and vowel features not only economizes the feature set to the greatest extent possible, but also helps to account for numerous parallelisms and interactions in consonant and vowel behaviors (Morén 2003:194). For example, some assimilation processes (including those examined in this work) involve the interaction of consonants and vowels, indicating that they share certain features. Complex consonants in this model can have vocalic as well as consonantal features. And it is the sharing of vocalic features that explains such interactions.

According to the Parallel Structures Model, phonological segments are composed of a limited set of identical structures and a limited set of privative, abstract features (Morén 2006:18). Feature combinations are thus maximized to ensure an effective degree of economy.

1.3 Class Nodes

The structure of the model relies on classifying features into class nodes. The basic architecture is essentially that proposed by Clements (1991) and is shown in (1).

(1) The basic structure of the PSM (Morén 2003:262)



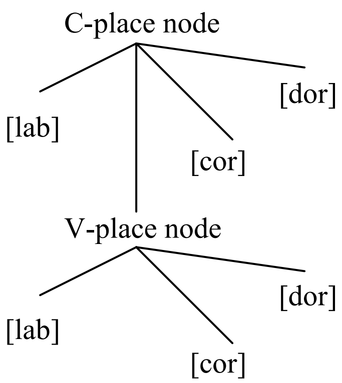
1.3.1 Place Nodes

The unification of consonant and vowel place of articulation has been suggested in current theory of feature geometry mainly in work by Clements (1991) and Clements and Hume (1995). They propose a single set of articulator-based place features (e.g. [labial], [coronal], [dorsal]) which cross-classify C-place and V-place class nodes. Moreover, harmony patterns and secondary place articulations provide evidence that V-place is dependent on C-place.

Consonant places of articulation are quite straightforward. According to Clements and Hume (1995:276), a parallel structure can be assigned to vowels: round vowels involve participation of both of the lips, thus are [lab], front vowels involve the front of the tongue and the palate, thus are [cor], and back vowels involve the tongue dorsum and the velum, thus are [dor].

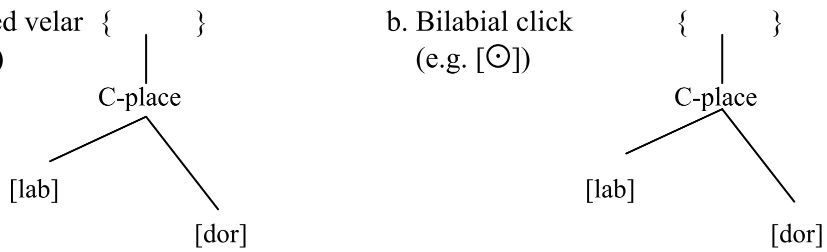
The PSM incorporates the same ideas about place of articulation into its structure. In addition, it makes a distinction between active and passive articulators. Because this is irrelevant to the current study, it will not be discussed here (for detailed discussion see Morén 2003). The diagram in (2) outlines the structure of place node in the PSM.

(2) The basic structure of place nodes



While simple consonants only have a C-place node (e.g. [lab], [cor], or [dor]), vowels have both C-place and V-place nodes, with a terminal feature on the V-place node. Consonants with secondary articulation have terminal features on both C-place and V-place nodes. On the other hand, complex segments have a single root node and more than one terminal feature associated with that class node (Morén 2003:234). For example, a labialized velar [k͡p] and a bilabial click [ʘ] can both have multiple C-place features ([lab] and [dor]), as shown in (3). In other words, they constitute an equivalence class phonologically, despite being phonetically different. An interesting prediction of this (to be tested empirically) is that no one language can contrast the doubly-articulated [k͡p] and [ʘ].

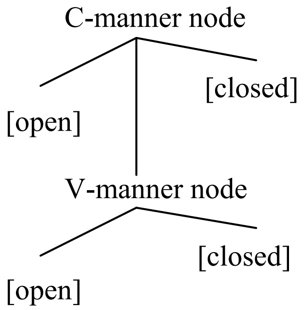
(3) a. Labialized velar (e.g. [k͡p]) b. Bilabial click (e.g. [ʘ])



1.3.2 Manner Nodes

In order to provide manner structures that parallel the structures used for place, the PSM proposes (4).

(4) The basic structure of manner nodes



This representation captures the articulatory similarity between consonant constriction and vowel constriction using parallel nodes and the same terminal features, which makes it different from Clements and Hume (1995). There are two manner nodes, one for consonants and one for vowels, and two features, [open] and [closed]. Moreover, V-manner is dependent on C-manner, just as Clements claims that V-place is dependent on C-place. Using this geometry, a stop has a C-manner of [closed], a fricative has a C-manner of [open], a high vowel has a V-manner of [closed], and a low vowel has a V-manner of [open] (Morén 2003:224). This distribution eliminates the need for the major class features.[1] Consonants differ from vowels via the presence or absence of a C-manner terminal feature. Sonorants differ from obstruents via the presence or absence of a V-manner terminal feature. Thus, the answer to the question why the major class features do not behave like other features is simply that they are not features at all. They are defined structurally rather than featurally, as outlined in (5).

(5) Major class feature distinctions in the PSM (Morén 2003:227)

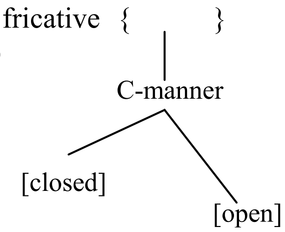
Consonant class:	Presence of a C-manner feature
Vowel class:	Absence of a C-manner feature
Sonorant class:	Presence of a V-manner feature
Obstruent class:	Absence of a V-manner feature

[1] The major class features are typically considered to be [±consonantal] and [±sonorant]. Current models do not give a satisfactory answer as to why the major class features do not behave as other features do. That is, they do not seem to spread or de-link independently, and while other features may be absent from a given segment or even absent from an entire language, the major class features seem always to be present. Some accounts stipulate that the major class features behave the way they do because they are associated directly with the root node (Morén 2003:195-197).

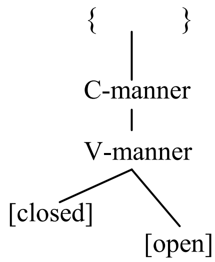
Furthermore, the model eliminates the need for a [lateral] feature by assuming that it is likewise defined structurally in terms of manner features. For example, if laterals are sonorous in a language, they can be specified for C-manner[closed] and V-manner [closed].

Such complex segments which combine [open] and [closed] manner features are found for both consonants and vowels. A language that has both a fricative [s] and a lateral fricative [ɬ] can distinguish them structurally by assigning a C-manner[open] terminal feature to [s] and an additional C-manner[closed] feature to the articulatorily complex [ɬ], as shown in (6a). On the other hand, mid vowels are specified for both V-manner[open] and V-manner[closed] to be distinguished from high and low vowels (6b). This is justified phonetically since they involve simultaneous raising and lowering gestures which result in an intermediate tongue position and a vocal tract constriction mid-way between a high and low vowel (Morén 2003:235).

(6) a. Lateral fricative (e.g. [ɬ])



b. Mid vowel (e.g. [e])



1.3.3 Laryngeal Nodes

The PSM claims that the laryngeal representations and feature set are basically the same as manner of articulation. This makes sense from an articulatory perspective since both laryngeal specifications and manner of articulation involve degrees of constriction of the vocal tract and articulator rigidity (Morén 2003:233).

The model suggests a similar mapping between consonantal and vocalic laryngeal features based on similarities between various degrees of glottal constriction and tones. It argues, for example, that constricted glottis and spread glottis in the consonants behave parallel to high and low tones in the vowels. These facts may be interpreted as evidence of [closed] and [open] features associated with C-laryngeal and V-laryngeal nodes respectively.

This parallel behavior captures the assimilation asymmetries between consonant and vowel laryngeal features. As we will see in Buchan laryngeal assimilation, for example, the vocalic laryngeal feature may spread from a vowel across intervening consonants without association-line crossing if there are adequate constraints against associating a vocalic laryngeal feature with consonants.

1.4 An Illustration of the PSM

The basis of the Parallel Structures Model is parsimony. By assuming that a grammar has as few features as possible (given the contrasts necessary), it eliminates those redundant features that make no difference in the observable predictions of the phonology. In order to achieve this, the model presupposes that each feature is in principle autonomous and that more complex structures are built from less complex structures. A natural requirement of the model, thus, is that every independently-occurring feature in the grammar is represented exclusively with a simple segment – having only a manner feature, only a place feature, or even only a laryngeal feature. These segments which have only one feature each will be referred to as the "unit segments".[2] More complex segments form as a result of adding other (already used) features to unit segments. This way maximal economy is achieved in the grammar.

One crucial assumption of the model is that it denies a one-to-one mapping between phonetics and phonology. This has three main implications. First, phonological behavior may be a more important diagnostic of representation than pronunciation. Therefore, the phonological feature specifications of a certain segment do not necessarily match its phonetic characteristics. For example, the phonetic affricates may be represented as phonological stops, if they behave like stops in a language. Second, by focusing on the contrastive inventory of a given language, segments are included only if there is positive phonological evidence for their existence. The result of this is usually not a mirror of the phonetic inventory. Third, the model hypothesizes that phonological encodings of a given phonetic form are determined on a language-by-language basis. For instance, the same IPA symbol can have different feature specifications in different languages depending on how it behaves and patterns.

In order to demonstrate how the Parallel Structures Model applies these principles to establish minimal feature specifications, it is necessary to examine a whole phonologically contrastive inventory. For expository reasons, I will consider the impoverished inventory of Hawaiian, which consists of 8 contrastive consonants [p, t, h, n, m, l, w, ʔ] and 5 contrastive vowels [a, i, e, o, u], [3] following (Morén 2005). In this small inventory, segments contrast in C-place, C-manner, and V-manner, but not in V-place or laryngeal features. C-place contrasts are limited to [labial] and [coronal]. C-manner contrasts display stop, fricative, and nasal features. Overall, the

[2] The model also allows featureless segments (e.g. epenthetic vowels). These are not "unit segments", but rather bare nodes.

[3] Morén (2005) argues that the following pairs are allophonic, but not contrastive, in Hawaiian: [k]~[t], [l]~[r], and [w]~[v]. As a consequence, one phonologically contrastive segment represents each pair.

inventory contrasts among two major classes (consonants and vowels) and within each of these major classes, there are manner and height distinctions.

Based on the earlier discussion of manner nodes, we can distinguish the major class features in this language. Stops are characterized with a C-manner[closed] feature, fricatives with a C-manner[open] feature, and nasals with both C-manner [closed] and V-manner[closed]. On the other hand, high vowels are characterized with a V-manner[closed] feature, low vowels with a V-manner[open] feature, and mid vowels with both V-manner[closed] and V-manner[open]. Given these assumptions, we can describe the Hawaiian inventory in (7). Shaded cells indicate “unit segments”.

(7) PSM feature specifications for Hawaiian segment inventory (Morén 2005)

			C-place		C-manner		V-manner	
			lab	**cor**	**closed**	**open**	**closed**	**open**
Consonant	Mannerless	**[w]**	✓					
		[l]		✓				
	Stop	**[ʔ]**			✓			
		[p]	✓		✓			
		[t]		✓	✓			
	Continuant	**[h]**				✓		
	Stop+ Continuant	**[n]**			✓	✓		
		[m]	✓		✓	✓		
Vowel	High	**[i]**					✓	
		[u]	✓				✓	
	High+Low	**[e]**					✓	✓
		[o]	✓				✓	✓
	Low	**[a]**						✓

Several observations need to be highlighted in this chart. First, the model requires two mannerless “unit segments” which represent the features C-place[lab] and C-place[cor]. The choice of [w] and [l] here is phonetically justified because the glide [w] involves participation of the lips and the lateral [l] involves the front of the tongue and the palate. In addition, [w] and [l] seem to have the weakest constriction of all the consonants in this language. Second, the more structurally complex segments are built from the less complex ones. For example, the rounded high vowel [u] is composed of V-manner[closed], represented in [i], in addition to C-place[lab]. Third, the characterization of the glide [w] is consonantal in this language, while the same phonetic sound may have V-place in some other languages. Finally, relative markedness relationships among manners and heights are captured via relative structural complexity of the segments (Morén 2006:21). For instance, stops and fricatives are less marked than nasals because they each have only a single manner feature, whereas nasals have two. Similarly, high and low vowels are less marked than mid vowels because they each have only a single manner feature, whereas the mid vowels have two.

1.5 Summary

The Parallel Structures Model utilizes parallel structures and feature sets whenever possible. Moreover, it eliminates a large number of features from the grammar. This guarantees an economical representation of the grammar based on relatively abstract (but still phonetically-grounded) features and structures. The parallelism of the model is achieved by a vowel class node being dependent on a consonant class node with regard to place of articulation, manner of articulation, and laryngeal features, and the same features are used at both levels. This model denies the existence of major class features and classifies them structurally through the presence or absence of manner features. Further, the model claims that manner of articulation and laryngeal specification use the same features since they both represent degree of vocal tract constriction and articulator rigidity (Morén 2003:243).

The assumption that more complex structures are built from less complex structures is central to the analysis of any language inventory. And the assumption that consonants and vowels make use of the same features captures consonant-vowel interactions in a straightforward manner. These basic assumptions in the architecture of the PSM will prove extremely useful in characterizing the phonemic systems of Cairene Arabic and Buchan Scots in the subsequent chapters.

Chapter 2

Contrast and Phonological Activity in Cairene Arabic

2.1 Introduction

Surprisingly, there is little agreement among linguists on the inventories of the Arabic dialects of today. Compared to Classical Arabic, there have been significant changes in the number and pronunciation of both consonant and vowel phonemes in the modern dialects. Conflating dialectical data with the standard language and among the dialects themselves has resulted in serious confusion whenever phonological distinctions and contrasts are analyzed in specific dialects. This chapter is an attempt to provide a coherent and detailed analysis of the synchronic facts of one dialect, namely Cairene Arabic (henceforth Cairene).[4] The analysis will focus on the phonological phenomenon of *emphasis*, the understanding of which has direct implications for the size and structure of the whole inventory.

Emphasis has been considered such a prominent characteristic of Arabic that the language is sometimes called *luɣat ad-dˤa:d*, the language of *dˤa:d*, the name of one of the emphatic consonants. Such emphatic segments are known to condition adjacent strings of segments to bear the same property, a mechanism usually described as "emphasis spread". Emphasis spread (henceforth ES) is a process of assimilation by which a phonological feature,[5] i.e. pharyngealization, extends over more than one segment (Owens 1993:25) through a regular pattern. ES in Cairene is regulated by an intricate set of factors which have been the subject of much controversy, including the consonants which constitute underlying emphatics, the

[4] The data discussed in this chapter comes from my own dialect, a colloquial variety spoken in Cairo.

[5] A number of different terms have been employed to refer to this phenomenon. In addition to 'emphasis', which is a translation of the Arabic *tafxim*, the terms 'velarization', 'backing', 'pharyngealization', and recently 'dorsalization' have been widely used.

features needed to define them, the rules needed to describe their effect on neighboring segments, and the effect of opaque segments on assimilation. This chapter tries to resolve some of these controversial issues and provide a uniform representation of emphasis spread facts in the Parallel Structures Model of feature geometry. My analysis suggests that the behavior of segments under ES diagnoses inventory structure and featural makeup.

The inventory of Cairene Arabic exhibits extensive phonetic variations sometimes limited to very specific environments. The first section in this chapter describes the phonetics of Cairene showing some of these variations. Then, by presenting phonological behavior and data, I will make some predictions about the phonologically contrastive inventory of Cairene. The following section establishes the feature specification for each segment in the Parallel Structures Model, leading to a uniform description of the phonemic system. Given PSM specifications, emphasis spread facts fall out neatly. This is further demonstrated in autosegmental and optimality-theoretic analyses of ES. The final section compares my analysis to previous accounts of emphasis spread in Cairene Arabic.

2.2 The Surface Inventory of Cairene Arabic

2.2.1 Surface Consonants

The surface inventory of Cairene consonants is given in (1).

(1) *Detailed table of 47 phonetic Cairene consonants*

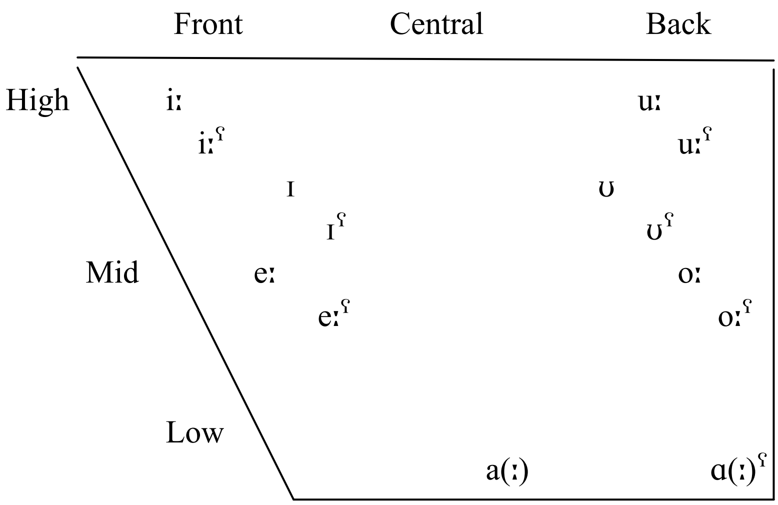
	Bilabial		Dental		Palatal		Velar		Uvular	Pharyngeal		Glottal
Stop		b bˤ	t tˤ	d dˤ			k kˤ	g gˤ	q			ʔ ʔˤ
Fricative	f fˤ	v vˤ	s sˤ	z zˤ	ʃ ʃˤ	ʒ ʒˤ	x xˤ	ɣ ɣˤ		ħ ħˤ	ʕ ʕˤ	h hˤ
Nasal		m mˤ		n nˤ								
Lateral				l lˤ								
Trill				r rˤ								
Glide		w wˤ				j jˤ						

Two important observations need to be highlighted regarding this consonant inventory. First, it is quite striking that all consonants except [q] have both plain and pharyngealized counterparts. The difference can be clearly heard next to low vowels: all consonants are plain next to [a] and pharyngealized next to [ɑˤ], including the pharyngeals themselves. However, as we will see in the next section, [q] can only precede [ɑˤ], but never [a]. Second, the lack of a voiceless labial stop in Cairene (as in other Arabic dialects) results in a gap that deserves explanation.

2.2.2 Surface Vowels

The chart in (2) shows the approximate locations of short and long monophthongs in Cairene.[6] Note that the pharyngealized vowels have significantly lower F2 than non-pharyngealized vowels (Zawaydeh 1998). This is reflected in the backing and lowering of pharyngealized vowels in comparison with non-pharyngealized vowels of similar quality. A puzzling asymmetry about this chart is the absence of short mid vowels [e, o], which will be discussed in detail subsequently.

(2) *Chart: Surface vowels in Cairene*



2.3 The Contrastive Inventory of Cairene Arabic

The model of phonology adopted here excludes allophonic details from the surface form. To describe the phonemic system, therefore, we should analyze how segments behave in the language based on phonologically contrastive behavior. The data provided in this section will focus on the interactions of pharyngealized and non-pharyngealized segments and the asymmetrical distribution of mid vowels.

2.3.1 Contrastive Consonants

Pharyngealized Consonants

One interesting characteristic about Cairene Arabic inventory is that all segments except [q] have pharyngealized counterparts, but some of these are found only in very restricted environments. All consonants are necessarily emphatic in a syllable containing a pharyngealized vowel [ɑˤ], as shown in (3).

[6] There are many more phonetic forms of vowels that surface according to stress, consonant sequence, and morphology; but such details are beyond the scope of this study. See Harrell (1957), Norlin (1987), or Gary and Gamal-Eldin (1982) for more detailed discussion of phonetic allophones.

(3)	[rˤɑˤmˤɑˤdˤ]	‘ophthalmia’	[ʔˤɑˤbˤlˤɑˤ]	‘ma’am’
	[mˤɑˤːmˤɑˤ]	‘mum’	[fˤɑˤʔˤrˤ]	‘poverty’
	[tˤɑˤːbˤ]	‘cooked’	[dˤɑˤlˤɑˤːlˤ]	‘backsliding’
	[ʃˤɑˤtˤtˤɑˤ]	‘chili’	[jˤɑˤsˤtˤɑˤ]	(title)
	[gˤɑˤbˤrˤ]	‘algebra’	[kˤɑˤːkɪ]	‘cackle’
	[ɣˤɑˤrˤbˤ]	‘west’	[xˤɑˤdˤdˤ]	‘startled’
	[ʕˤɑˤsˤɑˤfiːr]	‘sparrows’	[ħˤɑˤrˤɑˤːmˤ]	‘forbidden’

However, of all the pharyngealized sounds, only some coronal consonants [dˤ, tˤ, sˤ, zˤ, rˤ] can appear in environments other than [ɑˤ]. Essentially, they exist in the onset of a syllable containing a long non-low vowel [iːˤ, uːˤ, eːˤ, oːˤ] or a short high vowel [ɪˤ, ʊˤ] and no other pharyngealized sounds in the word (4).

(4)	[tˤiˤːnɪ]	‘my mud’	[tˤuˤːbɪ]	‘my stones’
	[zˤʊˤlˤmɪ]	‘my injustice’	[dˤɪˤħɪk]	‘laughed’
	[sˤeˤːfɪ]	‘my summer’	[sˤeˤːnɪ]	‘Chinese’
	[rˤoˤːħɪ]	‘my soul’	[rˤuˤːħɪ]	‘go (f.sg.)’

All other pharyngealized consonants only occur in syllables containing a pharyngealized low vowel [ɑˤ]. Their non-pharyngealized counterparts only occur in syllables not containing a pharyngealized low vowel, if none of the consonants [dˤ, tˤ, sˤ, zˤ, rˤ] exists in the same word. This is exemplified in (5).

(5)	[bˤɑˤːbˤɑˤ]	‘dad’	[baːba]	(name of a Coptic month)
	[ʔˤɑˤbˤlˤɑˤ]	‘ma’am’	[ʔabla]	‘before’
	[wˤɑˤlˤlˤɑˤ]	‘by God’	[walla]	‘or’
	[kˤɑˤːkɪ]	‘cackle’	[kaːki]	‘khaki’
	[ʔˤɑˤxˤxˤ]	‘brother’	[baxx]	‘sprinkled’

This complementary distribution has led to many claims about the underlying nature of both vowels and consonants. I take the fact that all consonants are pharyngealized in syllables containing a pharyngealized low vowel [ɑˤ] as evidence that this vowel has an underlying pharyngealization feature. On the other hand, the restricted distribution of pharyngealized non-low vowels suggests that the presence or absence of pharyngealization is contrastive for the coronals [dˤ, tˤ, sˤ, zˤ, rˤ].

In addition to assimilation within syllables, Cairene also displays what is usually called “emphasis spread”. This is, essentially, long distance assimilation of the pharyngealization feature throughout the phonological word domain, triggered by a segment that bears this feature contrastively. Emphasis spread is bidirectional, but there are interesting differences in behavior depending on the direction of spread.

Spreading from right to left is absolute and extends to the beginning of the word, whereas spreading from left to right is interrupted by a subset of vowels and consonants. I claim that the underlying triggers of emphasis spread are limited to the set of pharyngealized coronals [dˤ, tˤ, sˤ, zˤ, rˤ] and the pharyngealized low vowel [ɑˤ]. These are the only underlying emphatic segments in the language. The set of targets depends on the direction of spread. In leftward spread, all segments in the word domain are targets, as in (6) and (8). In rightward spread (7), the targets are all segments except non-tautosyllabic [ɪ, iː, eː, ʒ]. These non-targets are also the set of blockers; they neither become pharyngealized nor allow pharyngealization to spread through them, as shown in (9). Watson (2002) and Younes (1993) suggest that the glide [j] is also a blocker in Cairene. However, the evidence they provide is exclusively based on cases of [j] adjacent to [ɪ]. All examples in which [j] occurs without [ɪ] do not show a blocking effect, indicating that [j] is not contrastively opaque to ES. Note also that the voiceless palatal fricative [ʃ] is not a blocker.

The examples below introduce surface phonological representations of these emphasis spread facts. Curly brackets indicate the pharyngealization domain of target segments. Triggers are marked as pharyngealized inside the brackets, {ˤ}. Opaque segments in both blocked and unblocked patterns are shown in bold.

(6) *Right-to-left spread with no blockers*

/{bɑsɑtˤ}/	'entertained'	/{ʃɑbɑtˤ}/	'clung'
/{ħɑmɑdˤ}/	'became sour'	/{ʔɑbjɑdˤ}/	'white'
/{mɑɣɑsˤ}/	'stomachache'	/{bɑːzˤ}/	'malfunctioned'

(7) *Left-to-right spread with no blockers*

/{tˤɑbbɑx}/	'cook'	/{tˤɑħuːnɑ}/	'mill'
/{dˤɑlɑːl}/	'backsliding'	/{dˤʊjuːf}/	'visitors'
/{sˤɑjjɑːd}/	'fisherman'	/{sˤʊdfɑ}/	'coincidence'
/{sˤʊdɑːʕ}/	'headache'	/{zˤʊlm}/	'oppression'

(8) *Unblocked right-to-left spread*

/{jɪʔʊsˤsˤ}/	'cuts'	/{jɪbuːzˤ}/	'malfunctions'
/{mɪbjɑdˤ}/	'ovary'	/{tɪnbɪsɪtˤ}/	'you become entertained'

(9) *Blocked left-to-right spread*

/{sˤɑː}ħ**ɪ**b/	'friend'	/{tˤɑwɑː}b**ɪ**ʕ/	'stamps'
/{dˤɑruː}r**ɪ**/	'necessary'	/{mɑˤj}j**ɪ**t**ɪ**/	'my water'
/{ʕɑsˤɑ}f**iː**r/	'sparrows'	/{sˤɑ}ħ**iː**ħ/	'correct'
/{tˤɑr}**iː**ʔ/	'road'	/{dˤɑ}l**iː**ʕ/	'robust'
/{tˤɑbɑ}ʔ**eː**n/	'two plates'	/{zˤɑr}f**eː**n/	'two envelopes'
/{tˤɑ}**ʒ**akɪstaːn/	'Tajikistan'		

An interesting complication in emphasis spread is that the pharyngealized trill [rˤ] is a trigger, but spreading from [rˤ] is blocked in both directions. Unlike other triggers where ES is never blocked from right to left, ES from [rˤ] is blocked in this direction. Compare (8) with (10c).

(10) (a) *Leftward spread from /rˤ/*

/{baʔarˤ}/	'cows'	/{gʊħrˤ}/	'burrow'
/{bʊħu:rˤ}/	'seas'	/{ʕʊbu:rˤ}/	'crossing'

(b) *Rightward spread from /rˤ/*

/{rˤamad}/	'ophthalmia'	/{rˤahawa:n}/	'ambler'
/{rˤasu:l}/	'messenger'	/{rˤumma:n}/	'pomegranate'

(c) *Blocked leftward spread from /rˤ/*

/tɪ{ga:rˤa}/	'trade'	/sɪ{fa:rˤa}/	'embassy'
/ʔɪnfɪ{ga:rˤ}/	'explosion'	/ʔɪstɪʕ{ma:rˤ}/	'occupation'

(d) *Blocked rightward spread from /rˤ/*

/{rˤa:}mɪ/	(personal name)	/{rˤʊma:}dɪ/	'grey'
/{rˤa:}gɪl/	'man'	/{rˤa}b**i:**ʕ/	'spring'

Emphasis spread is fundamentally bidirectional in Cairene, as shown in (11a). In terms of blocking, the bidirectional pattern is the union of leftward and rightward spread: ES from all triggers except [rˤ] is not blocked from right-to-left, but blocked in the other direction (11b-c). This dual effect also applies within the same word.

(11) (a) *Bidirectional ES*

/{mazˤlu:m}/	'oppressed'	/{basˤala}/	'onion'
/{xadˤdˤar}/	'made green'	/{matˤar}/	'rain'
/{ʕatˤʃa:n}/	'thirsty'	/{maʃrˤʊba:t}/	'drinks'
/{ʔʊmmaˤ:l}/	'of course'	/{maˤjja}/	'water'

(b) *Blocked bidirectional ES*

/{mɪtˤaj}jɪn**i:**n/	'muddy (pl.)'	/{ʔɪttɪsˤala:}tɪ/	'my communications'
/{mʊtazˤah}r**i:**n/	'demonstrators'	/{ʔazrˤabaj}ʒa:n/	'Azerbaijan'

(c) *Unblocked bidirectional ES*

/{jɪmʊtˤtˤaha}/	'he stretches it'	/{bɪdˤa:nʊ}/	'his testis'
/{ʔɪttɪsˤala:t}/	'communications'	/{ʔɪxtɪsˤa:sˤa:t}/	'specializations'

The Uvular and the Pharyngeals

The uvular consonant [q] does not trigger emphasis spread, but it causes a lowering of adjacent short high vowels [ɪ, ʊ] and the low vowel [a(:)], both short and long (12a). This is a kind of phonetic enhancement resulting from the extremely backed place of articulation for [q]. Thus, it is not phonologically significant. On the other hand, the pharyngeal consonants [ħ] and [ʕ] may only elicit a phonetic lowering of short high vowels [ɪ, ʊ] as in (12b); they may exist next to a lowered [$\text{ɑ}^{(\text{ʕ})}$] just as targets of ES. The long vowels [iː uː aː oː eː], by contrast, are not lowered in the immediate environment of the pharyngeals or the uvular (Watson 2002:278) as in (12c). To make this phonetic effect clear, I transcribe lowered high vowels with ˕.

(12)	(a)	[qɑˤwmɪ]	'national'	[qɑːˤfɪla]	'caravan'
		[ʔɪnqɪ˕laːb]	'turnover'	[qʊ˕ddaːs]	'mass'
	(b)	[ɪ˕ħna]	'we'	[ħʊ˕bb]	'love'
		[tɪ˕ʕmɪl]	'she makes'	[ʕʊ˕mf]	'violence'
	(c)	[qoːs]	'bow'	[qeːd]	'restraint'
		[waħiːd]	'alone'	[beːʕ]	'sale'
		[loːħ]	'board'	[mabħuːħ]	'hoarse'

Labial Stops

It is important to tackle the asymmetry in the laryngeal specification of stops. As is typical in Arabic dialects, there is a voiced bilabial stop, but not a voiceless bilabial stop. Since there is no contrast for this segment, the surface realization could be either voiced or not and the implication would not be the specification of a phonological feature. Rather, the voicing would either be a default spontaneous voicing like the one found for sonorants, or it could be a language-particular phonetic enhancement strategy. I will assume the latter.

Borrowed Consonants

Before outlining the contrastive inventory, it is worthwhile to clarify the status of the so-called borrowed consonants in Cairene. In most accounts (e.g. Lehn 1963; Watson 2002), one or more of the consonants [v], [ʒ], or [q] are excluded from the inventory or, at best, described as "marginal" phonemes. The main reasons for this include that they are "extremely rare", "usually associated with loanwords", or "limited to the speech of educated speaker". Such arguments seem to be non-synchronic, as I discuss below in more detail.

Contrary to Standard Arabic, Cairene has a voiced labio-dental fricative [v] which is usually restricted to loanwords (Watson 2002:14) as exemplified in (13). From an acquisition perspective, children who use these words do not know that they are borrowed. In addition, there is one minimal pair in which voiced [v] contrasts with its voiceless counterpart [f]: [vɪlla] ~ [fɪlla] 'villa' ~ 'cork'. And although a fraction of uneducated speakers replace [v] with [f] in some words, I argue that [v] should appear phonologically as part of Cairene Arabic inventory.

(13)

[tɪlɪvɪzjoːn]	‘television’	[vɪdjʊ]	‘video’
[vɪlla]	‘villa’	[vajruːs]	‘virus’
[vɪtamiːn]	‘vitamin’	[nʊvambɪr]	‘November’

The palato-velar fricative [ʒ] also seems to surface in Cairene (Gary and Gamal-Eldin 1982). The segment is only found in loanwords (usually in place of [d͡ʒ]), some of which are extremely common and established everyday language, as shown in (14). Furthermore, [ʒ] is phonologically active as a blocker of ES. This participation of a borrowed sound in one of the most intrinsic phonological phenomena in the borrowing language is a strong argument that [ʒ] is a full-fledged participant in the phonological system.

(14)

[ʒakɪtta]	‘jacket’	[bɪʒaːma]	‘pajamas’
[tɪknʊlʊʒja]	‘technology’	[ʔʊksʊʒiːn]	‘oxygen’
[ʒɪhaːn]	(Persian name)	[beːʒ]	‘beige’

Finally, I claim that the uvular stop [q] is also a segment in the contrastive inventory of Cairene. One of the well-known facts is that Standard Arabic [q] has been reduced historically to a glottal stop reflex in Cairene (Watson 2002). This systematic process has led to its description as a “marginal” or “borrowed” sound. However, it is maintained in the language in numerous words, including those mentioned in (12). Further, it is associated with a phonetic quality of “semi-emphasis” (Ferguson 1956), which suggests that it is an active segment in the inventory.

Outline of Cairene Contrastive Consonants

Based on the above discussion, we can describe the contrastive consonant inventory of Cairene Arabic in (15).

(15) *Phonetic descriptions of 29 contrastive consonants*

	Bilabial	Dental	Palatal	Velar	Uvular	Pharyg	Glottal
Stop	b	t tˤ d dˤ		k g	q		ʔ
Fricative	f v	s sˤ z zˤ	ʃ ʒ	x ɣ		ħ ʕ	h
Nasal	m	n					
Lateral		l					
Trill		r rˤ					
Glide	w		j				

2.3.2 Contrastive Vowels

Vowel Length

Cairene has four vowel qualities that come in long-short pairs [ɪ, ʊ, a, ɑˤ] and [iː, uː, aː, ɑˤː] in addition to two long mid vowels [oː] and [eː]. Although short and long vowels exhibit contrasts in minimal or semi-minimal pairs (16), the length feature is almost always predictable from the morphology and prosody of the language. Discussion of these complexities is beyond the scope of this work and length will be ignored here.

(16)	[sɪbtiːnɪ]	'you (f.sg.) left me'	[sɪbtɪnɪ]	'you (m.sg) left me'
	[sɪnnuːhʊm]	'grind (pl.) them'	[sɪnnʊhʊm]	'grind (m.sg) them'
	[maːlɪk]	'your (f.sg.) money'	[malɪk]	'king'
	[tˤɑˤlˤɑˤbˤ]	'asked'	[tˤɑːˤlˤɪˤbˤ]	'demanded'

(Harrell 1957:62)

Mid Vowels and Diphthongs

A puzzling fact about Cairene vowel system is connected to the absence of short mid vowels. Long mid vowels alternate with long high vowels (17a) and with long low vowels (17b). However, short mid vowels are absent from the surface phonology.[7]

(17) (a) *Long-mid vs. long high vowels*

[meːl]	'inclination'	[miːl]	'incline (m.sg)'
[bˤeːˤdˤ]	'eggs'	[bˤiːˤdˤ]	'lay eggs (m.sg)'
[moːt]	'death'	[muːt]	'die (m.sg)'
[dˤoːˤrˤ]	'turn (n.)'	[dˤuːˤrˤ]	'turn (m.sg)'

(b) *Long-mid vs. long low vowels*

[beːt]	'house'	[baːt]	'spent the night'
[tˤeːˤrˤ]	'birds'	[tˤɑːˤrˤ]	'flew'
[loːm]	'blame (n.)'	[laːm]	'blamed'
[sˤoːˤm]	'fasting'	[sˤɑːˤmˤ]	'fasted'

(Harrell 1957:62)

Jastrow and Behnstedt (1980) claim that the long-mid vowels have developed historically from Classical Arabic sequences of vowel + glide: aj → eː and aw → oː. This is schematized as follows.

[7] Abdel-Massih (1972) mentions short [e] and [o] in Cairene inventory. Words with short [e] and [o] are obtained by morphological processes, adding pronominal suffixes to verbs and nouns with long [eː] and [oː] vowels, respectively. By means of a rule shortening long vowels before two following consonants, he gets the minimal pair: [betna] 'our house' (from [beːt] 'house') vs. [bɪtna] 'we spent the night'. Although I have several objections to this conclusion, discussion of such morphologically-derived examples is beyond the scope of this research.

(18)	Classical Arabic: //sˤɑjf//	→	Cairene: /{sˤeːf}/	‘summer’
	Classical Arabic: //lawn//	→	Cairene: /loːn/	‘color’

However, Cairene has also kept several diphthongs:[8] [ɪw, ɪj, aw, aj, ɑˤw, ɑˤj], as shown in (19).

(19)	[ʔɪwʕa]	‘go away’	[mɪjja]	‘hundred’
	[dawʃa]	‘noise’	[lajla]	(personal name)
	[tˤɑˤwˤlˤɑˤ]	‘backgammon’	[zˤɑˤjˤtˤɑˤ]	‘uproarious (f.sg.)’

To reconcile these two facts, Broselow (1976) argues that coalescence in Cairene was a historical process which no longer applies. As a result, newer forms with diphthongs were preserved intact. This terminated historical process has led to a situation in which mid-vowel monophthongs contrast with derived diphthongs in minimal pairs in the modern dialect. This is shown in (20).

(20)	[ʕawza]	‘wanting (f.sg.)’	[ʕoːza]	‘want (n.)’	(Watson 2002:23)
	[ʃajla]	‘carrying (f.sg.)’	[ʃeːla]	‘burden’	(Watson 2002:23)
	[bˤɑˤjˤdˤɑˤ]	‘laying (eggs)’	[bˤeːˤdˤɑˤ]	‘egg’	

From a diachronic perspective, we may be able to say that the absence of short mid vowels is simply an accident of history and that mid vowel phonemes are subject to a constraint prohibiting them from associating with a single mora (Watson 2002: 48). However, such analysis is inapplicable to the synchronic facts of the modern dialect. I suggest that mid vowels are still the result of merger, and that high vowels and glides are featurally distinct from one another (one is vocalic and the other is consonantal). In essence, long mid vowels are underlyingly combinations of low + high vowels, while diphthongs are underlyingly combinations of low vowels + glides. (21) summarizes the facts of modern Cairene mid vowels and diphthongs.

(21) *Diphthongs and long mid vowels in Modern Cairene*

(a) //aj//	→ /aj/		//aw//	→	/aw/	
//lajla//	→ /lajla/	(personal name)	//mawguːd//	→	/mawguːd/	‘present (adj.)’
(b) //ai//	→ /eː/		/au/	→	/oː/	
//sˤaif//	→ /{sˤeːf}/	‘summer’	//laun//	→	/loːn/	‘color’

---

[8] Diphthongs may come in two flavors. Rising diphthongs (aka on-glides) consist of a glide preceding a vowel, e.g. [jʊ]. Falling diphthongs (aka off-glides) generally have a full vowel followed by a glide, e.g. [ai] (Source: www.everything2.com). Since onset glides are more consonantal than vocalic, I will restrict the definition of diphthongs to off-glides, excluding such sequences as [wɪ, wʊ, wa, wɑˤ, jɪ, ju, ja, jɑˤ] which also exist in Cairene.

This conclusion has two main advantages. First, it accounts for the contrast between mid vowels and diphthongs in the modern dialect without resorting to diachronic analysis. Second, it explains away the existence of minimal pairs in which mid-vowel monophthongs contrast with derived diphthongs in the modern dialect.

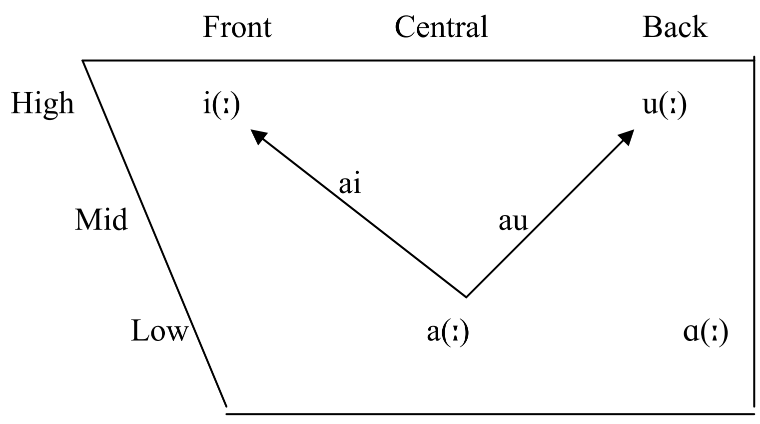
Pharyngealized Vowels

Another important issue to consider is the effect of ES on participating vowels. ES is a segmental process by which the pharyngealization feature spreads from an underlying segment and expands over a larger domain. The quality of both consonants and vowels in this domain is affected to varying degrees. Target consonants are pharyngealized, while vowels in emphatic environments tend to become lower, retracted, or more centralized than those in non-emphatic environments (Hetzron 1997). Where this influence is unclear, it can be predicted from the surrounding emphatic consonants (Kaye 1997). Therefore, I also describe this effect on vowels as pharyngealization. In practice, all vowels can be pharyngealized as a result of ES: [u(ː), oː, a(ː)] are always targets and [i(ː), eː] are targets when adjacent to an underlying emphatic segment and blockers otherwise.

Outline of Cairene Contrastive Vowels

The above discussion leads to the contrastive vowel chart in (22).

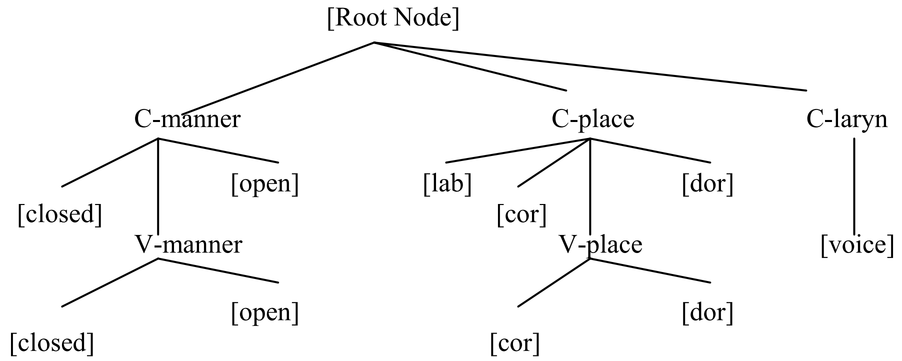
(22) *Vowel chart of 4 contrastive vowels in Cairene*



2.4 Phonological Features in Cairene Arabic

The feature geometric structure of Cairene Arabic is given in (23), assuming the Parallel Structures Model (Morén 2003). Based on the contrastive behavior of consonants and vowels discussed so far, I make some conclusions and assumptions to justify the phonological feature specifications for each segment in Cairene.

(23) *Cairene PSM Geometry*



2.4.1 Laryngeal Features

The only laryngeal feature pertinent to Cairene is [voice]. Voicing describes the vibration of the vocal cords in the larynx. Segments which lack the feature [voice] are produced with open vocal folds (Watson 2002). However, as argued earlier, [voice] could be irrelevant for some segments in Cairene. Let us hypothesize that phonological voicing is represented by a C-laryngeal[voice] feature in this language. A neutral segment like the glottal stop [ʔ] which represents constriction in the larynx will be composed only of this feature. Besides, the segments [d, $d^ʕ$, z, $z^ʕ$, g, v, ɣ, ʕ] also have C-laryngeal[voice].

2.4.2 Mannerless Segments

If we assume that the pharyngeal feature V-place[dor] is the emphatic feature, it is convenient that the unit segment bearing only this feature is the low vowel [$ɑ^ʕ$] which determines most emphatic contrasts. Let us associate the blockers of ES [i(ː), eː, ʒ] with a V-place[cor] feature and assume that a combination of this feature and V-place[dor] is disallowed in this language. Since [eː] and [ʒ] are obviously complex segments, /i/ is most likely the unit segment for V-place[cor].

The glides in Cairene behave like consonants; thus they have C-place features; the high vowels have V-place features. In order to make the glide [w] featurally distinct from [ʊ], we will give it a C-place[lab] feature. For C-place[cor], there are two options: [r] and [j]. Because [r] is a trill in Cairene which is acquired by children relatively late, it is probably a more complex segment. The glide [j] does not have a

V-place[cor] feature since it is not opaque to ES. Thus, [j] is just C-place[cor]. Finally, there must be a segment bearing only the feature C-place[dor]. The likely possibilities are [k], [q], and [ħ] since they involve the tongue dorsum. However, as I show later both [k] and [q] have C-manner[closed]. So, [ħ] is the unit segment for C-place[dor], and [ʕ] its voiced counterpart. It is interesting to note that these mannerless segments [w, j, ħ] have the weakest constriction of all consonants.

Now we are left with having to determine the features of [ʒ] and [ʃ]. Since [ʃ] does not block ES, it cannot phonologically be the voiceless counterpart of [ʒ]. It is possible that neither of them has C-manner features because they do not participate in voicing contrasts, and we have already established that [ʒ] has V-place[cor] since it blocks emphasis spread. Therefore, let us hypothesize that [ʒ] is C-place[cor] and V-place[cor], while [ʃ] is C-place[cor] and C-place[dor]. These specifications fit into both the phonological patterns and the phonetic realizations.

2.4.3 Manner Consonants

The view that emphatics are consonants produced with a primary articulation at the dental/alveolar region and with a secondary articulation that involves the constriction of the upper pharynx was introduced within feature geometry. Under this view, it is the presence of the secondary place node "pharynx" that characterizes emphatic phonemes (Davis 1995). Because secondary place spreads, it should correspond to a V-place node in the PSM. Therefore, [t, d, s, z, r] and [$t^{ʕ}$, $d^{ʕ}$, $s^{ʕ}$, $z^{ʕ}$, $r^{ʕ}$] have C-place and [$t^{ʕ}$, $d^{ʕ}$, $s^{ʕ}$, $z^{ʕ}$, $r^{ʕ}$] have an additional V-place. As noted above, these underlying emphatic segments have C-place[cor], and because their articulation also involves pharyngeal constriction, they have an additional V-place[dor].

If [h] is just C-manner[open], then the fricatives [f, v, s, $s^{ʕ}$, z, $z^{ʕ}$, x, ɣ] all have place features. [f, v] are then C-place[lab]; [s, $s^{ʕ}$, z, $z^{ʕ}$] are C-place[cor]; and [x, ɣ] are C-place[dor]. On the other hand, let us hypothesize that the uvular stop [q] represents just a stop feature, C-manner[closed]. All other stops [b, t, $t^{ʕ}$, d, $d^{ʕ}$, k, g] should also have C-manner[closed] in addition to place. [b] is a labial stop with C-place[labial]; [t, $t^{ʕ}$, d, $d^{ʕ}$] are C-place[cor]; and [k, g] are C-place[dor].

The trill [r] is a complex segment with a coronal articulation because its pharyngealized counterpart is a trigger of ES. So, it belongs to the C-place[cor] class. It is also a sonorant with C-manner[open] and V-manner[closed] features. Finally, I will assume that nasals have both C-manner[closed] and C-manner[open], while the lateral has C-manner[closed] and V-manner[closed]. These feature specifications capture the intuition that the lateral is phonologically more sonorous than the nasals, but less sonorous than the trill in this language.

2.4.4 Other Vowel Segments

The low vowel [a] represents just V-manner[open] and the high vowel [ʊ] represents V-manner[closed]. We argued that the mid vowels are still the result of coalescence in Cairene: [eː] = /ai/ and [oː] = /au/. Therefore, [eː] combines the features for /i/ and /a/; so it is V-place[cor] and V-manner[open]. Furthermore, [oː] has the features for /u/ and /a/; so it is V-manner[open] and V-manner[closed].

We conclude that there are three contrastive heights in Cairene Arabic vowels: high, mid, and low. High vowels are marked with a V-manner[closed] feature; low vowels are marked with a V-manner[open] feature; and mid vowels are marked with both V-manner[closed] and V-manner[open].

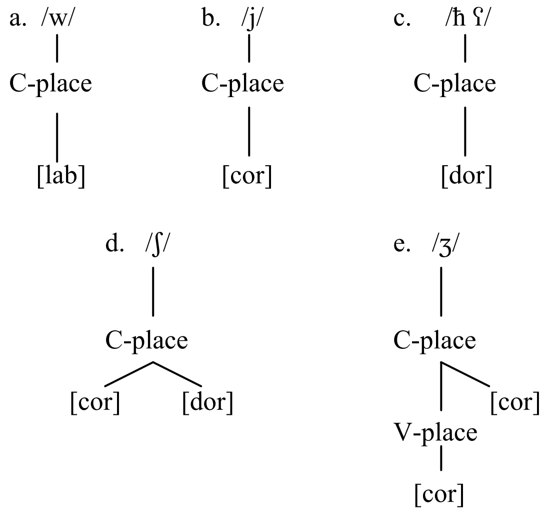
This leads to the following set of feature specifications for Cairene consonants and vowels in (24) through (32).

(24) *Feature specifications for 29 underlying consonants in Cairene*

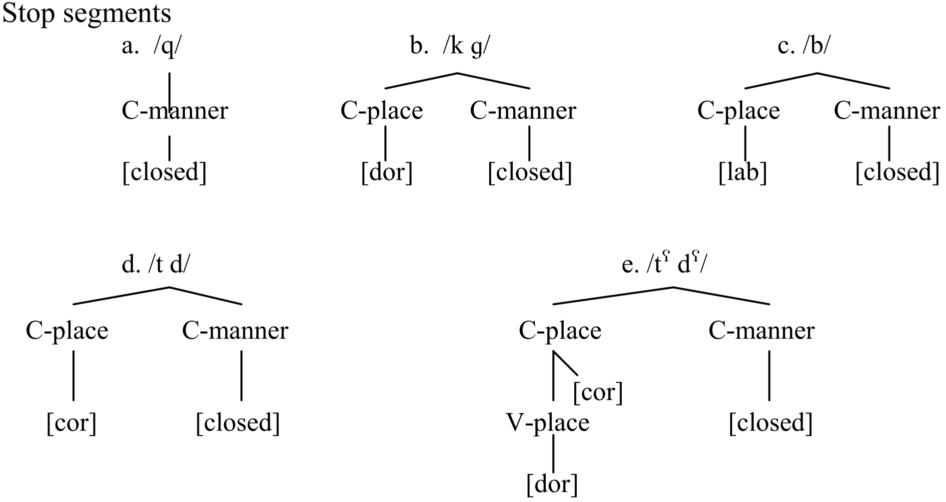
		C-place			V-place		C-manner		V-manner	C-laryn
	SR	**lab**	**cor**	**dor**	**cor**	**dor**	**closed**	**open**	**closed**	**voice**
Mannerless	/ʔ/									✓
	/w/	✓								
	/j/		✓							
	/ħ/			✓						
	/ʕ/			✓						✓
	/ʃ/		✓	✓						
	/ʒ/		✓		✓					
Stop	**/q/**						✓			
	/b/	✓					✓			
	/t/		✓				✓			
	/d/		✓				✓			✓
	/tˤ/		✓			✓	✓			
	/dˤ/		✓			✓	✓			✓
	/k/			✓			✓			
	/g/			✓			✓			✓
Continuant	**/h/**							✓		
	/f/	✓						✓		
	/v/	✓						✓		✓
	/s/		✓					✓		
	/z/		✓					✓		✓
	/sˤ/		✓			✓		✓		
	/zˤ/		✓			✓		✓		✓
	/x/			✓				✓		
	/ɣ/			✓				✓		✓
Nasal	**/n/**						✓	✓		
	/m/	✓					✓	✓		
Approximant	**/l/**						✓		✓	
	/r/		✓					✓	✓	
	/rˤ/		✓			✓		✓	✓	

The representations of each segment (ignoring voice) are given in (25) through (28).

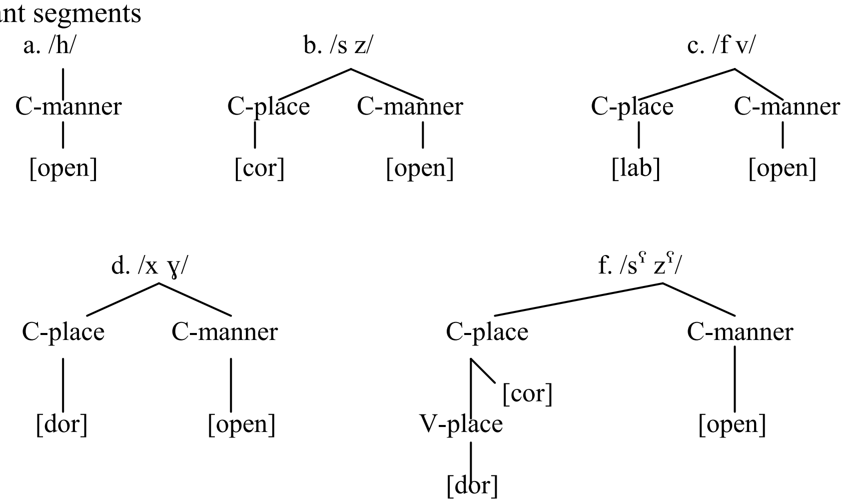
(25) Mannerless segments



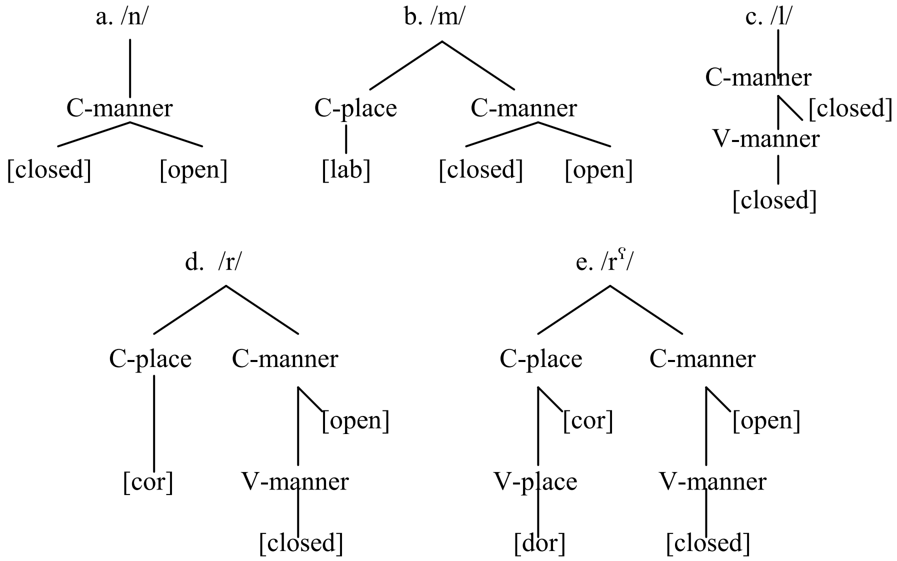
(26) Stop segments



(27) Continuant segments



(28) Nasal and approximant segments

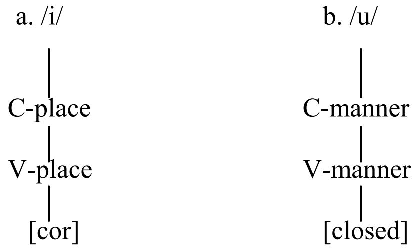


(29) *Feature specifications for 4 underlying vowels in Cairene*

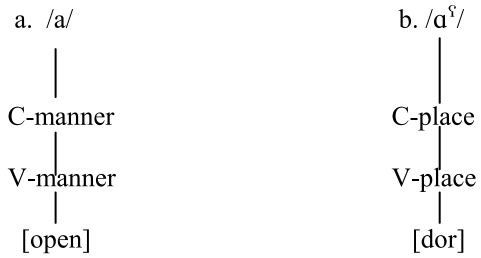
				V-place		V-manner	
		SR	**PF**	**cor**	**dor**	**closed**	**open**
High		**/i/**	**[ɪ]**	✓			
		/u/	**[ʊ]**			✓	
Low	non-emphatic	**/a/**	**[a]**				✓
	emphatic	**/ɑˁ/**	**[ɑˁ]**		✓		
Mid		**/eː/**	**[eː]**	✓			✓
		/oː/	**[oː]**			✓	✓

The representation of each segment is given below.

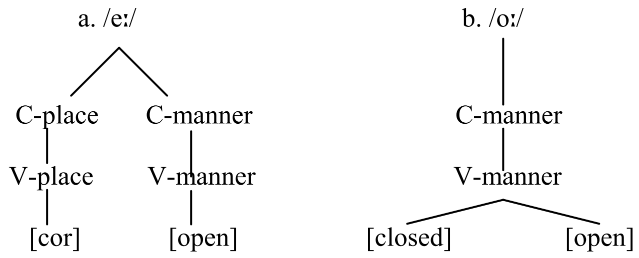
(30) High vowels



(31) Low vowels



(32) Mid vowels



2.5 Emphasis Spread – Synchronic Analysis

The main focus of this section is to describe and account for the blocking and directionality facts of ES in Cairene based on the assumptions we made about the nature of three classes of segments which behave phonologically different with regard to ES. Trigger segments include both pharyngealized coronals and the low vowel [ɑˤ] and are marked with the feature V-place[dor]. Potential targets are all segments within the word domain. Last is the opaque class of segments marked with the feature V-place[cor] which remain unchanged and block the continuation of spreading any further. To sum up, I adopt the view that ES is sensitive to the identity of the emphatic source and segments intervening between this source and the target of ES in addition to some constraints on the syllable and on directionality. § 2.5.1 is an autosegmental representation of these facts in Cairene, and § 2.5.2 is an account formulated in Optimality Theory.

2.5.1 Autosegmental Representation of Emphasis Spread

Constraints on Syllables

Having established that every segment in a syllable containing a pharyngealized low vowel is necessarily pharyngealized (ref. 3), I concluded that [ɑˤ] is the only underlying pharyngealized vowel. Furthermore, only some coronal consonants show contrasts next to other vowels (ref. 4); this is evidence that [tˤ, dˤ, sˤ, zˤ, rˤ] are the only underlying pharyngealized consonants. Thus, ES is a segmental process triggered by these coronal emphatics or the low back vowel. This conclusion, however, does not deny the fact that the syllable is doing some work in ES.

The data we have seen suggests that once a segment is pharyngealized, all other segments in the same syllable must also be pharyngealized (with certain restrictions on geminates). On the other hand, if a syllable contains one plain segment, all other segments in that syllable must be plain (33a). Furthermore, segments with a V-place[cor] feature are not opaque to ES when they exist in the same syllable as the emphatic trigger (33b). Finally, when rightward ES is blocked by a segment in the rime or coda of a syllable, the whole syllable fails to undergo pharyngealization (33c).

(33) *Syllabic behavior in ES*

(a) *Pharyngealized vs. plain syllables*

/{tˤuːb}/	[tˤuːˤbˤ]	'stone'	/tuːb/	[tuːb]	'repent'
/{sˤeːf}/	[sˤeːˤfˤ]	'summer'	/seːf/	[seːf]	'sword'
/{bɑːtˤ}/	[bˤɑːˤtˤ]	'armpit'	/baːt/	[baːt]	'spent the night'
/{ʔɑˤblɑ}/	[ʔˤɑˤbˤlˤɑˤ]	'ma'am'	/ʔabla/	[ʔabla]	'before'
/{wɑˤllɑ}/	[wˤɑˤlˤlˤɑˤ]	'by God'	/walla/	[walla]	'or'

(b) *Tautosyllabic V-place[cor] segments do not block rightward ES*

/{tˤ**iː**n}/	'mud'	/{sˤ**eː**f}/	'summer'
/{dˤɪjɑːʔ}/	(personal name)	/{sˤɪjɑːm}/	'fasting'

(c) *Whole syllables blocked with V-place[cor] segments in rime or coda*

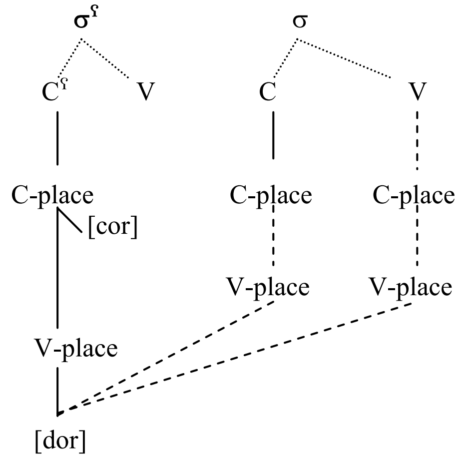
/{dˤɑruː}rɪ/	'necessary'	/{mɑˤj}jɪtɪ/	'my water'
/{ʕɑsˤɑ}f**iː**r/	'sparrows'	/{sˤɑ}ħ**iː**ħ/	'correct'

Essentially, all segments in the syllable must agree. A logical question is how to accommodate this suprasegmental fact together with a segmental analysis of ES. In a constraint-based grammar, this syllable-association condition could be represented by a highly ranked constraint which associates a V-place[dor] feature to the syllable. In order to avoid very complex structures here, I will represent this constraint with a pharyngealized syllable skeleton ($\sigma^{ʕ}$) without showing any association-line effects, and refer to it explicitly in my OT account of ES.

Rightward Spreading

The diagram in (34) illustrates the left-to-right ES pattern described so far. Note that C and V are placeholders for root nodes of consonant and vowel segments which are not blockers; $C^{ʕ}$ indicates a coronal consonant that triggers ES; and a subscript $_{0\sigma}$ indicates any number of syllables—Vowel manner and voice are missing for ease of exposition.

(34) $//[C^{ʕ}V]_{\sigma}[CV]_{0\sigma}// \rightarrow /[C^{ʕ}V]_{\sigma}^{ʕ}\ [CV]_{0\sigma}^{ʕ}/$



The crucial fact to point out here is that the V-place[dor] terminal feature on the coronal emphatic consonant spreads to the end of the phonological word, as marked by the dashed lines. As a consequence, any target segment will bear an additional V-place[dor] node to carry its acquired emphatic feature. No potential target segment has an underlying V-place node prior to spreading.

Blocking

Left-to-right ES in Cairene is blocked by non-tautosyllabic [i(ː), eː, ʒ][9] to the right of the underlying emphatic. In the system we developed, the opaque nature of these segments is a result of their place feature specification (V-place[cor]), the inability of this feature to combine with another place feature (V-place[dor]), and the effect of ES skipping these segments if they are adjacent to the trigger.

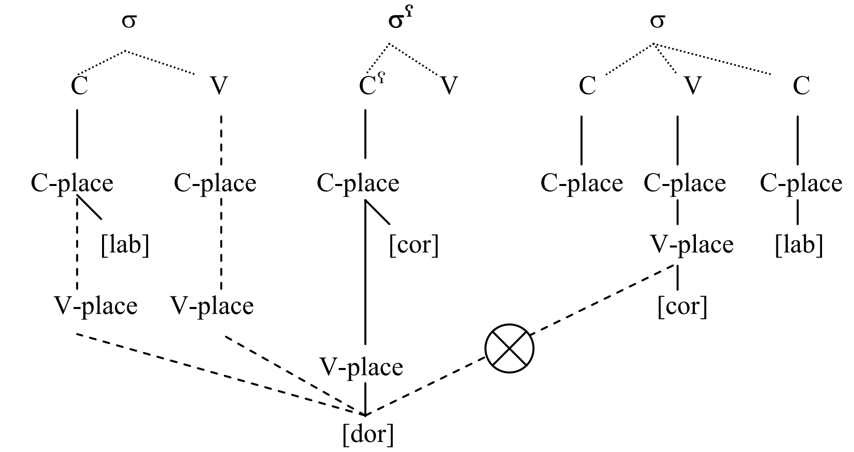
This opacity effect can be expressed in Grounded Phonology (Archangeli and Pulleyblank 1994) as a negative condition on the target of ES which prohibits the co-occurrence of the features V-place[dor] and V-place[cor] in rightward spreading. This feature cooccurrence restriction prevents any phoneme that is V-place[cor] from also being realized with the emphatic feature V-place[dor]. The dispreference of the resulting representation can be phonetically motivated by articulatory difficulty. Note that there are only two kinds of segments that underlyingly have a V-place node: V-place[cor] segments which block ES and V-place[dor] segments which trigger ES. The cooccurrence constraint between two features suggests that they are dominated by the same node in this language (Davis 1995:157).

The diagram in (35) shows the V-place[dor] feature trying to spread to all segments within the phonological word. It does so successfully to the left edge. However, on the other direction, spreading encounters a non-adjacent V-place[cor] segment [ɪ]. Assuming that the combination of V-place[cor] and V-place[dor] is prohibited in this language, the V-place[dor] feature cannot spread any longer and ES is blocked (indicated by a crossed line). Once blocked, the V-place[dor] feature cannot spread to any segment in that syllable.

---

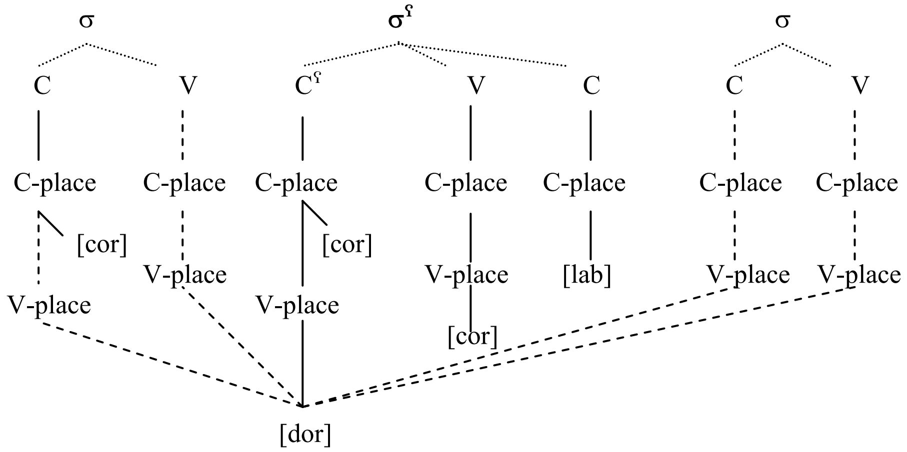
[9] A puzzling fact is that Arabic dialects differ in the set of segments that block emphasis spread. While there has been no attempt to explain this fact, the PSM gives insights into what constitutes a class of opaque segments in a particular language. By defining this class structurally (as having a V-place[cor] feature, for example) and by being flexible as to what features are attached to segments in each language (depending on phonological evidence), the PSM captures this variation in a straightforward manner. For example, in the Southern Palestinian Arabic dialect described by Davis (1995), the class of blockers consists of [i, j, ʃ, ʒ]. This would result in two major discrepancies with Cairene Arabic. First, [ʒ] and [ʃ] would form a voiced-voiceless pair since they behave similarly with regard to blocking. Second, the glide [j] would have a vocalic (V-place[cor]) rather than consonantal feature. In Cairene, however, [ʃ] and [j] are not specified for this "blocking" feature.

(35) //mas^{ʕ}aːjib// → /[mɑ]$_{σ}^{ʕ}$ [^{ʕ}sɑː]$_{σ}^{ʕ}$ [jɪb]$_{σ}$/ ‘misfortunes’



If a word has more than one potential underlying emphatic segment and no blockers, for example [r^{ʕ}] plus one of [t^{ʕ}, d^{ʕ}, s^{ʕ}, z^{ʕ}], it is impossible to tell which segment is the trigger and which is the target. However, in my analysis the right result will obtain whichever the underlying emphatic segment is. We just have to stipulate that one is an underlying emphatic and the other is not. On the other hand, if there are two potential underlying emphatic segments and any blockers, the choice of sponsor must be consistent with blocking. In that case, I will assume that the underlying sponsor is the segment adjacent to the blocker since ES will not be blocked. This is illustrated in (36) below.

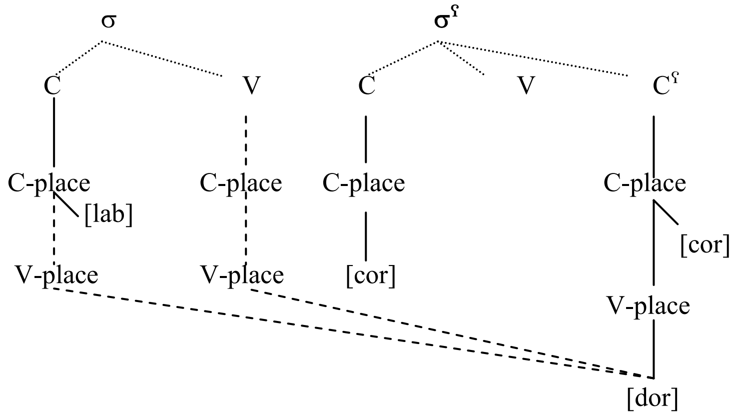
(36) //ras^{ʕ}ifna// → /[rɑ]$_{σ}^{ʕ}$ [s^{ʕ}if]$_{σ}^{ʕ}$ [nɑ]$_{σ}^{ʕ}$/ ‘our sidewalk’



Leftward Spreading

Emphasis spreads leftward from the triggers throughout the prosodic word and fails to be blocked by any segment within the stem. Watson (2002) takes this as evidence that right-to-left is the unmarked direction of ES. In phonetic terms, this is a way of enhancing the perceptual salience of pharyngeality. The failure of the constraint against V-place[cor, dor] to hold in leftward spread is due to constraint interactions that will be discussed in an OT framework. The following diagram suggests a representation for leftward ES.

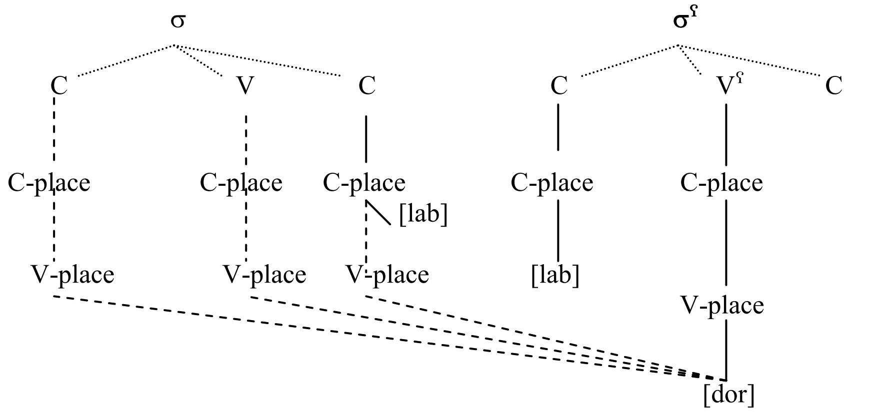
(37) //basatˁ// → /[bɑ]$_{\sigma}$ˁ [sɑtˁ]$_{\sigma}$ˁ/ ‘he entertained’



Vowel Triggers

From an underlying emphatic vowel [ɑˁ], emphasis spreads bidirectionally within the word. There are two crucial points to mention here. First, in the presence of emphatic coronal consonants, it is practically impossible to tell whether emphasis is triggered from the consonant or the vowel [ɑˁ]. I will stipulate it is the consonant which triggers ES in this case, although a sponsor [ɑˁ] would yield the same result. Second, in the absence of emphatic coronal consonants in the word, the emphatic vowel [ɑˁ] almost always occurs in every syllable. As a consequence, it is difficult to tell which [ɑ⁽ˁ⁾] is trigger and which is target (or whether both are triggers). The only exception to this is /{ʔʊmmɑˁːl}/ which indicates that the domain of ES is the phonological word here.

(38) //ʔummɑːˁ l// → /[ʔʊm]$_{\sigma}$ˁ [mɑˁːl]$_{\sigma}$ˁ / ‘of course’



2.5.2 Optimality-Theoretic Account of Emphasis Spread

In order to explain the interaction and behavior of consonants and vowels as triggers, targets, or blockers of emphasis spread, I will utilize the machinery of constraint interaction in Optimality Theory (McCarthy and Prince 1993a; Prince and Smolensky 2004). Recall that emphasis spread in Cairene is a bidirectional process in which the V-place[dor] feature assimilates throughout the phonological word domain. Although emphasis spread is bidirectional, there are differences in behavior depending on the direction of spread. Spreading from right to left is generally absolute and is never blocked, whereas spreading from left to right is blocked by a subset of vowels and consonants. This asymmetry requires two markedness constraints from the family of alignment constraints, which ensure the nearest possible coincidence of edges of phonological constituents (McCarthy and Prince 1993b). Constraints in the alignment category have been utilized in optimality-theoretic analysis of a wide range of phenomena, including feature spreading. To account for directionality effects in ES, I formulate the alignment constraints in (37).

(39)

a. ALIGN V-PLACE[DOR]-L (Pwd) *(abbr. L-ALIGN[DOR])*

The left edge of V-place[dor] feature must be aligned to the left edge of the prosodic word.

b. ALIGN V-PLACE[DOR]-R (Pwd) *(abbr. R-ALIGN [DOR])*

The right edge of V-place[dor] feature must be aligned to the right edge of the prosodic word.

These constraints align whole contiguous strings of pharyngealized segments to the left or right edge of the word. For simplicity of analysis, I assume that these alignment constraints are gradient in the 1993 fashion. If the V-place[dor] feature is one syllable away from a word edge, it incurs one violation of the constraint. For every additional syllable distance, an extra violation is given. Because ES is unblocked from right to left, the constraint in (39a) is highly ranked, while (39b) is more violable.

Rightward ES is blocked by non-tautosyllabic segments bearing a V-place [cor] feature. This requires a violable markedness constraint which poses a feature cooccurrence restriction on the combination of V-place[dor] and V-place[cor] in this language (40). The interaction of this constraint with the alignment constraints should reflect the dispreference for emphasis to spread to or beyond V-place[cor] segments.

(40) *V-PLACE[COR, DOR] *(abbr. *[COR, DOR])*

No segment should have both V-place[cor] and V-place[dor] features.

The relative ranking of the constraints L-ALIGN[DOR] and *[COR, DOR] can be determined by looking at an instance of leftward unblocked emphasis spread.

(41) L-ALIGN[DOR] >> *[COR, DOR]

	//jibu:zˤ//	L-ALIGN[DOR]	*[COR, DOR]
a	☞ {jɪbu:zˤ}		*
b	jɪ{bu:zˤ}	*!	

The tableau in (41) shows an example where the underlying emphatic segment is at the right edge of the prosodic word. In that case, pharyngealization spreads to the left edge of the word despite the existence of a V-place[cor] segment [ɪ]. Candidate (b) is an example of an output where [ɪ] blocks ES. However, this candidate violates the highly ranked L-ALIGN[DOR] constraint. Candidate (a), on the other hand, violates the *[COR, DOR] constraint since it contains a pharyngealized V-place[cor] segment. This violation is not a fatal one, resulting in (a) being the optimal candidate.

The relative ranking of the constraints R-ALIGN[DOR] and *[COR, DOR] can be determined by looking at an instance of rightward blocked emphasis spread.

(42) *[COR, DOR] >> R-ALIGN[DOR]

	//sˤa:ħib//	*[COR, DOR]	R-ALIGN[DOR]
a	{sˤɑ:ħɪb}	*!	
b	☞{sˤɑ:}ħɪb		*

The tableau in (42) shows an example where the underlying emphatic segment is at the left edge of the prosodic word, in which case pharyngealization spreads left-to-right. However, in that direction, ES is blocked when a V-place[cor] segment is encountered. Candidate (a) ignores this blocking segment and spreads through it; thus violating the highly ranked *[COR, DOR] constraint. Candidate (b) only violates the lower-ranked R-ALIGN[DOR] constraint, emerging as the optimal candidate. So far, L-ALIGN [DOR] dominates *[COR, DOR] which in turn dominates R-ALIGN [DOR].

In the last section, I hypothesized that once a segment has an underlying emphatic feature, V-place[dor], it associates this feature with every segment in the syllable. In a constraint-based grammar, this syllable-association constraint is ranked above other constraints working in the opposite direction, e.g. *[COR, DOR].

(43) ASSOCIATE V-PLACE[DOR]- σ *(abbr. σ-ASSOC[DOR])*

For every segment with a V-place[dor] feature, every other segment in the same syllable must bear that feature.

The inviolability of this constraint can be demonstrated in two ways. First, it can eliminate a candidate like /{sˤɑːħ}ɪb/ in tableau (42) in which the feature V-place [dor] is only associated with the segment [ħ] in the second syllable. Second, it would allow the feature V-place[dor] to spread in a word where a V-place[cor] segment exists in the same syllable as the emphatic trigger (ref. 33b for more examples). This is illustrated below.

(44) σ-ASSOC[DOR], L-ALIGN[DOR] >> *[COR, DOR] >> R-ALIGN[DOR]

	//sˤijaːm//	σ-ASSOC [DOR]	L-ALIGN [DOR]	*[COR, DOR]	R-ALIGN [DOR]
a	sˤɪjaːm	*!			*
b	{sˤɪ}jaːm			*	*!
c	☞ {sˤɪjɑːm}			*	

Candidate (a) does not spread emphasis at all, and therefore does not violate either L-ALIGN[DOR] or *[COR, DOR]. Nevertheless, it incurs a fatal violation of σ-ASSOC[DOR] constraint. Candidates (b) and (c) avoid this violation, which consequently results in violations of the *[COR, DOR] constraint. The R-ALIGN[DOR] constraint, therefore, has to decide which one of them is the winner.

Up to this point, one set of potential candidates have been ignored; those in which the underlying V-place[dor] feature is deleted. With the constraints we have now, such candidates will not violate any constraint. In order to rule out these undesirable candidates, I assume a faithfulness constraint in (45) which is undominated in this grammar. This constraint assures that an underlying emphatic segment is also emphatic at the surface (Vijver 1996).

(45) MAX V-PLACE[DOR] *(abbr. MAX[DOR])*

Every V-place[dor] feature in the input has a correspondent V-place[dor] feature in the output.

Having introduced these constraints, we are ready to consider more potential candidates. (46) describes the behavior of ES in a bidirectional example with a transparent V-place[cor] segment, the most complex case of unblocked ES in a word like //nizˤamhum// ‘their order’.

(46) σ-ASSOC[DOR] , MAX[DOR] , L-ALIGN[DOR] >> *[COR, DOR] >> R-ALIGN [DOR]

	//nizˤamhum//	σ-ASSOC [DOR]	MAX [DOR]	L-ALIGN [DOR]	*[COR, DOR]	R-ALIGN [DOR]
a	nɪzamhʊm		*!			
b	nɪzˤamhʊm	*!		*		*
c	nɪ{zˤɑm}hʊm			*!		*
d	nɪ{zˤɑmhʊm}			*!		
e	☞ {nɪzˤɑmhʊm}				*	

The tableau in (46) examines five candidates: one in which the underlying V-place[dor] feature is deleted (a); one in which the underlying pharyngealization feature does not spread at all (b); two in which the feature spreads within a limited domain (one or more syllables) (c) and (d); and finally a candidate in which all segments are associated with the underlying feature (e). The optimal candidate (e) does not violate any of the three highest ranked constraints.

Problematic Cases with Emphatic [r]

The underlying emphatic segments [tˤ, dˤ, sˤ, zˤ, ɑˤ] show substantial uniformity with regard to their behavior as triggers of ES. The pharyngealized trill [rˤ], on other hand, exhibits two mismatches with the other emphatics: ES from a sponsor [rˤ] is blocked in both directions and [rˤ] is de-emphasized where it comes in direct contact with a V-place[cor] segment.[10] Throughout the rest of this section, I will provide a solution to these two opaque cases within Optimality Theory.

Unlike other triggers where ES is never block from right to left, ES triggered by [rˤ] is blocked in this direction by non-adjacent V-place[cor] segments, as shown in (10c) and (47) below.

(47) *Blocked leftward spread from /r ˤ/*

/tɪ{gɑːrˤɑ}/	'trade'	/sɪ{fɑːrˤɑ}/	'embassy'
/wɪ{zɑːrˤɑ}/	'ministry'	/ʕɪ{mɑːrˤɑ}/	'block (N.)'
/ʔɪnfɪ{gɑːrˤ}/	'explosion'	/ʔɪstɪʕ{mɑːrˤ}/	'occupation'

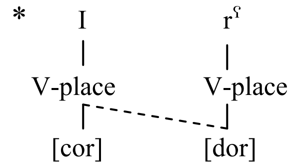
In order to account for this, we need to posit a more specific feature cooccurrence restriction against [rˤ] spreading its V-place[dor] feature to segments with V-place[cor] within the word domain. I will call this highly ranked constraint the R-CONDITION for

[10] There is one systematic exception to this. While [rˤ] is de-emphasized before the relational suffix *-i*, /{baʔarˤ}/ 'cows' ~ /baʔari/ 'beef adj', it is not de-emphasized next to the first person singular possessive pronoun *-i* suffix, /{baʔarˤi}/ 'my cows'. I will leave the analysis of this phenomenon to future investigation.

simplicity. (48a) formulates this constraint in OT terms (48b) illustrates it auto-segmentally, where *I* stands for a V-place[cor] segment (blocker).

(48) a. *R-COND*
V-place[dor] feature cannot be sponsored by [r] and be linked to a segment with a V-place [cor] feature in the word domain, no matter which segments intervene.

b.



To demonstrate this constraint at work, I will show a case from (47) in which a non-tautosyllabic [ɪ] blocks leftward ES from [rˤ].

(49) R-COND, σ-ASSOC[DOR], MAX[DOR] >> L-ALIGN[DOR] >> *[COR, DOR] >> R-ALIGN[DOR]

	//sifa:rˤa//	R-COND	σ-ASSOC[DOR]	MAX[DOR]	L-ALIGN[DOR]	*[COR, DOR]	R-ALIGN[DOR]
a	{sɪfɑ:rˤɑ}	*!				*	
b	☞sɪ{fɑ:rˤɑ}				*		
c	sɪfa:{rˤɑ}				**!		
d	sɪfa:rˤa		*!		**		*
e	sɪfa:ra			*!			

Four important facts should be pointed out in this tableau. First, the R-COND constraint eliminates the candidate in (a), which would be the optimal candidate in a parallel case where any other coronal consonant is the trigger of ES. Second, the relative ranking of MAX[DOR] and L-ALIGN[DOR] must be established here. If L-ALIGN [DOR] dominated MAX[DOR], candidate (e) would be the winner. Third, the gradient nature of the alignment constraint becomes useful in this example where the optimal candidate (b) violates it only once and candidate (c) twice. Finally, the constraints σ-ASSOC[DOR] and MAX[DOR] are presumably highly ranked since they are unviolated so far. Consequently, their relative ranking cannot be determined.

The other odd fact about [rˤ] is cases where it comes in direct contact with a V-place[cor] segment. Not only is emphasis spread blocked in these cases, but the underlying emphatic is itself de-emphasized[11] (Watson 2002:275), as exemplified in (50) below.

[11] There seems to be a few systematic exceptions to this generalization in cases like /dɪ{rˤɑ:sɑ}/ 'learning' and /ħɪ{rˤɑ:sɑ}/'guarding' where /rˤ/ does not undergo de-emphacization next to [ɪ] in certain environments. For a detailed discussion of these environments see Younes (1993; 1994).

(50) *De-emphacization of [r ˤ] next to [i(:)]*

/{xɑddɑrˤ}/	'he stupefied'	/taxdiːr/	'stupefying'
/{ʔɑkbɑrˤ}/	'older'	/kɪbiːr/	'old'
/sɪ{fɑːrˤɑ}/	'embassy'	/sɑfiːr/	'ambassador'
/{toːrˤ}/	'bull'	/tɪraːn/	'bulls'
/{gɑːrˤ}/	'neighbor'	/gɪraːn/	'neighbors'

In tableau (49) above, I examined the partially emphasized word /sɪ{fɑːrˤɑ}/ 'embassy'. Now let's see if the same constraint ranking holds for its de-emphasized derivative /safiːr/ 'ambassador'.

(51) R-COND, σ-ASSOC[DOR] >> MAX[DOR] >> L-ALIGN[DOR] >> *[COR, DOR] >> R-ALIGN[DOR]

	//safi:rˤ//	R-COND	ASSOC[DOR]	MAX[DOR]	L-ALIGN[DOR]	*[COR, DOR]	R-ALIGN[DOR]
a	{sɑfi:rˤ}	*!				*	
b	sa{fi:rˤ}	*!			*	*	
c	safi:rˤ		*!		**		
d	☞safi:r			*			

As the tableau indicates, the winner candidate violates MAX[DOR]. This constraint, in turn, must be ranked lower than the inviolable constraints R-COND and σ-ASSOC[DOR], giving the ranking in (51). This is a good example of an OT conspiracy where two opposite phonological processes are captured with the same constraint ranking.

2.6 Comparison with Previous Accounts

Having introduced the synchronic facts and analyses of Cairene Arabic, I will now move on to the discussion of previous accounts of emphasis spread. The discussion aims to shed light on their shortcomings and consequently emphasize the strengths of the present account. This account, however, owes a great deal to the insights of each of these accounts, to the end of developing a comprehensive analysis of ES in light of the Parallel Structures Model of feature geometry. In order to do this, let us begin with a summary of the PSM feature specifications of Cairene inventory (52), including underlying representations, surface forms, and phonetic forms.

(52) *Summary*

			C-place			V-place		C-manner		V-manner		C-laryn
UR	**SR**	**PF**	**lab**	**cor**	**dor**	**cor**	**dor**	**closed**	**open**	**closed**	**open**	**voice**
//ʔ//	/ʔ/	[ʔ]										✓
	/ʔˤ/	[ʔˤ]					✓					✓
//w//	/w/	[w]	✓									
	/wˤ/	[wˤ]	✓				✓					
//j//	/j/	[j]		✓								
	/jˤ/	[jˤ]		✓			✓					
//ħ//	/ħ/	[ħ]			✓							
	/ħˤ/	[ħˤ]			✓		✓					
//ʕ//	/ʕ/	[ʕ]			✓							✓
	/ʕˤ/	[ʕˤ]			✓		✓					✓
//i//	/i/	[ɪ]				✓						
	/iˤ/	[ɪˤ]				✓	✓					
//ɑˤ//	/ɑˤ/	[ɑˤ]					✓					
//ʃ//	/ʃ/	[ʃ]		✓	✓							
	/ʃˤ/	[ʃˤ]		✓	✓		✓					
//ʒ//	/ʒ/	[ʒ]		✓		✓						
	/ʒˤ/	[ʒˤ]		✓		✓	✓					
//q//	/q/	[q]						✓				
	/qˤ/						✓	✓				
//b//	/b/	[b]	✓					✓				
	/bˤ/	[bˤ]	✓				✓	✓				
//t//	/t/	[t]		✓				✓				
	/tˤ/	[tˤ]		✓			✓	✓				
//d//	/d/	[d]		✓				✓				✓
	/dˤ/	[dˤ]		✓			✓	✓				✓
//tˤ//	/tˤ/	[tˤ]		✓			✓	✓				
//dˤ//	/dˤ/	[dˤ]		✓			✓	✓				✓
//k//	/k/	[k]			✓			✓				
	/kˤ/	[kˤ]			✓		✓	✓				
//g//	/g/	[g]			✓			✓				✓
	/gˤ/	[gˤ]			✓		✓	✓				✓
//h//	/h/	[h]							✓			
	/hˤ/	[hˤ]					✓		✓			
//f//	/f/	[f]	✓						✓			
	/fˤ/	[fˤ]	✓				✓		✓			
//v//	/v/	[v]	✓						✓			✓
	/vˤ/	[vˤ]	✓				✓		✓			✓
//s//	/s/	[s]		✓					✓			
	/sˤ/	[sˤ]		✓			✓		✓			
//z//	/z/	[z]		✓					✓			✓
	/zˤ/	[zˤ]		✓			✓		✓			
//sˤ//	/sˤ/	[sˤ]		✓			✓		✓			
//zˤ//	/zˤ/	[zˤ]		✓			✓		✓			✓
//x//	/x/	[x]			✓				✓			
	/xˤ/	[xˤ]			✓		✓		✓			
//ɣ//	/ɣ/	[ɣ]			✓				✓			✓
	/ɣˤ/	[ɣˤ]			✓		✓		✓			✓
//n//	/n/	[n]						✓	✓			
	/nˤ/	[nˤ]					✓	✓	✓			
//m//	/m/	[m]	✓					✓	✓			
	/mˤ/	[mˤ]	✓				✓	✓	✓			
//l//	/l/	[l]						✓		✓		
	/lˤ/	[lˤ]					✓	✓		✓		
//r//	/r/	[r]		✓					✓	✓		
//rˤ//	/rˤ/	[rˤ]		✓			✓		✓	✓		
//u//	/u/	[ʊˤ]								✓		
	/uˤ/	[ʊˤ]					✓			✓		
//a//	/a/	[a]									✓	
	/aˤ/	[ɑˤ]					✓				✓	
//ai//	/eː/	[eː]				✓					✓	
	/eˤː/	[eˤː]				✓	✓				✓	
//au//	/oː/	[oː]								✓	✓	
	/oˤː/	[oˤː]					✓			✓	✓	

This feature system allows us to define ES trigger, target, and opaque classes of segments in a straightforward manner through the features V-place[dor] (associated underlyingly with triggers) and V-place[cor] (blockers). These two place features do not interfere with any other phonological process in the language. In the chart, underlying representations (UR) represent the contrastive segments of Cairene inventory as discussed in (15) and (22). They include the pharyngealized triggers of ES //$t^ʕ$, $d^ʕ$, $s^ʕ$, $z^ʕ$, $r^ʕ$, $ɑ^ʕ$//. Surface forms (SF) represent all output phonological forms. In that case, all consonants and vowels apart from the trigger class could potentially have pharyngealized counterparts as targets of ES. For example, /$q^ʕ$/ could be pharyngealized on the surface phonologically, although there is no distinction phonetically between a pharyngealized and a non-pharyngealized [q], as shown by the gap in the phonetic form (PF) for this segment. This leads to one of the most important aspects of the PSM, that phonetics and phonology do not always match. In line with these arguments, I will compare my analysis to previous accounts in the next subsections.

2.6.1 The Suprasegmental Account

In view of the inescapable extension of the emphatic feature beyond the segment over a larger domain, several linguists have interpreted emphasis as a prosodic feature (Harrell 1957; Lehn 1963; Broselow 1976; Tsereteli 1982; among others). For this approach, it is a primary concern to define the domain of emphasis. Most accounts regard the syllable as its minimal domain (Norlin 1987), hence the name “suprasegmental approach”. Proponents of this approach prefer to recognize no underlying emphatic vowels or consonants at all and treat emphasis as a redundant feature of the consonantal and vocalic systems (Lehn 1963). They argue that emphasis is a feature whose domain is the syllable. Thus, it can be treated as [±syllabic] (Kaye 1997). From the syllable, emphasis spreads over a larger domain (the utterance) affecting both vowel and consonant qualities.

A strong argument against this approach is that only certain segments (the coronal emphatics) provide contrasts in the environment of non-low vowels (ref. 4). Furthermore, ES is found only where there is a pharyngealized consonant coronal [$t^ʕ$, $d^ʕ$, $s^ʕ$, $z^ʕ$, $r^ʕ$] or the pharyngealized vowel [$ɑ^ʕ$]. In a suprasegmental account, however, the actual phonemic content of the syllable should be irrelevant (Zawaydeh 1998:120). Another reason to reject this approach is that it predicts that in a $C^ʕ$VCCB sequence, where CC is a geminate and B is a blocker, half of the geminate may be emphasized but not the other half (since the syllable boundary falls between the two members of the geminate). However, empirical facts show that this is an erroneous prediction (Younes 1993:135-136). Finally, there are obvious difficulties of devising effective notation for this approach (Ferguson 1956:452).

This discussion naturally leads to the conclusion that ES should be regarded as a segmental process. Despite the disadvantages of the suprasegmental approach, I argued that a satisfactory segmental analysis of ES should be able to account for some crucial syllabic effects. For example, V-place[cor] segments do not block ES when they exist in the same syllable as the emphatic trigger (33b). Moreover, when rightward ES is blocked by a segment in the rime or coda of a syllable, the whole syllable is not pharyngealized (33c). While available segmental accounts have never explained these facts, the account given in this study incorporates the role of the syllable in the analysis, as discussed in § 2.5.1.

2.6.2 The Vocalic Account

One of the main alternatives to the suprasegmental account is the treatment of emphasis as a phenomenon on the segmental level. A segmental analysis regards emphasis as an inherent feature of a certain segment, the influence of which spreads to adjacent segments due to coarticulation (Norlin 1987:11). However, the fact that emphasis is never an articulatory feature of only one phoneme makes it unclear whether consonants influence vowels or vice versa.

In view of the extensive qualitative variation of the vowels, Khalafallah (1969) posits that emphasis as a feature is inherent in the vocalic system of Saidi Egyptian Arabic. This entails that all vowels have plain and pharyngealized counterparts, whereas no consonants have underlying pharyngealized qualities. While this proposition may be valid for the dialect he describes,[12] it is inappropriate for Cairene where there are no contrasts in vowels apart from the low back [ɑˤ]. Zawaydeh (1998:120) also argues that if a word does not have pharyngealized coronals (or [ɑˤ]), there would be no explanation why other vowels in the words are not pharyngealized.

Overall, Khalafallah (1969) tries to achieve economy by "positing a phoneme of emphasis simultaneous with vowels". However, he fails to account for the limited distribution facts. I argue that the logic behind this approach is not false altogether. Economy should be sought, but not at such a high price. This was accomplished in the present analysis by assuming that the low vowel has spilt into two phonemes: a plain [a] and a pharyngealized [ɑˤ]. The latter is a trigger of ES, replacing a large controversial set of "secondary emphatics" as will be shown in the subsequent section.

[12] Given that some languages have a contrast between pharyngealized and plain vowels, such as the Khoesan language !Xoo.

2.6.3 The Consonantal Account

Another segmental approach defines two classes of consonants as triggers of emphasis spread. The first class is the partially uncontroversial primary coronal emphatics [dˤ, tˤ, sˤ, zˤ]. Where ES is documented in stems in which no coronal emphatics exist (ref. 5), this approach recognizes another class of triggers composed of [labial] and [dorsal] segments which have the effect of lowering adjacent //a// to [ɑˤ]. These are traditionally called the "secondary emphatics".

This is one of the most widely pursued approaches to ES (e.g. Jakobson 1957; Abdel-Massih 1975; Norlin 1987; Watson 2002). Although it provides valid analysis, it ignores the striking observation that all examples of "secondary emphatics" must contain a low vowel [ɑˤ]. In my analysis, this fact is accounted for by positing [ɑˤ] as an underlying ES trigger specified for V-place[dor]. The most controversial points in this account relate to the status of [rˤ] and the existence of the "secondary emphatics", which I discuss below.

Emphatic [r]

The status of emphatic [rˤ] has been the subject of much controversy in ES literature. While some accounts acknowledge the strong evidence in support of treating [rˤ] as primarily an emphatic consonant, none of them includes it in the same class as the other coronal emphatics. It is unquestionable that [rˤ] spreads emphasis to other segments. However, there are two notable phonological differences between [rˤ] and the coronal emphatics [dˤ, tˤ, sˤ, zˤ]. The first difference is the effect of blockers on leftward spread of a V-place[dor] feature sponsored by [rˤ]. The second is the de-emphasis of [rˤ] next to V-place[cor] segments in certain well-defined environments (Younes 1994). I have shown that these exceptions can be accounted for by means of constraint interactions.

Harrell (1957) notes a third difference between [rˤ] and coronal [dˤ, tˤ, sˤ, zˤ], namely its distribution with vowels. Recall that of all the pharyngealized sounds, only these coronal consonants can appear in environments other than [ɑˤ] contrasts. Harrell claims that [rˤ] has a limited distribution with vowels in that it does not appear in these environments. He states that there are no examples of independent occurrence of [rˤ] with [iː, uː, eː, oː]. I claim, however, that combinations of [rˤ] with [iː] and [eː] are impossible because of the postulated de-emphasis effect. On the other hand, [rˤ] does occur next to [uː] in [rˤuːħ] 'go (imp.)' and [rˤuːmi] 'Roman' and next to [oː] in [rˤoːħ] 'spirit' and [rˤoːb] 'robe'—which makes its distribution similar to the coronal emphatics. From these arguments, we conclude that [rˤ] should be classified with the primary triggers of emphasis.

Secondary Emphatics

The list [rˤ, lˤ, mˤ, bˤ, xˤ, kˤ] comprises the traditional “secondary emphatics” in Cairene. [rˤ] is usually considered the most prominent secondary emphatic due to the rarity of the other consonants (Watson 2002). As a consequence, generalizations about “secondary emphatics” are usually based on the behavior of [rˤ], which calls them into question. The most obvious difference between [rˤ] and [lˤ, mˤ, bˤ, xˤ, kˤ] is that the latter group is restricted to the neighborhood of [ɑˤ], while [rˤ] is not. We have already discussed the status of [rˤ] and why it should be classified with the coronal emphatics. In this section, therefore, I limit the discussion to the other secondary emphatics: [lˤ, mˤ, bˤ, xˤ, kˤ].

In items which also contain one of the primary coronal emphatics [dˤ, tˤ, sˤ, zˤ, rˤ], examples of the secondary emphatics may be found in all positions and with all vowels. This occurrence may be called “conjunct secondary emphatics” (Harrell 1957). Conjunct secondary emphatics are not a concern in the literature since their surface forms are unarguably explained by emphasis spread. However, occurrences of secondary emphatics in items without [dˤ, tˤ, sˤ, zˤ, rˤ] (which may be called “independent secondary emphatics”) are both statistically rare and limited in distribution (Harrell 1957).

The debate about these “independent secondary emphatics” mainly concerns their phonological nature, their limited effect as triggers of ES, and the features that unify them. While emphatic/non-emphatic contrasts involving the primary emphatics are found in all vocalic environments, contrasts involving the secondary emphatics are found only next to the low vowel [ɑˤ] (Younes 1994). Below is a list of native words with the so-called “secondary emphatics” underlined.

(53) *Emphasis spread from non-coronals*

[ʔˤɑˤ <u>lˤl</u>ˤɑˤhˤ]	‘God’	[wˤɑ<u>ˤlˤl</u>ˤɑˤ]	‘by God’
[<u>m</u>ˤɑˤjˤjˤɑˤ]	‘water’	[<u>m</u>ˤɑˤjˤjɪtɪ]	‘my water’
[ʔˤɑˤ<u>bˤb</u>ˤ]	‘father’	[ʔˤɑˤ<u>xˤx</u>ˤ]	‘brother’
[fˤɑˤ<u>x</u>ˤmˤ]	‘lavish’	[mˤʊˤfˤɑˤ<u>xˤx</u>ˤɑˤmˤ][13]	‘emphasized’
[<u>k</u>ˤɑˤːkɪ]	‘cackle’	[ʔˤʊˤ<u>mˤm</u>ˤɑˤː<u>l</u>ˤ]	‘of course’

Because the secondary emphatics are invariably accompanied by the back variant of the low vowel, it is reasonable to conclude that the presence of back low vowels in the neighborhood of certain consonants is taken by native speakers as a signal that such consonants are emphatic (Ferguson 1956; Younes 1994). An examination of loanwords supports this conclusion: a foreign word with a low back

[13] Emphasis seems to be optional in this word, according to Harrell (1957:76).

vowel that is borrowed into Cairene Arabic is usually interpreted as emphatic, as shown in (54).

(54) *Cairene Loanwords with emphatic character*

[bˤɑˤnˤtˤɑˤlˤoˤ:nˤ]	'pants' (Italian *pantalone*)	[bˤʊˤsˤtˤɑˤ]	'post'
[bˤʊˤrˤnˤeˤ:tˤɑˤ]	'beret' (Italian *berrettino*)	[sˤɑˤlˤoˤ:nˤ]	'saloon'
[sˤɑˤlˤɑˤtˤɑˤ]	'salad'	[lˤɑˤmˤbˤɑˤ]	'lamp'
[bˤɑˤtˤɑˤ:tˤɪˤsˤ]	'potatoes'	[kˤɑˤ:kˤɑˤ]	'persimmon'
[mˤɑˤ:mˤɑˤ]	'mom'	[bˤɑˤ:bˤɑˤ]	'dad'
[ʔˤɑˤbˤlˤɑˤ]	'ma'am'	[fˤɑˤrˤɑˤnˤsˤɑˤ]	'France'
[bˤɪˤrˤɪˤtˤɑˤnˤjˤɑˤ]	'Britain'	[ʔˤɪˤtˤɑˤlˤjˤɑˤ]	'Italy'

These cases provide evidence that speakers hear the vowel quality and not the consonant, as exemplified in [lˤɑˤmˤbˤɑˤ] 'lamp' in which all vowels and consonants are emphatic throughout. Suppose that this word is borrowed from Italian *lampa*, in which case the consonants are clearly non-emphatic. The Italian vowel [a] was mapped onto the most similar phoneme [ɑˤ] which is expected in Cairene after an emphatic consonant. In borrowing, the vowel allophone was kept essentially unchanged and the consonants were made emphatic to correspond to it, not vice versa (Harrell 1957:79). This is evidence that the pharyngealized low back vowel [ɑˤ] is a trigger of ES and that it is unnecessary to posit a class of "secondary emphatics".

The table in (55) compares the consonantal account with the synthetic account presented here in terms of the emphatic/ non-emphatic distinctions they make and the disambiguation of ES facts.

(55) *Comparison of two approaches to emphasis spread*

		Consonantal Account	**Synthetic Account**
Emphatic/ non-emphatic Distinctions	[cor]	Yes	Yes
	[lab]	Yes	No
	[dor]	Yes	No
	low vowel	No	Yes
Other Facts	Segmental	Yes	Yes
	[cor] emphatic segments	//tˤ dˤ sˤ zˤ//	//tˤ dˤ sˤ zˤ rˤ//
	Secondary emphatic segments	//rˤ lˤ mˤ bˤ kˤ xˤ//	None
	Underlying emphatic vowels	None	//ɑˤ//
	Explains [rˤ] resemblance to [cor] emphatics	No (different class)	Yes (with exceptions)
	Explains why ✓emphatic [cor] + [ɪ] *emphatic [dor/lab]+ [ɪ]	No	Yes
	Domain of ES	- Prosodic word for primary emphatics - Syllable for secondary emphatics	Prosodic word for all triggers

There are two main differences between the two accounts. While the former identifies two qualities (emphatic/ non-emphatic) for each of the consonants [l, m, b, x, k], the latter restricts them to one quality. Moreover, the consonantal account recognizes only one underlying low vowel quality [a] and no contrast between front [a] and back [ɑ]. The synthetic account, however, recognizes two underlying qualities of the low back vowel: one emphatic and another non-emphatic.

As the table shows, the Synthetic Account makes fewer distinctions in the contrastive inventory and yet explains all the facts about the nature of the emphatics in a straightforward and economical way. It unifies the triggers of ES in one class, explains the controversial status of emphatic [rˤ], and assumes one domain for ES. The Consonantal Account, on the other hand, is less economical in that it recognizes two classes of triggers and two domains for emphasis spread. Hence, the Synthetic Account is preferable to the Consonantal Account.

2.7 Concluding Remarks

One of the major departures I made from traditional emphasis spread analyses is that the pharyngealized low vowel [ɑˤ] is the only underlyingly emphatic vowel. All consonants are necessarily emphatic in a syllable containing this vowel. This is robust evidence that [ɑˤ] is a trigger of ES, an important conclusion missed in most analyses. What have traditionally been called "secondary emphatics" are underlyingly plain consonants which become targets of ES triggered by [ɑˤ]. Besides [ɑˤ], I argued in favor of five underlying coronal emphatic consonants [dˤ, tˤ, sˤ, zˤ, rˤ].

Underlying emphatic consonants in Cairene form only one class //dˤ, tˤ, sˤ, zˤ, rˤ, ɑˤ// which is structurally distinguished by a V-place[dor] feature. Members of this class of segments trigger emphasis spread bidirectionally in the phonological word causing targets in this domain to bear an additional V-place[dor] feature. Generally, non-tautosyllabic segments with a V-place[cor] feature block left-to-right ES. Tautosyllabic V-place[cor] segments do not block due to a highly ranked constraint on associating emphasis to the syllable.

The Parallel Structures Model of feature geometry served as the framework for this analysis. It helped us to account for all the above generalizations in an elegant and straightforward manner. A major advantage of using this model is that it unifies the classes of participating segments through distinctive features, e.g. V-place[dor] and V-place[cor]. Significantly, it describes phonological phenomena in line with the complete phonological inventory of the language via simple and economical representations.

Chapter 3

Contrast and Phonological Activity in Buchan Scots

3.1 Introduction

Buchan is part of Aberdeenshire in north-east Scotland. The dialect spoken in this area exhibits a unique type of assimilation which involves an interesting set of phonotactic restrictions. First, it is directly connected with the distribution of vowels in stressed and unstressed syllables. Second, vowel distribution is related to a set of consonants for which voicing appears to be the only unifying characteristic. Third, assimilation applies both progressively and regressively. Finally, it does not only apply within morphemes, but also from roots into suffixes resulting in productive alternations in the participating suffixes.

Assimilation in Buchan Scots (henceforth Buchan) is a vowel raising process which applies to vowels in two types of trochees. In monosyllabic trochees, it is regressive consonant-to-vowel assimilation which applies from certain consonants in the coda position to stressed vowels. In disyllabic trochees, the process was noted by Dieth (1932:73) as progressive assimilation affecting the vowel of any unstressed second syllable, be it a suffixed or a monomorphemic form. The quality of the unstressed vowel is determined by either vowel height in the root or the quality of intervening consonants as schematized in (1). In essence, the progressive assimilation is both consonant-to-vowel and vowel-to-vowel.

(1) *Summary of progressive assimilation in Buchan* [from (Paster 2004:360)]

Accented vowel	Intervening consonant	Unaccented vowel
high	any consonant	high
non-high	voiced obstruent or [l m n ŋ] followed by voiceless obstruent	high
non-high	any other consonant or sequence	non-high

My contribution in this chapter is to present a coherent analysis of the Buchan facts in the Parallel Structures Model as well as resolve some of the problematic issues related to assimilation in this dialect. In order to build up such analysis, we need to develop detailed feature specifications for all segments in the language. For this purpose, I will start with a layout of the Buchan phonetic inventory showing all surface variations in consonants and vowels. By providing the relevant data, I will then develop a contrastive inventory of the Buchan dialect based on contrastive phonological evidence. Unless otherwise stated, the data used here comes from a reasonably modern study by Wölck (1965), also cited in Fitzgerald (2002).[14] The data provides robust evidence that there is a similarity in the consonant distribution with accented and unaccented vowels. This observation is a strong case in favor of a raising analysis for Buchan assimilation, contrary to the lowering analysis proposed by Paster (2004). Building on the conclusions I draw from these data, it will be feasible to work out the feature specifications for all contrastive segments in the language. And based on full PSM feature specifications, the following section will provide autosegmental representations and optimality-theoretic analysis of the assimilation pattern. Finally, I will compare my analysis to previous accounts of Buchan assimilation, outlining the strengths and limitations of each.

3.2 The Surface Inventory of Buchan Scots

3.2.1 Surface Vowels

The Buchan vowel system is made up of 5 long, 5 half-long, 8 short, and 3 diphthongs. The charts in (2) give the surface inventory of Buchan vowels with the approximate location of monophthongs and diphthongs.

(2) *Chart: Surface vowels in Buchan* [based on Wölck (1965)]

	Front	Central	Back/ Round
high	i iˑ iː	ɨ	u uˑ uː
mid	e eˑ eː	ə	o oˑ oː
low	a aˑ aː		ʌ

Diphthongs	[ei]	
	[ai]	[au]

[14] The analysis in this chapter extends to the slightly different dialect described by Dieth (1932) and Paster (2004). Although I cite data from these sources, the focus remains to be the dialect noted in Wölck (1965) and Fitzgerald (2002). It is important to note that the general pattern of assimilation seems to be principally the same in all descriptions from the 1930s to the contemporary time.

This inventory is basically the same as that of Wölck (1965) with two minor modifications. First, I have replaced front [ɪ] with the more central [ɨ] since it behaves phonologically like a central vowel, as will be shown later. Second, for completeness' sake I included vowel length distinctions as stated in Dieth (1932).

3.2.2 Surface Consonants

The surface inventory of Buchan consonants is given in (3).

(3) *Detailed table of 27 phonetic Buchan consonants*

	Bilabial	Labiodental	Interdental	Aleveolar	Alveopalatal	Palatal	Velar	Gt	L-V
Stop	p b			t d			k g		
Fricative		f v	θ ð	s z	ʃ ʒ	ç	x	h	ʍ
Affricate					t͡ʃ d͡ʒ				
Nasal	m			n			ŋ		
Lateral				l					
Trill				r					
Glide					j				w

This consonant inventory is fairly similar to that of Scots. Yet it is worth noting the absence of the labial-velar fricative [ʍ] in older descriptions of Buchan. Dieth (1932) mentions the shifting of that consonant to [f] in many lexical items such as [fat] 'what', [faː] 'who', [fɨn] 'when', etc. However, he states that in the Buchan dialect of his day there was a growing tendency toward using [ʍ] especially in loanwords from Scots. Moreover, I found instances of [ʍ] in Paster's (2004) recent fieldwork on Buchan. Thus, I include it in the inventory.

3.3 The Contrastive Inventory of Buchan Scots

Having described the phonetic inventory, I will proceed to introduce and analyze the distribution and behavior of consonants and vowels in Buchan with the aim of establishing the phonologically contrastive segments in the language. The main focus will be the interactions of some vowels and consonants in what seems to behave like an unfamiliar type of assimilation.

3.3.1 Contrastive Vowels

Vowel Length

Buchan has five vowel qualities that come in short- half-long- long variants [i, e, u, o, a], [iˑ, eˑ, uˑ, oˑ, aˑ], and [iː, eː, uː, oː, aː] (4).[15] However, the length distinction

[15] For the low-back vowel //A//, there is a slight difference in phonetic quality between long and half-long [ɑ] vs. short [a] which can best be noticed in successive words like [for ɑː ðat] 'for all that', [saks kjɑːks] 'six cakes' (Dieth 1932). For practical purposes, though, the two sounds will count as one here and [a] will be used indiscriminately for both.

does not appear to be contrastive and is partially predictable from syllable structure. For example, open syllables are associated with long vowels, while syllables closed by obstruents have shorter vowels. In addition, length is clearly irrelevant for the purposes of vowel raising addressed in this study. Hence, it will be ignored here and each of these five vowels will count as having one quality in the system of contrast.

(4) *Vowel length pairs*

[uː]	'wool'	[puˑʒɨn]	'poison'	[hux]	'hooch'
[woː]	'stop'	[noˑt]	'note'	[knok]	'clock'
[kaːr]	'calves'	[kaˑp]	'cup'	[kaf]	'chaff'
[eː]	'one'	[greˑp]	'fork'	[eb]	'shallow'
[tiː]	'too'	[gliˑb]	'glebe'	[hiç]	'high'

(Dieth 1932:2-4)

Vowel Distribution

All eight vowel qualities of Buchan are allowed in stressed syllables. The forms in (5) show the range of vowels permitted in monosyllabic content words, those words that must be stressed. The left-hand column lists permissible open syllables, and the right-hand column lists permissible closed syllables. In the latter case, the coda is always [n] (Fitzgerald 2002).

(5) *Vowel contrasts in monosyllabic content (stressed) words:*

	Open Syllables		**Closed Syllables**	
[i]	[li]	'lie'	[bin]	'bone'
[ɨ]	--		[bɨn]	'bind'
[u]	[su]	'sow (n.)'	[tun]	'town'
[e]	[se]	'sea'	[hen]	'hen'
[ə]	--		[fən]	'fin'
[o]	[θro]	'throw'	[don]	'Don'
[a]	[sa]	'sow (v.)'	[han]	'hand'
[ʌ]	--		[fʌn]	'when'

(Fitzgerald 2002:63)

The chart in (2) shows three central vowels that are always short [ɨ, ə, ʌ] versus a set of five vowels that have long and short versions. It is clear from the data in (5) that only a subset of vowels is permitted in monosyllabic words with an open syllable. Specifically, it is those three central vowels that cannot appear in open monosyllables, which indicates that they behave as a natural class as I formulate in section 3.4.

The set of vowels allowed in stressed syllables is larger than the set of vowels allowed in unstressed syllables. While all eight vowels are allowed in stressed syllables, only four vowels, [i, ɨ, e, ə], can appear in the unstressed syllables of trochees and iambs, as outlined in (6). The vowels [u, o, ʌ, a] do not occur in unstressed syllables, meaning that they never occur more than once within prosodic words (Fitzgerald 2002:63).

(6) *Surface inventory of unstressed vowels*

(a) Post-tonic position (trochees)

	Front	Central
high	i	ɨ
mid	e	ə

(b) Pre-tonic position (iambs)

	Central
high	ɨ
mid	ə

Stress in Buchan is generally word-initial in which case all four vowels [i, ɨ, e, ə] can occur in unstressed syllables (post-tonically). In the less common non-initial stress pattern, only two possible vowels [ɨ, ə] can occur in the initial unstressed syllable (pre-tonically), as shown in (7). Furthermore, the environment following these two vowels allows the widest range of vowel contrasts with no apparent height restrictions (Fitzgerald 2002:64).

(7) *Vowel co-occurrence patterns with non-initial stress (Pre-tonic)*

(a) [ə]......V́

[i]	[ðəstrín]	'*thestreen* - yesterday' [16]	[kəmplín]	'complain'
[ɨ]	[əhɨ́n]	'*ahind* - behind'	--	
[u]	[əlú]	'allow'	[ərún]	'around'
[e]	[ðədé]	'today'	[əmézt]	'amazed'
[ə]	[ðənə́xt]	'tonight'	--	
[o]	[əmó]	'among'	[ədóp]	'adopt'
[a]	[strəmáʃ]	'*stramash* - smash'	[əkwánt]	'acquainted'
[ʌ]	[əmʌ́n]	'among'	[təmʌ́rə]	'tomorrow

(b) [ɨ]......V́

[i]	[mɨnír]	'*mineer* - make noise'	--	
[ɨ]	--		--	
[u]	[ɨnjúx]	'enough'	[d͡ʒɨlúz]	'*jalouse* - suspect'
[e]	[dɨpén]	'depend'	[ɨkspék]	'expect'
[ə]	[bɨgə́n]	'begin'	--	
[o]	--			
[a]	[ɨgzákle]	'exactly'	[bɨgán]	'began'
[ʌ]	--		--	

(Fitzgerald 2002:64-65)

[16] Where Scots and English glosses are given, italicized glosses indicate Scots words.

The set of contrasts permitted in unstressed syllables is not only smaller than that permitted in stressed syllables, but the quality of unstressed vowels in the initial stress pattern is at least partially predictable from the preceding stressed vowel. The basic tendency in trochees is that non-high unstressed vowels follow non-high vowels, and high unstressed vowels follow high vowels (Fitzgerald 2002). This is exemplified in (8) and (9) below.

(8) *Stressed non-high vowels + unstressed non-high vowels (trochees)*

(a) $\acute{V}_{\text{non-high}}$ + $V_{\text{non-high}}$ [e]

[e]	[beke]	'*baikie* - container'	[leme]	'loam (dim.)'
[ə]	[skərle]	'*skirlie* - oat-meal'	[bəte]	'bit (dim.)'
[o]	[tofe]	'toffee'	[d͡ʒoke]	'Jackie'
[a]	[tate]	'potato'	[ʃale]	'shell (dim.)'
[ʌ]	[bʌke]	'*buckie* - whelk'	[pʌkle]	'pickle (dim.)'

(b) $\acute{V}_{\text{non-high}}$ + $V_{\text{non-high}}$ [ə]

[e]	[femlə]	'family'	[berəks]	'barracks'
[ə]	[lətlən]	'*littlin* - infant'	[θərəp]	'*thirrap* - kink'
[o]	[borə]	'borrow'	[slorəx]	'*slorach* - slobber'
[a]	[ʃalə]	'shell'	---	
[ʌ]	[ʌŋkə]	'uncouth'	[ʌmən]	'woman'

(9) *Stressed high vowels + unstressed high vowels (trochees)*

(a) $\acute{V}_{\text{high}}$ + V_{high} [i]

[i]	[drixi]	'*dreichy* - dreary'	[dimi]	'dame (dim.)'
[ɨ]	[sɨmɨtri]	'cemetery'	[twɨnti]	'twenty'
[u]	[budi]	'*boodie* - ghost'	[mui]	'mouth (dim.)'

(b) $\acute{V}_{\text{high}}$ + V_{high} [ɨ]

[i]	[idjɨt]	'idiot'	[d͡ʒilɨs]	'jealous'
[ɨ]	[wɨndɨ]	'window'	[gɨgɨt]	'big'
[u]	[hulɨt]	'owl'	[surɨk]	'*sourock* - sorrel'

(Fitzgerald 2002:66-67, 73)

While non-high vowels never follow high vowels, front high vowels [i, ɨ] can follow non-high vowels if certain consonants, C^{Ψ}, precede them (detailed discussion of these consonants to follow). Some examples are given in (10).

(10) *Stressed non-high vowels + unstressed high vowels (trochees)*

(a) $\acute{V}_{\text{non-high}}$ + C^{Ψ} + V_{high} [i]

[e]	[speɲi]	'*spainyie* - Spanish'	--	
[ə]	[kəlti]	'*kiltie* - kilt (dim.)'	[brəmstin]	'brimstone'
[o]	[podli]	'*podlie* - coalfish'	[dorbi]	'*dorbie* - stonemason'
[a]	[bradi]	'*bridie* - meat pie'	[sani]	'sandy'
[ʌ]	[krʌni]	'*crannie* - cranny'	[skʌdi]	'*scuddy* - naked'

(b) $\acute{V}_{\text{non-high}} + C^{\Psi} + V_{\text{high}}$ [ɨ]

[e]	[elbɨ]	'elbow'	[feʒɨn]	'pheasant'
[ə]	--		--	
[o]	[bodɨ]	'body'	[ovɨn]	'oven'
[a]	[kabɨd͡ʒ]	'cabbage'	[fadɨm]	'fathom'
[ʌ]	[rʌbɨt]	'rabbit'	[krʌmpɨt]	'crumpet'

(Fitzgerald 2002:66-67)

The pattern discussed thus far can be summarized as follows: both within morphemes and across morpheme boundaries, post-tonic unstressed vowels must be high if the preceding vowel is high no matter what consonants intervene. On the other hand, if the stressed vowel is non-high, unstressed vowels can be either non-high or high, depending on the intervening consonant. This is outlined in (11).

(11) *Outline of vowel co-occurrence in Buchan*

	High	Non-high
High	✓	*
Non-high	✓ / C^{Ψ} —	✓

The fact that non-high vowels never follow high vowels suggests that unstressed vowels in Buchan undergo raising after stressed high vowels or certain consonants (C^{Ψ}). A lowering analysis fails to account for this significant fact as I show in section 3.6.3. The examples above show that vowel raising applies to unstressed vowels within both monomorphemic and suffixed (diminutive) forms. [17]

Outline of Buchan Contrastive Vowels

To sum up, the system has 3 high vowels and 5 non-high. All 8 can occur in stressed syllables contrastively, while only 4 can occur in unstressed syllables, i.e. participate in assimilation. Principally, unstressed non-high vowels become high when followed by stressed high vowels or certain consonants. The 8 contrastive vowels in Buchan are shown in (12).

(12) *Phonetic description of 8 contrastive vowels in Buchan*

	Front	Central	Back/ Round
high	i	ɨ	u
mid	e	ə	o
low	a		ʌ

[17] However, assimilation does not apply from a root into a clitic in the modern dialect (Paster 2004). Clitics probably exist outside the trochee domain (e.g. prosodic word), which explains their non-participation in raising.

3.3.2 Contrastive Consonants

Consonant Distribution with Stressed Vowels

Within monosyllabic stressed syllables, the central vowels [ɨ] and [ə] exist in complementary distribution with regard to the coda consonant. [ɨ] occurs before voiced stops and fricatives, or a nasal + voiceless stop (or just [ŋ] in some cases) (13a). [ə] occurs before voiceless stops (except [k]) and fricatives or a liquid + consonant, or [m] (13b) (Wölck 1965:24-25). Before [k, n], however, there seems to be some oppositions between [ɨ] and [ə] as shown in (13c-d).

(13) *[ɨ] versus [ə] in stressed syllables*

(a)	[sɨb]	'sib'	[gɨd]	'go & give'	[brɨg]	'bridge'		
	[dɨv]	'do'	[hɨz]	'his, us'	[bɨnʃ]	'bench'		
	[tɨnt]	'tent'	[lɨnθ]	'length'	[skɨmp]	'skimp'		
	[sɨŋ]	'sing'	[bɨŋk]	'*bink* - bench'				
(b)	[pət]	'pit'	[nəp]	'nip'	[stəf]	'stiff'		
	[kəs]	'kiss'	[səx]	'sigh'	[kəl]	'kill'		
	[d͡ʒəm]	'Jim'	[fər]	'fir'	[stərk]	'stirk'		
(c)	[wɨn]	'wind'	[wən]	'win'	[bɨn]	'bind'	[bən]	'bin'
	[fɨn]	'find'	[fən]	'fin'				
(d)	[stɨk]	'*steek* - shut'	[stək]	'stick'	[sɨk]	'seek'	[sək]	'such'
	[brɨks]	'breeches'	[brəks]	'bricks'				

(Wölck 1965:24-25)

The distribution of these short central vowels shows that the voicing of obstruents can influence vowel height. Generally voiced obstruents occur after the high central vowel [ɨ] as in (13a), while voiceless obstruents and sonorants occur after the non-high central vowel [ə] as in (13b). In case of [n], I argue that the oppositions in (13c) are not contrastive due to the existence of two qualities of [n] as will be discussed in the following section. As for [k], I suggest for the sake of argument that only one central vowel [ə] surfaces in the nucleus, and that [ɨ] is just a phonetic realization of surface /i/. The front vowel /i/ is likely to become retracted in this environment because of the back articulation of [k]. This is further justified by the fact that [i] never appears before [k] phonetically.

This observation about consonant distribution with stressed vowels is central to my argument and will be relevant when we discuss consonant distribution with unstressed vowels. To facilitate comparison, I summarize the class of consonants that condition a high central vowel [ɨ] in stressed syllables in (14a) and those that condition a non-high central vowel [ə] in stressed syllables in (14b).

(14) (a) *Consonants allowing just a high stressed central vowel [ɨ] in CVC syllables*

	Bilabial +voi	Labiodental +voi	Interdental +voi	Aleveolar +voi	Alveopalatal +voi	Velar +voi
Stop	b			d		g
Fricative		v	ð	z	ʒ	
Affricate					d͡ʒ	
Nasal	mp				n nθ nʃ nt	ŋ ŋk
Lateral				lt		
Trill						

(b) *Consonants allowing just a non-high stressed central vowel [ə] in CVC syllables*

	Bilabial -voi	Labiodental -voi	Interdental -voi	Aleveolar -voi	Alveopalatal -voi	Velar -voi
Stop	p			t		k
Fricative		f	θ	s	ʃ	x
Affricate					t͡ʃ	
Nasal	m				n	
Lateral				l		
Trill				r		

Consonant Distribution with Unstressed Vowels

As discussed earlier, unstressed high vowels follow non-high vowels only when certain consonants intervene. If we assume a raising analysis of Buchan assimilation, then underlying non-high vowels undergo raising following these consonants; i.e. these consonants are triggers of raising. The class of trigger consonants is given below: (15a) shows orthographic single consonants[18] and (15b) shows orthographic consonant clusters.

(15) a. *Raising triggers- orthographic single consonants*

Voiced stop	b		d		g
Voiced fricative	v	ð	z	ʒ	
Voiced affricate				d͡ʒ	
Nasal			n		ŋ

b. *Raising triggers- orthographic consonant clusters*

1. *containing voiced obstruents*

Voiced stop + liquid	bl	dl		gl
Liquid + voiced stop	rb	rd		rg
Liquid + voiced stop + liquid		rdl		
Nasal + voiced obstruent		nz	nʒ	

2. *containing voiceless obstruents*

Nasal + voiceless stop	mp	nt		ŋk
/l/ + voiceless stop		lt		
Nasal + voiceless stop + liquid		ntl	ntr	
Nasal + voiceless stop + voiceless stop	mpt			

[18] I found two examples: [lajɨr] 'lawyer' and optional [kət͡ʃi - kət͡ʃi] 'kitchen' in which unstressed high vowels may appear after stressed non-high vowels with the consonants [j] and [t͡ʃ] intervening. I believe, however, that this is not a case of assimilation. Rather, the palatality of [j] and [t͡ʃ] disfavors a low vowel following them.

Raising triggers- orthographic single consonants

Following the voiced obstruents [b, d, ɡ, v, ð, z, ʒ, d͡ʒ], only high vowels can appear after stressed high or non-high vowels. In (16a) it is unclear whether the high vowel or the voiced obstruent causes raising to the unstressed vowel; it could be either. In (16b) only the voiced obstruent can trigger raising since the unstressed vowel is non-high.

(16) (a) *Stressed high vowel + voiced obstruent + unstressed high vowel (trochees)*

[blizɨr]	'blazer'	[briðɨr]	'brother'
[puʒɨn]	'poison'	[visɨt]	'visit'
[wɨdɨ]	'widow'	[dɨzɨn]	'dozen'

(b) *Stressed non-high vowel + voiced obstruent + unstressed high vowel (trochees)*

[robɨn] ,	*[robən]	'robin/robbing'	[mebi] ,	*[mebe]	'maybe'
[bodɨm] ,	*[bodəm]	'bottom'	[lodi] ,	*[lode]	'loadie (dim.)'
[feɡɨt] ,	*[feɡət]	'fagged'	[doɡi] ,	*[doɡe]	'doggie (dim.)'
[klovɨr] ,	*[klovər]	'clover'	[lʌvi] ,	*[lʌve]	'lovey (dim.)'
[neðɨr] ,	*[neðər]	'neither'	[pozi] ,	*[poze]	'posey'
[tesðɨr] ,	*[tesðər]	'tether'	[rozi] ,	*[roze]	'Rosie (dim.)'
[wad͡ʒɨr] ,	*[wad͡ʒər]	'wager'	[ked͡ʒ-i] ,	*[ked͡ʒe]	'cagie (dim.)'
[feʒɨn] ,	*[feʒən]	'pheasant'			

(Fitzgerald 2002:69-70; Paster 2004:366)

In order to explain why after the nasals [n, ŋ], the target unstressed vowel may surface as high, we must consider a historical process documented by Dieth (1932). His data reveal that the voiced stops [b, d, ɡ] have been dropped phonetically after their respective nasals in final position. In medial position, i.e. before *-in, -el (l̩), -er (ɨr, ər)*, none of the voiced stops has been inserted nor have historic ones been retained (1932:123).[19] The examples in (17) display phonetic realizations of historical nasal-voiced stop clusters in Buchan as compared to Standard English.

(17) *Nasal + voiced stop = nasal* (Dieth 1932:123)

Standard English			**Buchan Scots**		
-m(b)	-mbl̩	-mbə	-m	-ml̩	-mər
-nd	-ndl̩	-ndə	-n	-nl̩	-nər
-ŋ	-ŋɡl̩	-ŋɡə, (-ŋə)	-ŋ	-ŋl̩	-ŋər

(a)

[kem]	'comb'	[lam]	'lamb'	[wəim]	'womb'
[brʌml̩]	'bramble'	[tʌml̩]	'tumble'	[skeml̩z]	'shambles'
[t͡ʃaːmər]	'chamber'	[emər]	'ember'	[tɨmər]	'timber'

[19] With two exceptions: [bəndi] 'bendy' and [wɨndɨ] 'window'. The second is a borrowing from Standard English; the native form is [wɨnək] 'winnock'.

(b)	[lan]	'land'	[men]	'mend'	[run]	'round'
	[bɨnɨn]	'binding'	[hanɨ]	'handie'	[benɨd͡ʒ]	'bondage'
	[kanl̩]	'candle'	[hanl̩]	'handle'	[fenləs]	'weak'
(c)	[sɨŋ]	'sing'	[fʌŋɨn]	'pitching'	[ɨŋɨnz]	'onions'
	[sɨŋl̩]	'single'	[ɨŋlɨʃ]	'English'		
	[fɨŋɨr]	'finger'	[hʌŋər]	'hunger'		

Considering this, we can explain why after the nasals [n,ŋ] high vowels can surface as high or non-high. For those forms in which the vowel surfaces as high, the diachronic explanation is that a voiced /d/ existed historically, giving the raising pattern. This pattern was probably kept intact after the phonetic deletion of the voiced stop. From a synchronic perspective, I assume that those nasals which trigger raising are underlyingly nasal + voiced stop; that the voiced stop has merged with the nasal giving it a voiced character. Apart from the cases mentioned in (18a), nasals do not appear to trigger raising; i.e. non-high regularly surfaces as non-high when nasals intervene otherwise (18b). In order to distinguish these two classes of nasals which are underlyingly different but surface similarly, I will transcribe the nasal triggers with a voice diacritic underneath.

(18) (a) *Stressed non-high vowel + nasal + unstressed high vowel (trochees)*

[laŋ̬ɨr] , *[laŋ̬ər]	'longer'	[speŋ̬i] , *[speŋ̬e]	'*spainyie* - Spanish'
[san̬i] , *[san̬e]	'sandy'	[kran̬i] , *[kran̬e]	'*crannie* - cranny'
[kran̬i] , *[kran̬e]	'crow'	[han̬i] , *[han̬e]	'handie'
[θʌn̬ɨr] ,*[θʌn̬ər]	'thunder'	[hʌŋ̬ri] , *[hʌŋ̬re]	'hungry'

(b) *Stressed non-high vowel + nasal + unstressed non-high vowel (trochees)*

[keməst]	'chemist'	[t͡ʃamər]	'chamber'
[stanən]	'standing'	[skʌnər]	'*scunner* - flinch'
[menər]	'manner'	[denər]	'dinner'

(Dieth 1932:77; Fitzgerald 2002:72)

Raising triggers- orthographic consonant clusters

Having shown the impact of single consonants on the following unaccented vowels, I will now discuss the impact of orthographic consonant clusters. This will lead to the conclusion that some of these orthographic clusters discussed in the literature are not phonologically clusters.

It seems logical to claim that consonant clusters containing one of the voiced obstruents also trigger raising (19), i.e. they are phonologically clusters. In (15b.1), I tried to list all the clusters of which I could find examples in the limited data I have available.[20] However, I assume that all other possible consonant sequences containing voiced obstruents will cause raising to the unstressed vowel.

(19) *Stressed non-high V + consonant cluster w/ voiced obstruent + unstressed high V*

[eblɨnz]	'*aiblins* - perhaps'	[ʌgli]	'ugly'
[podli]	'*podlie* - coalfish'	[kodlɨn]	'codling'
[dorbi]	'dorbie'	[ʃargɨr]	'*sharger* - puny'
[gerdɨn]	'garden'	[hardli]	'hardly'
[tanzi]	'tansy'	[ganʒi]	'*guernsey* - pullover'

(Fitzgerald 2002:71; Paster 2004:366)

While voiceless stops alone have no effect on raising vowels, voiceless stops following nasals and [l] behave as triggers. As a rule, only high vowels can appear after stressed non-high vowels when one of the following orthographic clusters intervenes: [mp, nt, ŋk, lt] and [mpt, ntl, ntr].[21]

(20) *Stressed non-high V + (nasal or [l] + voiceless obstruent) + unstressed high V*

[lʌmpi]	'lumpy'	[krʌmpɨt]	'crumpet'
[grantɨt]	'granted'	[denti]	'dainty'
[ʃʌlti]	'sheltie'	[kəlti]	'kiltie'
[haŋki]	'hanky'	[haŋkɨt]	'hank'
[hʌntli]	'Huntly'	[kʌntri]	'country'

(Fitzgerald 2002:70-71; Paster 2004:366)

However, we have seen earlier that plain nasals do not trigger assimilation since those which appear to raise the following vowel are underlyingly nasal + voiced stop. Moreover, neither liquids nor voiceless stops trigger raising on their own. Taking these facts into account, it is difficult to explain why the sequences [mp, nt, ŋk, lt] cause raising if they are simply clusters of two non-triggers. I infer that these four complex structures are actually phonological singletons which share a feature in common with the voiced obstruents, making them triggers of raising. From now on, these stopped sonorants will be transcribed with IPA tie bars to show that they are complex phonological segments. Longer sequences documented to trigger raising such

[20] Another trigger cluster that has been cited is [lk]. However, Wölck claims that it causes optional raising, as in the pair /əlke – əlki/ 'ilka'. Since this seems to be an extremely rare and optional case, it will be ignored here.

[21] I found only two counterexamples to this rule: [stʌmpərt] 'stump(ert)' and [kaŋkərt] 'cankert' in which the clusters do not seem to trigger harmony. Since both examples end in complex codas [rt], the trill cannot be extrasyllabic. And trills are known to have a lowering effect themselves in the syllable. Therefore, the unstressed vowels undergo vowel reduction before [r] in the unstressed syllable.

as [mpt, ntl, ntr] are then clusters of a stopped sonorant from the set [m͡p, n͡t, ŋ͡k, l͡t] and some other segment, and thus expected to trigger raising.[22]

An asymmetry pointed out by Paster (2004) is that r + voiceless obstruent sequences are transparent to assimilation. She gives phonetic evidence that the pre-obstruent trill [r] is devoiced in Buchan and therefore does not cause voicing in the obstruent. According to my account, this sequence is not a phonological singleton, but simply a cluster lacking the relevant feature. Consequently, it is not expected to trigger raising.

To summarize the distribution of consonants with unstressed vowels, I give the charts in (21).

(21) (a) *Consonants allowing just high unstressed vowel [i,ɨ] in CVCV trochees*

	Bilabial +voi	Labiodental +voi	Interdental +voi	Aleveolar +voi	Alveopalatal +voi	Velar +voi
Stop	b			d		g
Fricative		v	ð	z	ʒ	
Affricate					d͡ʒ	
Nasal	m͡p				n̬ n͡t	ŋ ŋ͡k
Lateral				l͡t		
Trill						

(b) *Consonants allowing just non-high unstressed vowel [e,ə] in CVCV trochees*

	Bilabial -voi	Labiodental -voi	Interdental -voi	Aleveolar -voi	Alveopalatal -voi	Velar -voi
Stop	p			t		k
Fricative		f	θ	s	ʃ	x
Affricate					t͡ʃ	
Nasal	m				n	
Lateral				l		
Trill				r		

Now compare the charts in (14) with (21). It is hard to miss the similarities between two corresponding consonant sets. On the one hand, the set of consonants that condition a non-high stressed central vowel (14b) and those that condition a non-high unstressed central vowel (21b) are identical. On the other hand, the consonants that condition a high stressed central vowel (14a) and those that condition a high

[22] Mary Paster (p.c.) pointed out to me the difficulty in further justifying post-stopped sonorant segments. For example, they would be unusual in that they cannot occur as onsets. Although this may be problematic for my analysis, the alternative post-sonorant voicing is not without problems. Paster (2004) suggests a rule by which voicing assimilates into voiceless obstruents from a preceding nasal or lateral. According to this rule, the feature [voice] spreads from a nasal or lateral to a following [-sonorant] segment. However, this requires another condition for trigger (or blocker) consonants to be both [voiced] and [-sonorant], while my account requires them to be specified for only one feature. More importantly, post-sonorant voicing is unable to account for the behavior of plain nasals as triggers of assimilation.

unstressed central vowel (21a) are nearly identical. The only difference between them is the existence of [nθ] and [nʃ] clusters in (14a), but not in (21a). In order to resolve this, I will assume that these clusters are underlyingly /ntθ/ and /ntʃ/; thus they are combinations of /n͡t/ and a fricative.[23]

Apart from Trigo (1986), this important observation has been overlooked in previous accounts of the language. I infer from this striking similarity that the set of consonants in (21a/ 14a) not only trigger raising of the following unstressed vowels in disyllabic CVCV trochees, but also trigger raising of the preceding stressed vowels in monosyllabic CVC trochees. In addition, there must be a correlation between these consonants and high vowels since they seem to be concurrent on both stressed and unstressed patterns. There must be a common phonological feature that makes these two groups of segments harmonious. In the next few paragraphs, I will present some phonological properties of these consonants and high vowels bearing on this correlation and suggest a feature that unites them.

Voicing and Laryngeal Lowering

It is important to note that trigger consonants correspond roughly to two classes of segments: (a) voiced obstruents and combinations of voiced obstruents with each other and with other sounds; (b) stopped sonorants and combinations of these with other sounds. By looking at class (a), it becomes obvious that voicing is the only relevant characteristic that makes these consonants trigger assimilation. Since assimilation in Buchan is one of vowel height (i.e. raising), there must be a phonetic correlation between voicing and vowel height. This section examines phonetic evidence in favor of such a correlation.

High vowels have been associated with the feature [ATR] (advanced tongue root). Trigo (1991) claims that "the most reliable acoustic cue of tongue root advancement is a lowered F1, which is caused both by the larger volume of the pharynx and the fact that protracting the tongue root increases the bulk of the tongue in the mouth, which gives a generally raised prepalatine dorsum." Generally, there is a phonetic tendency that a gesture in one dimension correlates with a compensatory gesture in another dimension (Archangeli and Pulleyblank 1994:172). The acoustic effect of tongue root advancement is the same as that of lowering the larynx, a characteristic of voicing. In fact, the correlation between vowel height [ATR] and

[23] Evidence for this comes from the fact that many languages avoid nasal-fricative sequences. In Venda, affricates and fricatives preceded by nasals are realized identically with affrication. For example, /m/ + /bvuda/ → [mbvudɔ] 'a leak' and /m/ + /vulɛdza/ → [mbvulɛdzɔ] 'finishing'. Based on such compelling facts, Steriade (1991) argues that the underlying representations for [nasal + affricate] and [nasal + fricative] clusters should be identical, the difference being simply one of implementation [cited in Padgett (1994)].

voicing has been documented in several languages, e.g. Madurese (Trigo 1986) and Armenian (Vaux 1998).

It is now worthwhile to discuss voicing in Buchan. Buchan voiceless stops [p, t, k] have been described by Dieth (1932) as lacking aspiration. “Since aspiration and no aspiration no longer divides (voiced from voiceless) stops, voice and intensity become the main discriminating factors (1932:85).” Paster (2004:380) suggests that since voiceless stops were not aspirated, their Voice Onset Time (VOT) must have been very small, which would obscure the distinction between voiced and voiceless stops. Without VOT, voicing would be the only contrastive clue in stops.

Paster (2004) argues that voicing in the stops must therefore be augmented by some other articulatory mechanism in order to compensate for the weakened vocal cord vibration caused by the buildup of pressure behind the closure in these sounds. She suggests that this mechanism is in fact larynx lowering (2004:381). Kohler (1984) also suggests a correlation between voicing and laryngeal lowering:

> “To maintain voicing during an obstruction, the supraglottal pressure rise has to be reduced by a cavity enlargement, either passively, by flexible wall expansion, or actively, by controlled articulatory movement, e.g. lowering of the larynx or fronting of the tongue (1984:163).”

I infer that laryngeal lowering (abbreviated [LL]), and not [voice], is the relevant phonological feature for assimilation in Buchan Scots. As a consequence, voiced obstruents and stopped sonorants which trigger raising are specified for [LL], but not plain sonorants or voiceless stops. However, vowel raising is not only triggered by consonants. High vowels in stressed syllables also cause raising to underlying unstressed non-high vowels. I suggest, therefore, that high vowels in Buchan have an underlying [LL] feature, rather than [ATR]. This leads to the realization of two classes of assimilation triggers in Buchan: [LL] consonants and [LL] vowels. I will accordingly refer to vowel raising in Buchan as “[LL] assimilation”.

[Lowered Larynx] is represented in this system as a V-laryngeal rather than a C-laryngeal feature. The main reason for this proposition is that the target segments for assimilation are only vowels. Intervening voiceless obstruents are transparent to [LL] assimilation in Buchan; i.e. they do not become voiced after high vowels and the laryngeal feature [LL] can spread through them, resulting in the raising of non-high unstressed vowels. Voicing of consonants triggered by [LL] vowels has been observed in South-west Turkic languages and some dialects of Armenian (Vaux 1998:181). However, this is not the case in Buchan, where [LL] spreading actively applies from a vowel to a vowel or from a consonant to a vowel, but not from a vowel to a consonant.

To sum up, I argue for one distinctive feature involved in Buchan assimilation, namely [Lowered Larynx]. This feature captures the phonological contrast between voiced and voiceless obstruents and between high and non-high vowels. I suggest that the distribution of V_1 vowels in $\mathbf{\acute{V}_1}C_{[LL]}$ contexts and V_2 vowels in $\acute{V}_1$ $C_{[LL]}$ $\mathbf{V_2}$ and $\acute{V}_{1[LL]}$ C $\mathbf{V_2}$ contexts is a consequence of [LL] assimilation. The [LL] feature spreads locally from voiced obstruents and stopped sonorants, $C_{[LL]}$, or long-distance from high vowels, $V_{[LL]}$, to the following or preceding non-high vowel in the trochee. Target segments are vowels not specified for [LL], i.e. non-high, and all consonants except the triggers are transparent to assimilation. This bidirectional process results in raising the target vowels.

Back Fricatives

The articulation of orthographic *ch* is Buchan is either palatal or velar. After [i, e] it is the palatal [ç] and after [a, o, ʌ, u] it is the velar [x]. The general distribution of the fricatives [ç, x, h] is as follows: in final and medial positions either [ç] or [x] are used depending on the preceding vowel (22a); in initial position [h] is used. But when the glide [j] follows the initial consonant, it sounds like [ç] as in (22b) (Dieth 1932).

(22)	(a)	[lax]	'laugh'	[tjux]	'tough'	[hox]	'leg'
		[plux]	'plough'	[drʌxt]	'drought'	[rox]	'rough'
		[breçɨn]	'horse-collar'	[driç]	'tedious'	[leç]	'low'
	(b)	[çjʌu]	'hoe'	[çjuk]	'hook'	[çjux] /[hjux]	'cliff'
		[hiç]	'high'	[haːx]	'haugh'		
						(Dieth 1932:112-113)	

From this complementary distribution, I infer that these three sounds [ç, x, h] are not contrastive phonologically. Rather, they are phonetic allophones of one phoneme. Let's call it /x/ in the contrastive inventory.

Glides

The bilabial glide [w] does not surface before the rounded vowels [o, u] as in (23) (Dieth 1932:90). I take this as evidence that [w] is vocalic in Buchan. It shares the same place of articulation with the rounded vowels and merges with them on the surface when underlyingly adjacent.

(23)	[uː]	'wool'	[sux]	'howl'	[uk]	'week'
	[suːrd]	'sword'	[ʌmən]	'woman'	[aθort]	'athwart'

Similarly, the alveopalatal glide [j] does not surface before the high vowel [i] as in [iːr] 'year' (Dieth 1932:91), again evidence that it has vocalic features.

Outline of Buchan Contrastive Consonants

Following the above discussion, the contrastive consonant inventory of Buchan is given in (24).

(24) *Phonetic description of 27 contrastive consonants*

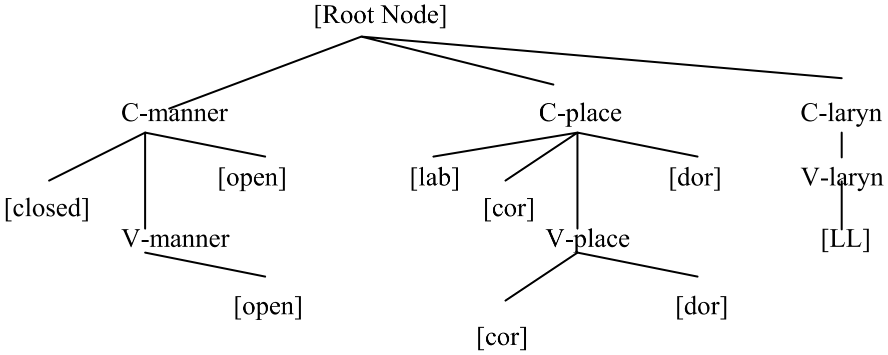
	Labial		Interdental		Alveolar		Alveopalatal		Velar		Lab-vel
Stop	p	b			t	d			k	g	
Fricative	f	v	θ	ð	s	z	ʃ	ʒ	x		ʍ
Affricate							t͡ʃ	d͡ʒ			
Nasal	m	m͡p			n	n͡t			ŋ	ŋ͡k	
Lateral					l	l͡t					
Trill					r						

It is interesting to note that the number of consonants in the phonetic description (3) is equal to the number of contrastive consonants in (24). This is the result of adding four phonologically complex segments [m͡p, n͡t, ŋ͡k, l͡t] and removing four phonetically redundant sounds from the inventory [ç, h, w, j]. This shows that the phonological inventory does not necessarily map to the phonetic descriptions.

3.4 Phonological Features in Buchan Scots

The feature geometric structure of Buchan Scots is given in (25), assuming the Parallel Structures Model (Morén 2003). Based on the contrastive behavior of consonants and vowels discussed thus far, I will argue for the existence of these phonological features in Buchan Scots and justify the feature specifications for individual segments in the language.

(25) *Buchan PSM Geometry*



3.4.1 Laryngeal Features

We have seen that stressed high vowels in Buchan cause raising to unstressed non-high vowels post-tonically. In addition, some consonants have a similar raising effect on the following vowel in the non-initial stress pattern and on the preceding vowel in monomorphemic (stressed) stems. These two groups of segments, thus, constitute the triggers of raising assimilation in Buchan. As I discussed earlier, there is phonetic evidence that the assimilated feature is "Lowered Larynx" [LL] (Trigo 1991:129).

This feature is represented here by the high vowel [ɨ] and is attached to the following segments in addition: voiced obstruents [b, d, g, v, ð, z, ʒ, d͡ʒ], stopped sonorants [m͡p, n͡t, ŋ͡k , l͡t], and high front vowels [i, u]. I showed that nasals, liquids, and voiceless stops on their own do not trigger assimilation.

3.4.2 Mannerless Consonants

Given the contrastive consonant chart in (24), we notice that all consonants except [ʍ, r, x] exist in voiced-voiceless pairs. If there are three places of articulation for consonants, it is reasonable to assume that these three exceptions represent "unit segments" for place features, given their weak constriction. I will assume that labial-velar [ʍ] represents C-place[lab] and that the velar character of this segment is a phonetic enhancement. On the other hand, there is evidence that the trill [r] is not sonorant in Buchan, therefore mannerless. Unlike the sonorant lateral [l], the trill [r] does not combine phonologically with voiceless stops to form [LL] segments which trigger raising, i.e. [r] + voiceless stop clusters are transparent to assimilation. Consequently, [r] is the "unit segment" for C-place[cor]. Finally, as discussed earlier, /x/ is the phonological realization of the three phonetic allophones [ç, x, h], which all involve the tongue dorsum. Therefore, /x/ stands as just a C-place[dor] segment.

3.4.3 Manner Consonants

If [s] represents just C-manner[open], then all other fricatives except [x] should have this feature. It is straightforward to claim that [z] is also placeless and that [f, v] are C-place[lab]. Now the fricatives [θ, ð, ʃ, ʒ] are fairly close in their place of articulation. In order to distinguish them, I assume that the interdentals [θ, ð] have C-place[cor], while the alveopalatals [ʃ, ʒ] have V-place[cor] since their place of articulation is closer to front vowels.

Parallel to the fricatives, the stops are represented by a C-manner[closed] feature singled out in [t], with [d] its voiced counterpart. All other stops [p, b, k, g, t͡ʃ, d͡ʒ] should also have C-manner[closed] in addition to place. [p, b] are labial stops with

C-place[labial] and [k, g] are velar stops with C-place[dor]. Since the PSM denies identical mapping between phonetics and phonology, the phonetic affricates [t͡ʃ, d͡ʒ] are represented as phonological stops. They correspond phonologically to [ʃ, ʒ]; thus they have V-place[cor].

The lateral and nasals are sonorants in Buchan. I will assume that [l] is placeless, thus having C-manner[closed] and V-manner[open] features. It follows that the labial [m] has C-place[lab], the alveolar [n] has C-place[cor], and the velar [ŋ] has C-place[dor] in addition to the manner specifications mentioned. Moreover, the complex segments [m͡p, n͡t, ŋ͡k, l͡t] have the same features as their non-stopped voiceless counterparts plus an additional [LL] feature.

3.4.4 Vowel Segments

I already argued that [ɨ, i, u] have an [LL] feature. There are five more vowels in Buchan: [ə, e, o, ʌ, a], two of which [ʌ, a] are low vowels involving a V-manner [open] feature. Furthermore, I claimed that under [LL] assimilation, [ə] raises to [ɨ] and [e] raises to [i]. If assimilation means the addition of an [LL] feature, then [ə] must be featureless, given that [ɨ] has only an [LL] feature. Now we are left with two vowels: [e, o]. I assume that [e] is the "unit segment" for V-place[cor] and [o] for V-place[dor], assuming that lip protrusion is just a phonetic enhancement, as in many other languages.

Parallel to [ə, ɨ], we can deduce the feature specification for [i] and [u] by adding [LL] to [e] and [o]. Thus, [i] has V-place[cor] + [LL] and [u] has V-place[dor] + [LL]. Recall from (5) that the three more central vowels [ɨ, ə, ʌ] stand out from other vowels in that they cannot appear in open monosyllables. Therefore, they should belong to one class. From a phonological perspective, this might be interpreted as three placeless vowels (high, mid, low) while the vowels that can be long have place features. As a consequence, [ʌ] will be specified as only V-manner[open] and [a] is both V-manner[open] and V-place[dor]. This is consistent with the phonetic articulation of [a] in Buchan which is relatively backed.

We conclude that there are only two contrastive heights in Buchan vowels: low and non-low. There are no high or mid vowels in this language, which explains the absence of a V-manner[closed] feature. Rather, the non-low class is divided into [LL] and non-[LL] vowels.

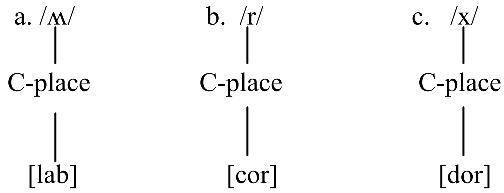
The above discussion leads to feature specifications for Buchan consonants and vowels as shown in (26) through (34).

(26) *Feature specifications for 27 underlying consonants in Buchan*

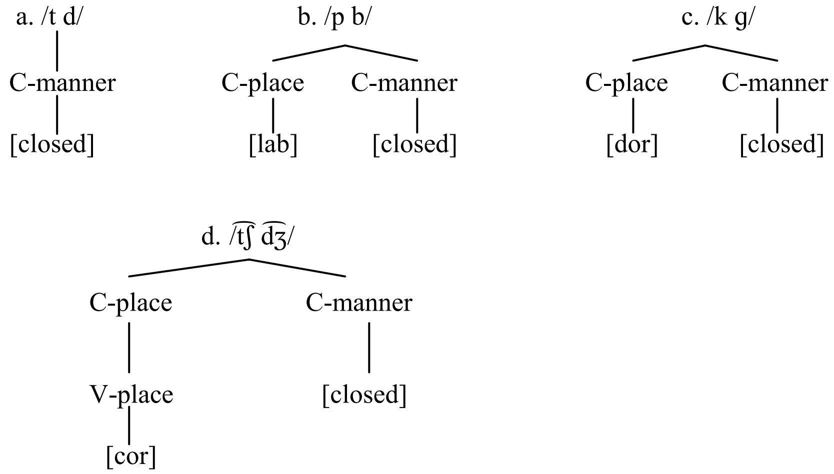
		C-place			**V-place**	**C-manner**		**V-manner**	**V-laryn**
	SF	**Lab**	**cor**	**dor**	**cor**	**closed**	**open**		
Mannerless	**/ʍ/**	✓							
	/r/		✓						
	/x/			✓					
Stop	**/t/**					✓			
	/d/					✓			✓
	/p/	✓				✓			
	/b/	✓				✓			✓
	/k/			✓		✓			
	/g/			✓		✓			✓
	/t͡ʃ/				✓	✓			
	/d͡ʒ/				✓	✓			✓
Continuant	**/s/**						✓		
	/z/						✓		✓
	/f/	✓					✓		
	/v/	✓					✓		✓
	/θ/		✓				✓		
	/ð/		✓				✓		✓
	/ʃ/				✓		✓		
	/ʒ/				✓		✓		✓
Sonorant	**/l/**					✓		✓	
	/l͡t/					✓		✓	✓
	/m/	✓				✓		✓	
	/m͡p/	✓				✓		✓	✓
	/n/		✓			✓		✓	
	/n͡t/		✓			✓		✓	✓
	/ŋ/			✓		✓		✓	
	/ŋ͡k/			✓		✓		✓	✓

The representation for each segment is given below (ignoring LL).

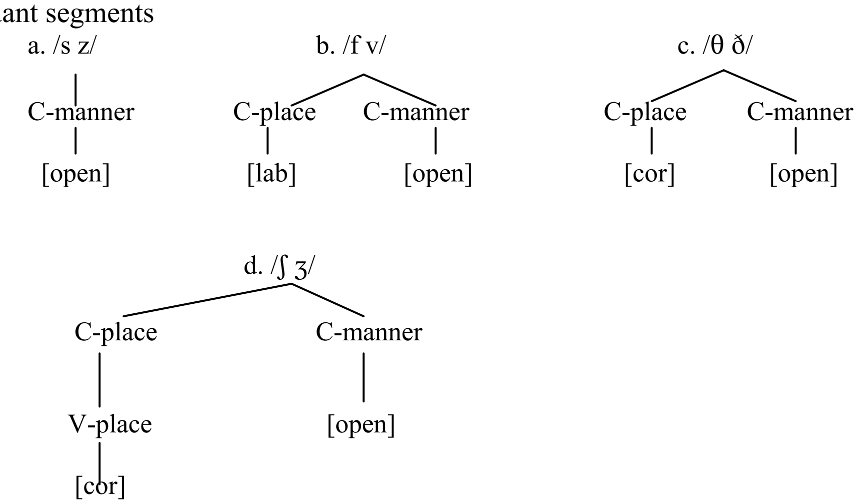
(27) Mannerless segments



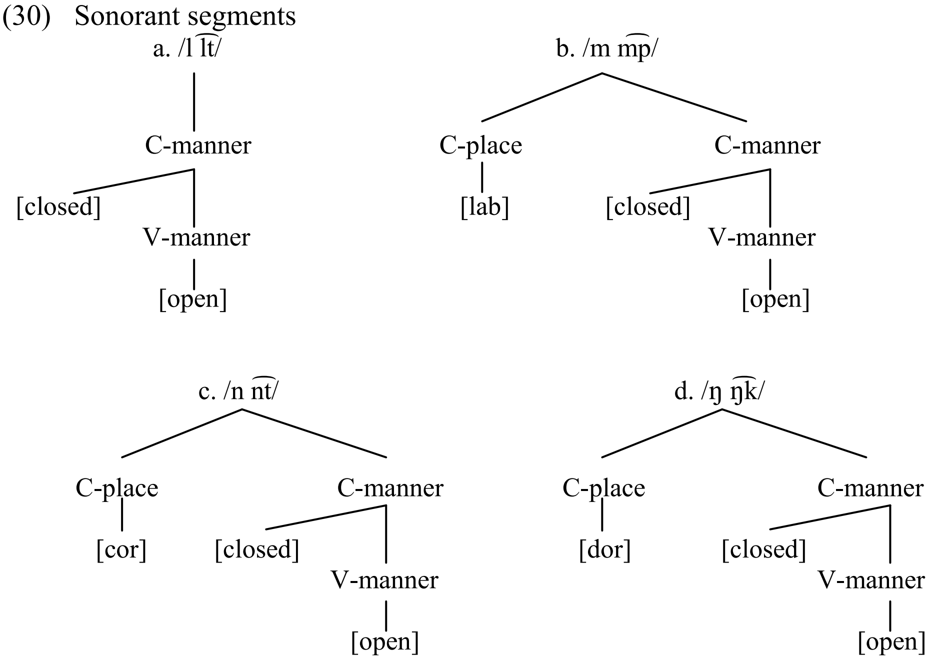
(28) Stop segments



(29) Continuant segments



(30) Sonorant segments

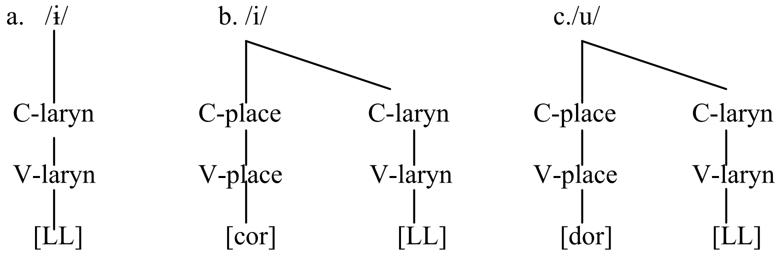


(31) *Feature specifications for 8 underlying Vowels in Buchan*

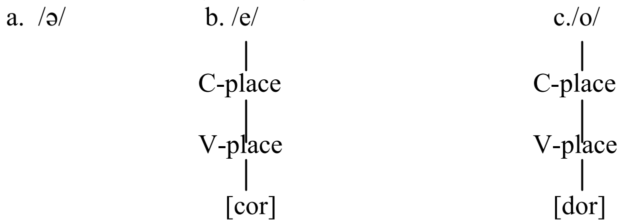
		V-place		V-manner	V-laryn
	SF	**cor**	**dor**	**open**	**LL**
Non-Low Vowels	**/ə/**				
	/ɨ/				✓
	/e/	✓			
	/i/	✓			✓
	/o/		✓		
	/u/		✓		✓
Low Vowels	**/ʌ/**			✓	
	/a/		✓	✓	

The representation for each segment is given below.

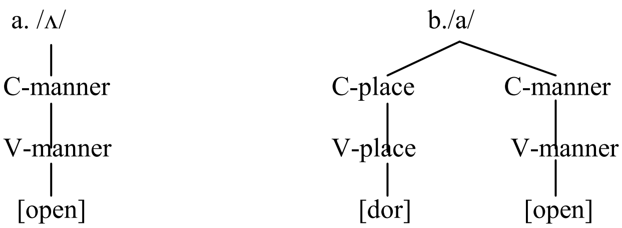
(32) [LL] vowels (non-low)



(33) Non-[LL] vowels (non-low)



(34) Low vowels



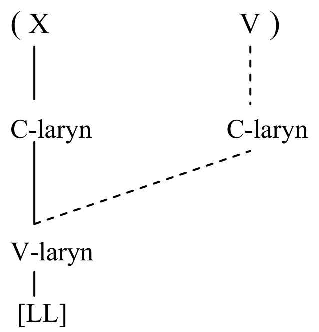
3.5 [Lowered Larynx] Assimilation – Synchronic Analysis

This section is meant to describe and account for the facts of [LL] assimilation in Buchan based on the behavior of three participating classes of segments. Trigger segments include voiced obstruents, stopped sonorants, and high vowels. The unifying feature for this class is V-laryn[LL]. Target segments are vowels not specified for [LL] which undergo raising in the domain of a trigger. These are the unstressed non-high vowels in disyllabic trochees and stressed non-high vowels in monosyllabic trochees. There are no blocker segments for this process, but there is a class of transparent segments, namely all consonants except the triggers. These segments remain unchanged and assimilation applies across them. In this section, I provide a synchronic analysis of the phonological interactions of these classes. § 3.5.1 is an autosegmental representation of [LL] assimilation, and § 3.5.2 is an optimality-theoretic account.

3.5.1 Autosegmental Representation of [LL] Assimilation

The diagram in (35) describes the assimilation pattern discussed so far. Note that X is placeholder for root nodes of consonant or vowel segments specified for [LL]; V indicates a vowel; and brackets indicate that the order of X and V is irrelevant.

(35) $//(X_{[LL]}\ V)// \rightarrow /(X_{[LL]}\ V_{[LL]})/$



The crucial fact to point out here is that the V-laryngeal[LL] node on the trigger consonant or vowel spreads to the following or preceding non-high vowel. The stress facts are to be dealt with in an OT analysis. Notice that potential target segments (non-high vowels) have no underlying V-laryngeal node prior to assimilation.

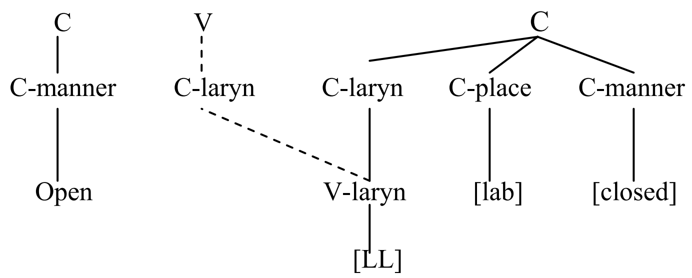
Let *D* stand for any [LL] consonant and *I* for any [LL] vowel; *T* for any non-[LL] consonant, and *E* for any non-[LL] vowel. Because raising assimilation is never blocked, the pattern **IDE* would never surface. The attested assimilating patterns are

(i) *IDI* (ii)*EDI* (iii)*ID* (iv)*ITI*. The first pattern is ambiguous: the trigger could be either the [LL] consonant or the [LL] vowel. The other three patterns are analyzed below in more detail.

Leftward Spreading from Consonant Triggers (monosyllabic trochees)

The pattern *ID* represents regressive assimilation of the [LL] feature. Since no consonant can acquire an [LL] feature through spreading, any surface *D* must be underlyingly specified for [LL]. Assuming that the vowel preceding *D* in monosyllabic trochees is underlyingly non-high, the [LL] consonant causes raising of that vowel by spreading the V-laryngeal[LL] node to it. This is illustrated in (36).

(36) //səb// → /sɨb/ 'sib'

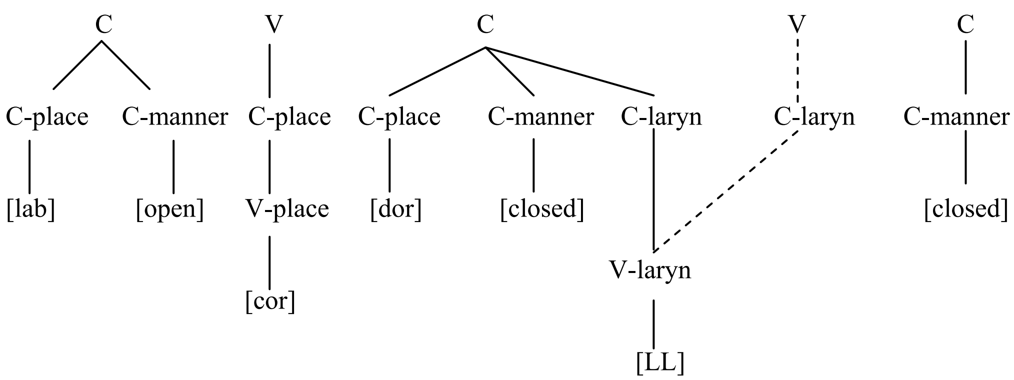


In this example, the V-laryn[LL] node spreads to unstressed featureless [ə] resulting in the raising of this mid vowel to high [ɨ] with an [LL] feature.

Rightward Spreading from Consonant Triggers (disyllabic trochees)

The pattern *EDI* is a case of progressive assimilation in which the trigger of raising must be the [LL] consonant. If the unstressed vowel is underlyingly non-high, it raises to high by acquiring a new V-laryngeal[LL] node from the consonant trigger, as shown in (37).

(37) //fegət// → /fegɨt/ 'fagged'

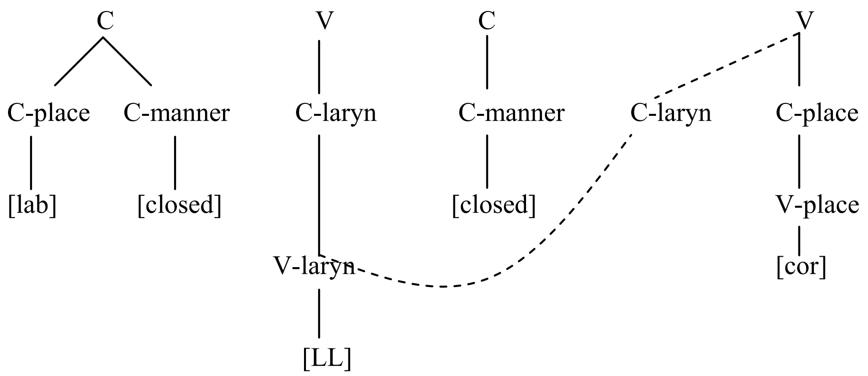


The process in (37) is identical to that in (36) except for the direction of assimilation. Contrary to current accounts, Buchan assimilation does not only apply to unstressed vowels within disyllabic trochees, but also to stressed vowels in monosyllabic trochees.

Vowel Triggers

The pattern *ITI* is also a case of progressive assimilation where the initially stressed [LL] vowel triggers raising of the unstressed vowel. This is the only case which can be called "vowel harmony". The consonant is not specified for [LL] here and therefore transparent to harmony. Even if the intervening consonant is a voiceless obstruent which can theoretically be voiced by gaining an [LL] feature, it is skipped because of a highly ranked constraint against consonants acquiring an [LL] feature. This is illustrated in (38).

(38) //pite// → /piti/ 'pity'



In this example, the V-laryn[LL] node spreads to unstressed [e] which has V-place[cor]. As a consequence, the vowel obtained has both V-place[cor] and [LL] features, i.e. [i].

3.5.2 Optimality-Theoretic Account of [LL] Assimilation

This section is an attempt to capture the vowel raising and stress facts of [LL] assimilation in Buchan Scots in the framework of Optimality Theory (McCarthy and Prince 1993a; Prince and Smolensky 2004). I provide a straightforward account through the interaction of constraints on association line linking and delinking and traditional faithfulness constraints. Other accounts using alignment constraints may also be possible, although not preferable considering the strictly bounded nature of assimilation in Buchan.

The first constraint to introduce is a constraint that requires an [LL] feature on a segment to link to other segments regardless of direction. This constraint is easily justifiable as one working on the opposite direction of the widely used NO-LINK constraints. One of the principles of OT is that constraints are in conflict, and therefore it is reasonable to formulate the LINK[LL] constraint in (39).

(39) LINK[LL]
An underlying [LL] feature on a segment must be linked to at least one non-sponsor vowel in the foot domain.

In conflict with this constraint is a constraint against linking features to segments that are not linked in the input. In other words, this is an anti-spreading constraint that incurs a violation mark for the insertion of a new association line. I call this general constraint DEP-LINK[LL], following Akinlabi (1994).

(40) DEP-LINK[LL]
Do not associate the feature [LL] to a segment that did not have it underlyingly.

This constraint may be violated in multiple loci. That is, it assigns a violation mark to every new association of the [LL] feature in the output. The basic motivation for this is to explain the transparency of consonants between two harmonizing vowels. Multiple violations of this constraint will eliminate candidates where [LL] spreads to intervening consonants in addition to non-high vowels.

However, this constraint is unable to rule out candidates in which [LL] spreads regressively from consonants to stressed non-high vowel in disyllabic trochees. In order to achieve this, I will propose a more specific constraint against inserting a new [LL] association to a stressed vowel in (41).

(41) V́-DEP-LINK[LL]
Do not associate the feature [LL] to a stressed vowel that did not have it underlyingly.

Finally, in order to rule out candidates in which the underlying [LL] feature is deleted, I propose a highly ranked faithfulness constraint against feature deletion.

(42) MAX [LL]
Every [LL] feature in the input has a correspondent [LL] feature in the output.

We know that DEP-LINK[LL] is a low-ranked constraint. Because it is always violated by the assimilating candidate, it must be dominated by the other three constraints, as shown in tableau (43). In all the following tableaux, solid lines in the autosegmental representations indicate underlying association lines to [LL] features (in the input) and dashed lines indicate inserted associations to [LL] features (in the output).

(43) LINK[LL] , MAX[LL], V́-DEP-LINK[LL] >> DEP-LINK[LL]

	f e g ə t [LL]	**PF**	LINK[LL]	MAX[LL]	V́-DEP-LINK[LL]	DEP-LINK[LL]
a	f e g ə t [LL]	[fegət]	*!			
b	☞ f e g ə t [LL]	[fegɨt]				*
c	f e g ə t [LL]	[fekət]		*!		
d	f e g ə t [LL]	[figət]			*!	*
e	f e g ə t [LL]	[figɨt]			*!	**

The [LL] segment in candidate (a) does not spread its [LL] feature at all, which incurs a fatal violation of LINK[LL]. Candidate (c) deletes its [LL] feature to avoid LINK[LL] violations, but in doing so it violates the highly ranked faithfulness constraint MAX[LL]. Candidates (b), (d), and (e) spread their [LL] feature to other vowels and thus violate DEP-LINK[LL]. However, (d) and (e) violate V́-DEP-LINK[LL] as well. This is a case where the violations of one candidate are a superset of the violations of another candidate. Candidate (d) is said to be "harmonically bounded" by the optimal candidate (b).

Now let us consider an example where an underlying stressed high vowel triggers raising of the unstressed non-high vowel of the trochees, skipping an intervening voiceless obstruent. The tableau in (44) shows that the same constraint ranking holds for vowel-to-vowel harmony. The constraint LINK[LL] here rules out candidates in which [LL] spreads to the consonant (d) or does not spread at all (a). Double violations of DEP-LINK[LL] results in eliminating candidate (e). Finally, V́-DEP-LINK[LL] is irrelevant because the stressed vowel is underlyingly high, and thus cannot acquire a new [LL] feature.

(44) LINK[LL] , MAX[LL], V́-DEP-LINK[LL] >> DEP-LINK[LL]

	n i p ə r / [LL]	PF	LINK[LL]	MAX[LL]	V́-DEP-LINK[LL]	DEP-LINK[LL]
a	n i p ə r / [LL]	[nipər]	*!			
b	☞ n i p ə r / [LL]	[nipɨr]				*
c	n i p ə r / [LL]	[nepər]		*!		
d	n i p ə r / [LL]	[nibər]	*!			*
e	n i p ə r / [LL]	[nibɨr]				**!

Finally, tableau (45) demonstrates that the same constraint ranking could account for regressive assimilation of [LL] in monosyllabic words.

(45) LINK[LL] , MAX[LL] >> V́-DEP-LINK[LL] >> DEP-LINK[LL]

	s ə b / [LL]	PF	LINK[LL]	MAX[LL]	V́-DEP-LINK[LL]	DEP-LINK[LL]
a	s ə b / [LL]	[səb]	*!			
b	☞ s ə b / [LL]	[sɨb]			*	*
c	s ə b / [LL]	[səp]		*!		

The contribution of tableau (45) is that it defines the ranking of the V́-DEP-LINK[LL] constraint in relation to LINK[LL] and MAX[LL]. The optimal candidate (b) fails to satisfy V́-DEP-LINK[LL], meaning that this constraint is ranked lower than the other inviolable constraints.

3.6 Comparison with Previous Accounts

The unique facts of vowel distribution in Buchan have raised some curiosity, and several analyses have been proposed for the pattern. By comparing these accounts to my analysis, I will emphasize the strengths of the raising account and its ability to explain all the facts of Buchan assimilation. Moreover, I will show how the PSM allows a better understanding of consonant and vowel distribution. I will start with a summary of the PSM feature specifications of the Buchan segment inventory in (46).

(46) *Summary*

			C-place			V-place		C-manner		V-manner	V-laryn
	UR	SF	lab	cor	dor	cor	dor	closed	open	open	LL
Manner-less	//ʎ//	/ʎ/	✓								
	//r//	/r/		✓							
	//x//	/x/			✓						
Stop	//t//	/t/						✓			
	//t̬//	/d/						✓			✓
	//p//	/p/	✓					✓			
	//p̬//	/b/	✓					✓			✓
	//k//	/k/			✓			✓			
	//k̬//	/g/			✓			✓			✓
	//t͡ʃ//	/t͡ʃ/				✓		✓			
	//t̬͡ʃ//	/d͡ʒ/				✓		✓			✓
Continuant	//s//	/s/							✓		
	//s̬ //	/z/							✓		✓
	//f//	/f/	✓						✓		
	//f̬//	/v/	✓						✓		✓
	//θ//	/θ/		✓					✓		
	//θ̬//	/ð/		✓					✓		✓
	//ʃ//	/ʃ/				✓			✓		
	//ʃ//	/ʒ/				✓			✓		✓
Sonorant	//l//	/l/						✓		✓	
	//l̬//	/l͡t/						✓		✓	✓
	//m//	/m/	✓					✓		✓	
	//m̬//	/m͡p/	✓					✓		✓	✓
	//n//	/n/		✓				✓		✓	
	//n̬//	/n͡t/		✓				✓		✓	✓
	//ŋ//	/ŋ/			✓			✓		✓	
	//ŋ//	/ŋ͡k/			✓			✓		✓	✓
[LL] Vs	//ɨ̬//	/ɨ/									✓
	//i̬//	/i/				✓					✓
	//u̬//	/u/					✓				✓
Non-[LL] Vs	//ə//	/ə/									
		/ɨ/									✓
	//e//	/e/				✓					
		/i/				✓					✓
	//o//	/o/					✓				
Low Vs	//ʌ//	/ʌ/								✓	
	//a//	/a/					✓			✓	

This feature system defines all natural classes in Buchan and captures several facts in a simple and straightforward manner. First, mannerless consonants are those that do not contrast in voiced-voiceless pairs. Second, the distribution of the three central vowels [ɨ, ə, ʌ] is explained by their placeless specifications. Third, the stops, fricatives, and sonorants have fairly parallel distribution. The lack of C-place[cor] stops and C-place[dor] fricatives can be explained as a means of perceptual distinguishability. Fourth, the class of assimilation triggers, whether consonants or vowels, is clearly defined by an [LL] feature. Finally, the feature specifications for underlying targets //ə, e// is equal to the features of their respective surface forms /ɨ, i/ minus [LL], a correspondence that directly explains the mechanism of assimilation.

3.6.1 The Restricted vs. Unrestricted Harmony Account

The account given by Fitzgerald (2002) is more of a description than a theoretical contribution, characterizing assimilation in Buchan as vowel harmony of two types. "Unrestricted harmony" occurs when high vowels only follow high vowels, and non-high vowels only follow non-high vowels. "Restricted harmony" occurs when high vowels follow both high and non-high vowels, while non-high vowels follow only non-high vowels. Harmony is explained in terms of both reduction and raising following certain environments.

These "environments" do not show empirical coherence. For example, she claims that after voiced obstruents, only high vowels can appear whether the stressed vowel is high or non-high; whereas after voiceless obstruents, both high and non-high vowels can appear. However, all the examples cited for the "restricted harmony" pattern involve combinations of voiceless clusters with nasals. Similar inconsistencies can be said about nasals and liquids.

Although this account mentions the fact that non-high vowels never follow high vowels, it does not attempt to explain why. Moreover, the characterization of the harmony process is, at least implicitly, similar to Paster's blocking analysis. The reference to the disharmonic pattern as banning [ə] after voiced obstruents implies that "harmony" is blocked in this environment. In her conclusion, Fitzgerald admits that she does not address the issue of underlying forms, which makes it even more difficult to assess her analysis any further.

3.6.2 The [ATR] Harmony Account

Trigo (1986)[24] provides an alternative which has the most in common with the present account. Hers is a raising account of assimilation in Buchan based on the feature [ATR]. She argues that the production of voicing in obstruents requires an active enlargement of the pharyngeal cavity achieved in part by advancing the root of the tongue. As a consequence, she assumes that voiced obstruents are specified for [+ATR] so they have a raising influence on a preceding or a following vowel (Trigo 1986:5). Vowels immediately preceding and following a truly voiced obstruent become advanced at the tongue root due to phonetic coarticulation with the consonant, resulting in a slightly raised and fronted tongue dorsum (Trigo 1986:1).

She also discusses vowel-to-vowel harmony in Buchan which applies raising from roots to suffixes. For this effect, Trigo assumes (in accordance with my analysis) that the suffixal vowels are underlyingly non-high. The suffix alternations are due to spreading the feature [+ATR] from the high root vowel to the suffix (Trigo 1986:7).

The raising effect of ATR harmony is explained in terms of redundancy rules. First, a spreading rule spreads the feature [ATR] from a consonant to a preceding or following short front vowel in such a way that vowels following voiced obstruents become [+ATR]. Following this, rules sensitive to the value [ATR] supply short front vowels with the appropriate value for [high]. ATR harmony is therefore characterized as a phonological rule ordered before raising (Trigo 1986:11).

The main objection to this account is that the use of redundancy rules to map [±ATR] to [±high] reveals that height, rather than [ATR], is the harmonizing feature (Paster 2004:378). This does not apply to my analysis which discards redundancy rules as part of phonetics. It is, therefore, not a prerequisite of the PSM that segments have fully specified SPE-like bundles of features. I suggested a class of [LL] vowels, indicating the absence of [high] vowels in this language. Accordingly, assimilation is achieved in one swoop by spreading the [LL] feature, which is itself a realization of vowel height.

Trigo (1986) is one of the most comprehensive attempts available for assimilation in Buchan. To my knowledge, no other account relates the distribution of stressed vowels in monosyllabic trochees to the distribution of unstressed vowels in disyllabic trochees. The analysis given in this chapter intersects with Trigo's analysis in that they both give a raising account for assimilation, while they differ in the feature involved in assimilation and the use of the problematic redundancy rules.

[24] I would like to thank Mary Paster for providing me with this unpublished manuscript.

3.6.3 The Lowering Harmony Account

Paster (2004) characterizes the assimilation pattern in Buchan as lowering harmony: unstressed high vowels lower to non-high following stressed non-high vowels. This characterization bears two implications. First, lowering harmony is blocked by intervening [LL] consonants. Second, all unstressed vowels are underlyingly high. There are at least two reasons to reject a lowering analysis in favor of a raising analysis.

The first objection to a lowering account is that it ignores a compelling fact about Buchan vowel distribution, i.e. the fact that non-high vowels never follow high vowels even within morphemes. A lowering analysis fails to account for this because an underlying non-high vowel after a stressed high vowel would have to remain non-high, thus forming an illicit non-harmonizing case. In order to resolve this, Paster is obliged to make an unjustifiable assumption against the Richness of the Base that all unstressed vowels are underlyingly high even within monomorphemic forms. Therefore, all the cases in which a high unstressed vowel follows a high stressed vowel (assuming the ROTB for the underlying form) are problematic for a lowering analysis (ref. 9). A raising analysis, on the other hand, is able to account for all observed patterns of vowel distribution regardless of the nature of the unstressed vowel as follows. After a stressed high vowel: (a) if the unstressed vowel is underlyingly high, it remains high on the surface; (b) if the unstressed vowel is underlyingly non-high, it raises to high. After a stressed non-high vowel: (a) if the unstressed vowel is underlyingly high, it remains high; (b) if the unstressed vowel is underlyingly non-high, it also remains non-high. This is summarized in (47).

(47) *Raising vs. lowering analysis and vowel co-occurrence*

Stressed V		High		Non-high	
Underlying Unstressed V		//high//	//non-high//	//high//	//non-high//
Surface Unstressed V	*(a) Raising Analysis*	✓[high]	✓[high]	✓[high]	✓[non-high]
	(b) Lowering Analysis	✓[high]	*[non-high]	✓[high]	✓[non-high]

The second objection is that a lowering analysis also fails to account for the identical consonant distribution with unstressed and stressed vowels. Recall that the consonants that condition a high central vowel in monosyllabic trochees are almost identical to those that condition a high unstressed vowel in disyllabic trochees. A lowering analysis argues that these consonants are blockers of assimilation. If they are only blockers, why do they restrict their occurrence next to high central vowels in monosyllabic words? A raising analysis can explain this. These consonants are triggers of harmony to both unstressed and stressed target vowels (depending on the domain). They share the same feature [Lowered Larynx] with high vowels.

Paster (2004) puts forth three challenges to a raising analysis, all of which can be resolved. The first is that while the lowering analysis involves a single process of lowering that is blocked by voiced obstruents and certain combinations of other consonants, the raising analysis would require two distinct rules: one rule for raising unstressed front vowels following stressed high vowels, and another for raising unstressed front vowels following voiced obstruents and the trigger sequences (2004: 368). This is simple to refute given my account. As discussed earlier, Buchan assimilation involves a single feature [Lowered Larynx] that is relevant for both consonant and vowel triggers. This feature spreads to target vowels causing them to raise. In fact, a raising account is more economic than a lowering one in that it is unnecessary to posit a blocking mechanism to the analysis.

A second reason for Paster (2004) to favor a lowering analysis is that the raising analysis would require us to posit that the diminutive and adjectival suffixes correspond to underlying non-high vowels. She argues that this analysis, while possible, is unlikely because "the vowel of these suffixes was historically /i/, and remains /i/ in other modern dialects of Scots and English". However, in synchronic analysis, diachrony is not a reliable indicator, nor is behavior in other dialects. Paster discusses another reason for assuming an underlying //i// for these suffixes, namely that they surface as [i] in trisyllabic non-harmonizing forms as in (48).

(48)	(a)	[bʌbəli] ,* [bʌbɨli]	'bubbly'	[fɜngəri] , * [fɜngɨri]	'small finger'
		[bʌtəri] , * [bʌtəre]	'buttery'	[snɜkəri] ,* [snɜkəre]	'snikery'

The unstressed [ə] in [bʌbəli] and [fɜngəri] is presumably epenthetic before syllabic consonants. Assuming that, the [LL] consonants [b] and [g] will trigger raising in the suffix which accordingly surfaces as [i]. An alternative way to account for all these examples is to assume a raising rule to suffixes outside the foot in trisyllabic words.

The final challenge Paster (2004) poses to a raising analysis is a marginal set of counterexamples (49) showing stressed non-high vowels followed by unstressed non-high vowels with intervening [LL] consonants. In a raising account, these unstressed vowels would be expected to raise.

(49)	(a)	[endʒəl][25], *[endʒɨl]	'angel'	[prodəkt] , *[prodɨkt]	'product'
		[səvən] , *[səvɨn]	'seven'	[obdʒəkt] , *[obdʒɨkt]	'object'

[25] The schwa [ə] in my transcription corresponds to a [ɛ] in Paster's transcription. I stick to the vowel inventory that I started with for consistency.

(b)	[θərsde] ,	*[θərsdɨ]	'Thursday'	[fraide] ,	*[fraidɨ]	'Friday'
	[sʌnde] ,	*[sʌndɨ]	'Sunday'	[kɜrkde] ,	*[kɜrkdɨ]	'Kirkday'

The problem with the set in (49b) is quite obvious. They are all compound words containing *–day*. No one, including Paster herself, has posed that Buchan harmony applies to compound words. The words [endʒəl] and [səvən] are not true trochees counting the second vowel to be epenthetic before syllabic [l̩] and [n̩]. The last two cases [prodəkt] and [obdʒəkt] can be explained given that they are composed of two feet. Since [LL] consonants in the onset position of a foot do not trigger raising (e.g. [beke], *[biki] 'baikie'), high vowels are not expected to surface after them.

Based on these counter-arguments, we conclude that it is not justifiable to assume a lowering analysis of Buchan assimilation. In the face of robust generalizations discussed earlier in this section, assimilation in this dialect is best analyzed as one of raising.

3.7 Concluding Remarks

The distribution of vowels in Buchan Scots provides evidence that this dialect exhibits a unique type of assimilation unknown to other dialects of English. Since unstressed non-high vowels never follow high vowels in trochees, the assimilation must be one of raising, i.e. target vowels are underlyingly non-high. Furthermore, the parallel effect of voiced obstruents and stopped sonorants on stressed vowels in monosyllabic trochees and unstressed vowels in disyllabic trochees suggests that raising is triggered by these consonants in both environments.

Using the Parallel Structures Model, we have been able to capture these conclusions in an elegant and straightforward manner. All triggers (whether consonants or vowels) are underlyingly specified for the feature [Lowered Larynx], which is a vocalic feature. [Lowered Larynx] harmony in Buchan is sponsored by an underlying [LL] segment which targets non-high vowels. These structurally simple non-high vowels acquire an [LL] feature which they add to their structure to form a more complex segment. Feature specifications for all segments are established on the basis of contrastive phonological evidence, and abstracting away from the phonetics.

Chapter 4

Discussion and Conclusions

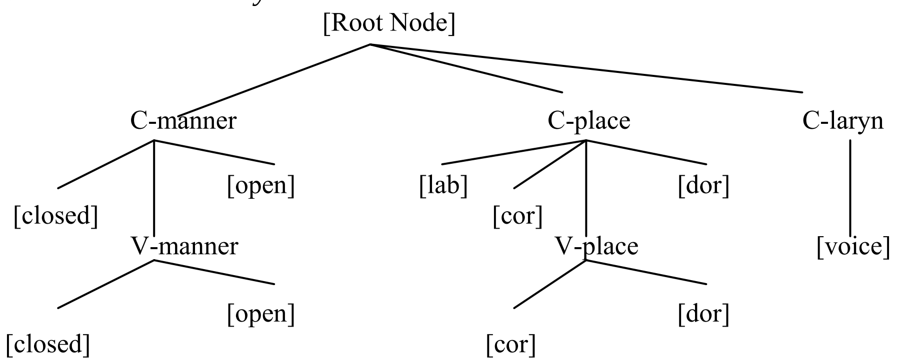
In non-linear phonology, featural assimilation has been analyzed as the product of spreading, that is, through cross-segmental linkage of a certain feature (Rose and Walker 2004). The current study proposed a unified account of two such processes in which vocalic features assimilate to neighboring segments with complex consonant-vowel interactions, namely emphasis spread in Cairene Arabic and lowered larynx assimilation in Buchan Scots. The Parallel Structures Model (Morén 2003) was employed to account for these phenomena.

The PSM is a restrictive model of feature geometry which provides an economical way of capturing the internal structure of phonemes in natural language. Adopting an approach to feature geometry which economizes the set of features to the greatest extent possible, the model formalizes feature hierarchies by making all vocalic place, manner, and laryngeal nodes dependent on their respective consonantal nodes. As a consequence, it provides a unified analysis for consonant and vowel interactions.

The analysis provided has shown that a restrictive model is able to attain greater empirical coverage and identifies the phonological patterns clearly. For example, we were able to eliminate the class of secondary emphatics from the Cairene inventory because they do not contrast in most environments. Such conclusions have important implications for language acquisition. By assuming that children are limited to a small set of choices in language, we are in a better position to explain how they acquire language at all, and how they acquire it so fast, given the astronomical number of possibilities. The Parallel Structures Model is thus an excellent example of a highly restrictive theory conceived with these ideas in mind.

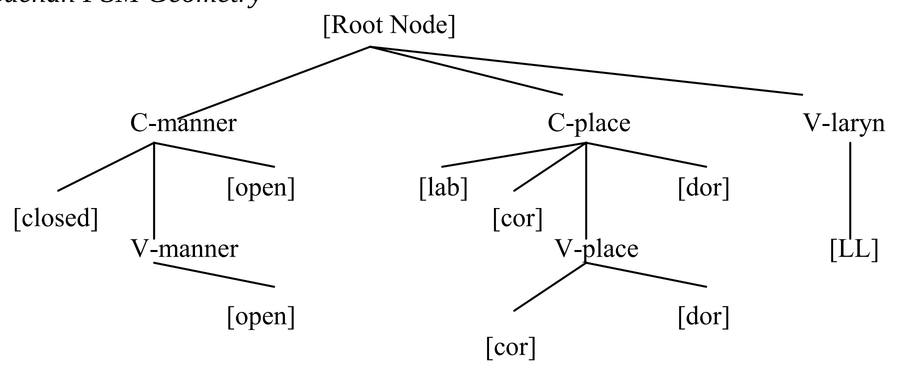
In this theory, feature specifications are justified largely on phonologically contrastive behavior. Therefore, it is crucial for the analysis to examine the relevant phonological system of contrasts. On the basis of overt evidence, we can develop the feature geometry of a particular language system. The feature geometric structure of Cairene Arabic is given in (1).

(1) *Cairene PSM Geometry*



The PSM avoids the use of redundant features in describing languages. As a consequence, the set of distinctive features may be different from one language to another, depending on language-particular contrasts. Compare the PSM geometry of Cairene Arabic in (1) with that of Buchan Scots in (2).

(2) Buchan PSM Geometry



Although the geometry is fundamentally similar, the two languages make use of different laryngeal features: voice vs. lowered larynx. In addition, while Cairene contrasts segments on the basis of a V-manner[closed] feature, Buchan segments do not contrast in relation to that feature. Eliminating redundant features in this manner enables us to define natural classes of segments clearly and to formulate predictions about their behavior in various phonological phenomena.

The PSM provides accurate and unified analysis of Cairene and Buchan assimilation facts by looking beyond the particular patterns to the complete phonemic inventories of the respective languages. Based on full characterization of these inventories, the assimilation facts of emphasis spread and lowered larynx assimilation fall out neatly. Despite some language-specific strategies, the model was able to capture the uniformity of these seemingly different patterns by positing restrictive and parallel measures on the grammar. The PSM represented such similarities in behavior in terms of the internal structure of natural classes of segments. This constitutes robust evidence in favor of the descriptive and explanatory adequacy of the model. Below is a summary of the most interesting parallels between the assimilation patterns studied in this work:

- The class of triggers is determined exclusively by the underlying featural structure of the segment. Both assimilation processes are triggered by a consonant or a vowel that sponsors a certain feature. Emphasis spread is triggered by an underlying V-place [dor] consonant //dˤ, tˤ, sˤ, zˤ, rˤ// or a V-place[dor] vowel //ɑˤ//. Lowered larynx assimilation is triggered by an underlying [LL] consonant from the set //b, d, g, v, ð, z, ʒ, d͡ʒ, m͡p, n͡t, ŋ͡k , l͡t// or an [LL] vowel //ɨ, i//.

- The assumption that more complex structures are built from less complex structures is central to the analysis of both phonological processes. On the one hand, plain and pharyngealized segments are distinguished from one another by a V-place[dor] feature. On the other hand, plain and [LL] segments are distinguished from one another by a V-laryn[LL] feature. Consequently, both assimilation processes can be regarded as the addition of a vocalic feature to a potential target, forming a structurally more-complex segment. In ES, a non-pharyngealized consonant or vowel (e.g. //f//) acquires a new V-place[dor] feature to form a structurally heavier pharyngealized phoneme (/fˤ/). In [LL] assimilation, a structurally simple central vowel (e.g. //ə//) acquires a new V-laryn[LL] feature to form a structurally more complex vowel (/ɨ/).

- Both assimilation patterns apply bidirectionally within the specified domain, and both show discrepancies in behavior related to the directionality of assimilation. Regressive ES is generally absolute and is never blocked, whereas progressive ES is blocked by a subset of vowels and consonants defined by the feature V-place[cor]. On the other hand, the direction of [LL] assimilation depends on the syllabic structure of the trochee.

We have seen that the relevant phonological features can be treated as autosegments in both patterns, meaning that features behave independently of their respective segments. This conclusion supports the need for structural representations in a constraint-based grammar like Optimality Theory. Assimilation in Eval can be viewed in terms of structural constraints, which tend to favor certain types of feature geometric structure. The interaction of these constraints with other markedness and faithfulness constraints captures phonological asymmetries in the grammar.

To sum up, I argued that the Parallel Structures Model of feature geometry (Morén 2003) can best account for the facts of emphasis spread and lowered larynx assimilation in Cairene and Buchan. By incorporating the analysis of these specific phenomena into the complete phonemic inventory of the respective languages, I was able to provide accurate and unified descriptions and representations of these phenomena in the framework of the Parallel Structures Model. Not only is this model able to accurately describe the phonological facts in these languages, but it also captures interesting parallels between them in terms of the internal structures of natural classes of segments.

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