POSTVELAR HARMONY: AN EXAMINATION OF ITS BASES AND CROSSLINGUISTIC VARIATION

by

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Abstract

This dissertation examines postvelar harmony in two unrelated languages: Palestinian Arabic and St'át'imcets Salish. In contrast to previous studies, it identifies two such harmonies for each language: pharyngealisation (tongue root retraction) harmony and uvularisation (tongue back retraction) harmony. The properties of the two harmonies in each language are detailed. Acoustic data are provided as support for the proposed analyses and for the grounded phonological accounts which are subsequently developed. The harmonic feature of pharyngealisation harmony in both Palestinian and St'á'timcets is identified as [RTR] (unspecified for primary or secondary status). The anchor for [RTR] in both languages is the NUC. Co-occurring secondary-[DOR] and secondary-[RTR] are identified as the harmonic features of uvularisation harmony. In both languages, the anchor for these co-occurring features is the root node. An Optimality Theory account of the two harmonies in each language is developed, in which Correspondence, Alignment, and Grounded Constraints have central roles. Constraint reranking is shown to yield the observed crosslinguistic variation in the harmonies. In the course of this examination, issues regarding the consonantal and vocalic inventories of Palestinian and St'át'imcets are adressed. It is argued that each has a more elaborate vocalic system than previously recognised, and that St'át'imcets, like Palestinian, has a set of underlying emphatic consonants.

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Soli Dei Gloriae

Chapter 1: Introduction

1.1. Aims

This thesis investigates postvelar harmony in two typologically, genetically, and geographically unrelated languages: Palestinian Arabic, a Semitic language, and St'át'imcets (Lillooet), a Salish language. The first aim is to present evidence that both these languages have two distinct postvelar harmonies, which are articulatorily implemented as pharyngealisation harmony and uvularisation harmony. Acoustic support for the distinction between the two harmonies in each language will be presented.

In identifying these two harmonies, the present analysis differs from previous analyses of both Palestinian and St'át'imcets. Previous studies have described only one postvelar harmony for Palestinian: 'emphasis spread'.[1] With the exception of Elmedlaoui (1995) on Moroccan Arabic, the same is true for Arabic in general.[2] Likewise, previous studies have described only one postvelar harmony for

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[1]See, e.g., Younes (1982), Card (1983), Herzallah (1990), Younes (1993), and Davis (1995).

[2]See, e.g., Lehn (1963), Maamouri (1967), Ghazeli (1977), Goad (1991), Bessell (1992), and Goad (1993). However, Elmedlaoui (1995) analyses Moroccan 'emphasis' as consisting of more than one type of harmony. As I have unfortunately learned of Elmedlaoui's study only after completing this work, it is not discussed in this thesis.

St'át'imcets: 'retraction'.[3] The same is true for Salish in general.[4] I will argue that there is more complexity to Arabic and Salish postvelar phonology than has been previously recognised.

The second aim is to show that pharyngealisation harmony and uvularisation harmony are harmony of the feature (primary- or secondary-) [RTR], and of secondary-[DOR] + secondary-[RTR], respectively. Pharyngealisation harmony is triggered by postvelar consonants, that is, by both gutturals and emphatics. The emphatic class includes segments, such as /s̙/, that are postvelar-articulated counterparts of non-postvelar consonants (e.g., /s̙/ is the postvelar-articulated counterpart of non-emphatic /s/). Gutturals include the pharyngeals and uvulars /ʕ ħ ʁ χ/ and, in Arabic, the laryngeals /ʔ h/. Uvularisation harmony is triggered only by emphatics. The representations I will propose for gutturals are seen in (1). Those I will propose for emphatics are seen in (2). (In (1) and (2), only the specifications relevant to the two harmonies are shown.) It is assumed that tongue root retraction is represented by [RTR] under [TR], not by [TR] by itself, based on crosslinguistic evidence that [TR] dominates both [RTR] and [ATR], the latter representing tongue root advancement; this issue will be discussed further in §1.3.2. The stacked place specifications for the uvular gutturals and emphatics follow Selkirk's

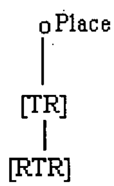
[3]See, e.g., van Eijk (1985), Czaykowska-Higgins (1987), Remnant (1990), and Bessell (1992).

[4]See, e.g., Mattina (1979), Kuipers (1981), Cole (1987), Doak (1987, 1989), Kuipers (1990), Bessell and Czaykowska-Higgins (1991), Bessell (1992), and Doak (1992).

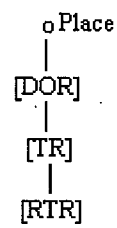
(1988) representation of primary vs. secondary place. This type of representation will be explained in §1.3.3.2.

(1) The Representations of Gutturals

a. pharyngeal and laryngeal gutturals: primary [TR]/[RTR]

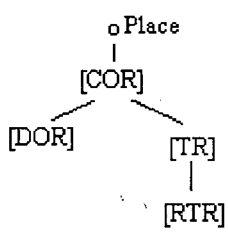


b. uvular gutturals: primary [DOR] and secondary [TR]/[RTR]

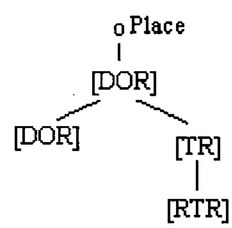


(2) The Representations of Emphatics: primary [COR], [DOR], or [LAB], secondary [DOR] and secondary [TR]/[RTR]

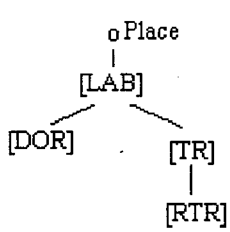
a. coronal emphatics



b. dorsal emphatics



c. labial emphatics

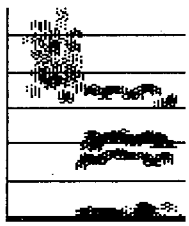


The third aim is to present an Optimality Theory (Prince and Smolensky (1993), McCarthy and Prince (1993a)) account of the two harmonies in Palestinian and St'át'imcets. First, it will be argued that ranked constraints on input/output Correspondence (McCarthy and Prince (1995)), featural Alignment (McCarthy and Prince (1993b)), and phonetic grounding (Archangeli and Pulleyblank (1994a)), both syntagmatic (Shahin (1993), Jiang-King (1996), Pulleyblank (1997)) and paradigmatic (Archangeli and Pulleyblank (1994a)), are primarily responsible for the properties of both harmonies in each language. Second, the crosslinguistic variation in the two harmonies will be argued to be due to simple constraint reranking.

1.2. Overview of the Thesis

In the remainder of this chapter, the representational assumptions of this study are first presented. The articulatory and acoustic properties of postvelar segments are then discussed. Next, a typology of phonological harmony is proposed. Optimality Theory is then introduced and the general nature of Correspondence, Alignment, and Grounded constraints is explained. Finally, the distinction between phonetics and phonology, and the role of phonetics in phonology, are discussed.

Chapter 2 first introduces Palestinian Arabic, clarifying the identity of the Palestinian phonemic inventory, with particular focus on the vocalic system. It then presents phonological evidence for Palestinian's distinct pharyngealisation and uvularisation harmonies, and acoustic findings that support that distinction. In chapters 2 and 3, to set the strictly acoustic portions of the thesis off from the rest of the text, the sylised spectrogram seen here:



will appear above the header of each section that presents acoustic findings.

Chapter 2 develops a theoretical account of the two harmonies in Palestinian. The OT constraints that impose the properties of each harmony are proposed. Their ranking is identified and the constraint interaction producing the two postvelar harmonies is shown.

Chapter 3 first introduces St'át'imcets Salish. It clarifies the St'át'imcets phonemic inventory, with focus on both the consonants and the vowels. It then presents phonological evidence for pharyngealisation harmony and uvularisation harmony in the language, and supporting acoustic findings. The specific properties of the two harmonies are shown to differ from those found in Palestinian. However, the fundamental nature of the two harmonies across the two languages is argued to be the same. The OT constraints responsible for St'át'imcets' postvelar harmonies are identified. Most are the same as those identified for Palestinian in chapter 2, but a reranking of the constraints yields St'át'imcets' own version of the two harmonies.

The final chapter summarises the thesis. In conclusion, it will be suggested that Niger Congo and Nilotic '[-ATR]' harmony[5] is pharyngealisation harmony, but with a non-consonantal source. The thesis will propose that languages in which pharyngealisation harmony has a non-consonantal source are predicted by the optimally vocalic realisation of the pharyngealisation harmony feature, [RTR]; see §2.4.2. Typological work investigating possible systemic differences between consonantal-source vs. non-consonantal-source pharyngealisation harmony, that is, work investigating the phonological consequences of a consonantal vs. vocalic source, is beyond the scope of this thesis.

1.3. Representational Assumptions

The feature geometry assumed here is seen in (3).[6] (See Appendix I for explanation of the abbreviations and symbols used in this thesis.) Note that the representations in (1) and (2) differ from this geometry by showing [COR], [DOR], and [LAB] to dominate [DOR] and/or [TR]/[RTR]. This apparent mismatch will be cleared up in §1.3.3.2.

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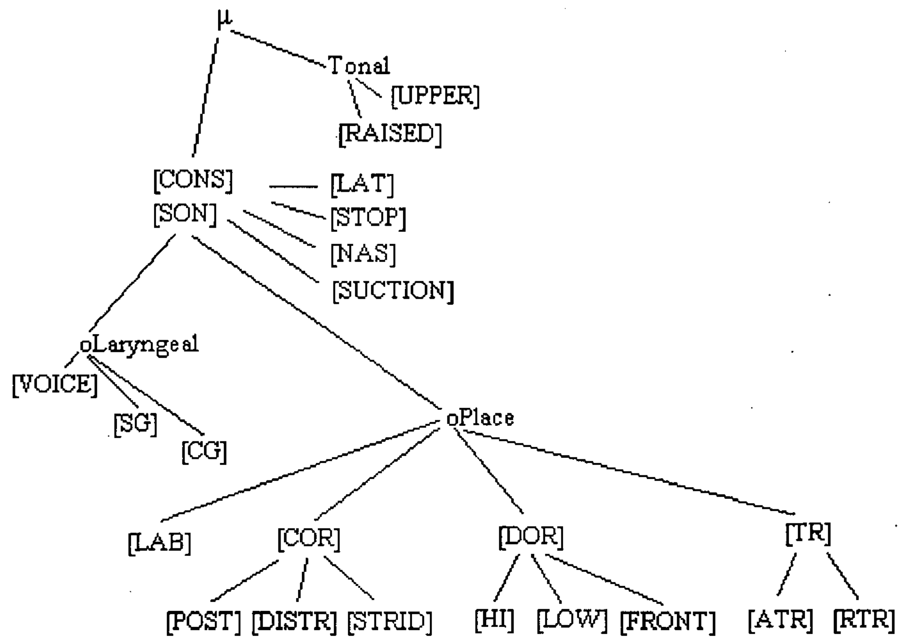
[5]See, e.g., Stewart (1967), Clements (1985), Ka (1988), Archangeli and Pulleyblank (1989), Clements (1991), Odden (1991), and Archangeli and Pulleyblank (1994a).

[6]Tonal features and [SUCTION] will not be discussed in this thesis, as neither is directly relevant to the phonological phenomena under investigation. See Archangeli and Pulleyblank (1994a) and Jiang-King (1996) for arguments that tonal features link directly to the mora. See Halle (1995) for evidence for [SUCTION], specified on clicks, and its direct linking to the root node.

(3)



Important assumptions that bear on this geometry will now be laid out.

1.3.1. Articulator Theory

Articulator Theory, developed by McCarthy (1985), Sagey (1986), and Halle (1988), will be assumed. Articulator Theory assumes, as do other feature geometric theories (see Clements (1985) and Mester (1986)) that distinctive features do not occur as unordered bundles, but in a hierarchical arrangement. The evidence for this is two-fold, as summarised by Kenstowicz (1994:146): first, certain features "introduc[e] a subdistinction within the category defined by another feature" (e.g., [DISTR], a finer distinction of [COR]); second, certain features "form recurrent groupings in phonological rules and constraints" (e.g., vowels show assimilation for height features like [HI] and [LOW], but not for [NAS]).

Articulator Theory further assumes that phonological features can be defined in either articulatory or acoustic terms (see McCarthy (1988:99)) and that their hierarchical ordering "directly reflects aspects of the human anatomy used in the production of speech" (Halle and Vaux (1994:1)). (Features which are defined in acoustic terms are here assumed to have an articulatory basis.) McCarthy (1988:105) traces the roots of this theory to "Jakobson's fundamental insight in the late 1930s that the classification of speech sounds exploited in phonology has a universal phonetic basis." Articulator Theory is widely adopted in phonological theory.[7] For further discussion of its justification, see Sagey (1986), McCarthy (1988), and Halle and Vaux (1994).

A second theory is Vowel Place Theory,[8] so-named by Halle and Vaux (1994) to highlight its central difference from Articulator Theory. Unlike Articulator Theory, Vowel Place Theory assumes that the feature geometry is primarily structured according to function. Phonetic basis is assigned a secondary role. The result is the proposal of distinct 'C-Place' and 'V-Place' nodes, motivated primarily to account for the observed non-effect of intervening consonants in cases of vowel assimilation. Halle and Vaux (1994) reject

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[7]For examples of works which adopt Articulator Theory, see Halle (1989, 1992), Selkirk (1993), Archangeli and Pulleyblank (1994a), Kenstowicz (1994), McCarthy (1994), Vaux (1994), and Halle (1995).

[8]For examples of works which adopt Vowel Place Theory, see Steriade (1987), Clements (1989), Herzallah (1990), Clements (1991), Odden (1991), Ni Chiosáin and Padgett (1993), Clements and Hume (1995), and Padgett (1995).

Vowel Place Theory because its V-Place node "has no clear anatomical status" [p.4]. They readdress the data presumed by Vowel Place theorists to indicate the V-Place node and show that they can be straightforwardly handled within Articulator Theory. (See Selkirk (1993) and Vaux (1994) for further critique of Vowel Place theory.)

It is assumed here that 'articulation' refers to constriction by the lips or tongue. Under this definition, laryngeal gesture is not an articulation. It is considered instead to be an airstream mechanism; see §1.3.3.1 for further discussion. The four articulators used in producing speech sounds are the lips, tongue blade/tip, tongue dorsum, and tongue root.[9] They are represented in (3) as the features [LAB], [COR], [DOR] and [TR]. The possibility of an Oral node under Place, as proposed by McCarthy (1994),[10] will not be discussed, as the presence or absence of this node does not impinge on the analysis of postvelar harmony to be presented in this thesis.

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[9]For examples of previous works which assume these four articulators, see Cole (1987), McCarthy (1988), Selkirk (1993), and McCarthy (1994).

[10]For further discussion of a possible Oral node, see Clements and Hume (1995:272) and Rose (1996).

1.3.2. The Articulator Feature [TONGUE ROOT]

The feature [TR] is assumed in the present work to represent the active articulator, tongue root. It is assumed to dominate the features [RTR] and [ATR], based on the evidence for distinct retraction and advancement features in Kiparsky (1985), Ringen (1989), Goad (1991), Casali (1993), Archangeli and Pulleyblank (1994a:200-245), and Steriade (1995a:149-151). This thesis investigates tongue root phenomena involving [RTR].

[TR] is not assumed to be a feature defining an 'orosensory region', as proposed by McCarthy (1994) for the feature [PHARYNGEAL]. McCarthy (1994) proposes [PHARYNGEAL] because of a classificatory problem relating to laryngeal gutturals. The discussion that follows first addresses what laryngeal gutturals are, then summarises the problem they have posed. It then summarises new findings of this thesis which suggest that laryngeal gutturals do not pose a problem after all.

1.3.2.1. The Assumed Problem with Laryngeal Gutturals

A laryngeal guttural is a /ʔ/ or /h/ that patterns with pharyngeal and uvular consonants (e.g., /ʕ ħ ʁ χ/) as a natural class. Such laryngeals have been shown to exist in Arabic and Hebrew (both Semitic) by McCarthy (1994), in Nisga (Tsimshianic) by Shaw (1991a), and in Iraqw (Cushitic) by, e.g., van der Hulst and Mous (1992) and Mous

(1993). Languages in which laryngeals do not pattern with pharyngeals and uvulars include Interior Salish languages (see Bessell and Czaykowska-Higgins (1991) and Bessell (1992)) and Tigre (Ethiopic Semitic; see McCarthy (1994) and Rose (1996)). That is, laryngeals do not necessarily pattern with pharyngeals and uvulars; rather, their patterning depends on the language.

The natural class consisting of pharyngeals and uvulars, and sometimes laryngeals, is termed the 'guttural' class by McCarthy (1994). McCarthy (1994) presents four types of evidence for the guttural class: (i) root co-occurrence restrictions; (ii) vowel lowering; (iii) avoidance of syllable-final gutturals; (iv) degemination. Examples of (i) - (iv) from McCarthy (1994) will be reviewed below. As will be shown, he provides evidence for the patterning of laryngeals with pharyngeals and uvulars in Arabic, which shows that the Arabic guttural class consists of /ʔ h ʕ ħ ʁ χ/.[11] (See Cole (1987) on Coeur d'Alene (Southern Interior Salish), Shaw (1991a) on Nisga, and Hayward and Hayward (1989) and Rose (1996) on Cushitic for further evidence for the guttural class.)

McCarthy draws his first set of evidence from Arabic root co-occurrence restrictions. Arabic roots "rarely or never contain adjacent homorganic consonants" [p.203]. Of interest here is the fact that "[r]oots combining two gutturals are significantly infrequent" [p.205].[12] As McCarthy points out, the co-occurrence restriction with respect to gutturals

[11]The guttural class of a particular variety of Arabic might include other gutturals, e.g., uvular /ɢ/, documented for Gazan Palestinian by Abu Shark (1997).

[12]See McCarthy's (1994:204) table showing this statistical infrequency.

requires reference to gutturals as a class, as a significant generalisation is lost if that class is not recognised.

The second type of evidence is from vowel lowering. McCarthy presents data from Arabic and Tiberian Hebrew (a pronunciation tradition of Biblical Hebrew) which show such lowering. Examples are presented in (4) and (5).

In the transcriptions below, the braces '{ }' are used to denote the fact that the data are surface phonological forms — distinct from underlying phonological forms, which are standardly enclosed by slashes ('//'), and phonetic forms, which are standardly enclosed by square brackets ('[ ]'). This notation will be used throughout this thesis. The distinction between underlying phonological form, surface phonological form, and phonetic form will be discussed in §7.1.1. In the present section, the surface phonological status of forms enclosed by '{ }' is inferred from McCarthy's discussion. In all other respects, the data cited in this section follow McCarthy's transcription; 'j' denotes a palatal approximant; a capital letter denotes an emphatic consonant (e.g., 'D' denotes emphatic ḍ).

In Modern Standard Arabic, the last vowel of the imperfect verb stem is lowered to {a} when adjacent to a guttural. This is illustrated by the Modern Standard Arabic verbal forms in (5), in comparison with those in (4). These data are from McCarthy (1994:207). (I have added the ungrammatical imperfect forms for clarity.) The relevant generalisation with respect to (4) and (5) is: whereas the final vowel of the imperfect verb stem surfaces unpredictably as non-low {i} or {u} when it is not adjacent to a guttural, it surfaces predictably as low {a} when it is adjacent to a guttural.

1.3.2. The Articulator Feature [TONGUE ROOT]

(4) Modern Standard Arabic Non-lowered Imperfects

	perfect	imperfect		
a.	{katab}	{jaktub}	(*{jaktab})	'to write'
b.	{Darab}	{jaDrib}	(*{jaDrab})	'to beat'

(5) Modern Standard Arabic Lowered Imperfects

	perfect	imperfect		
a.	{faʕal}	{jafʕal}	(*{jafʕil}, *{jafʕul})	'to do'
b.	{radaʕ}	{jardaʕ}	(*{jardiʕ}, *{jarduʕ})	'to prevent'

McCarthy provides no pairs involving laryngeals or uvulars. However, the further data in (6),[13] which illustrate the lowering in forms in which the guttural is a laryngeal or a uvular, support McCarthy's generalisation.

(6) Modern Standard Arabic Lowered Imperfects with Laryngeal and Uvular Gutturals

	perfect	imperfect		
a.	{ðahal}	{jaðhal}	(*{jaðhil}, *{jaðhul})	'to forget, overlook'
b.	{ʤahaz}	{jaʤhaz}	(*{jaʤhiz}, *{jaʤhuz})	'to finish off (e.g., a wounded person)'
c.	{ʃamaχ}	{jaʃmaχ}	(*{jaʃmiχ}, *{jaʃmuχ})	'to be high, tall, lofty'
d.	{taχam}	{jatχam}	(*{jatχim}, *{jatχum})	'to suffer from indigestion'

A second, related type of phenomenon is post-guttural blocking of vowel raising in 'Anaiza (Saudi) Bedouin. (McCarthy (1994:212) refers to it as a phenomenon in which raising "is systematically blocked or undone".) This is illustrated by the data in (8), compared to those in (7). The data in (7) and (8) are from McCarthy (1994:213) and (1994:212), respectively. (I have added the ungrammatical forms. McCarthy provides only surface forms for the data in (8); I have added the underlying forms as implied by his discussion.) The relevant generalisation from (7) and (8) is: whereas the initial vowel of

[13] I thank Dil Parkinson for help with the data in (6).

the verb or noun stem surfaces predictably as raised {i} when it does not immediately follow a guttural, it surfaces predictably as low {a} when it immediately follows a guttural.

(7) 'Anaiza (Saudi) Bedouin Raised Forms

a.	/katab/	{kitab}	(*{katab})	'he wrote'
b.	/ʤamal/	{ʤimal}	(*{ʤamal})	'camel'
c.	/bagar/	{bigar}	(*{bagar})	'cows'

(8) 'Anaiza (Saudi) Bedouin Forms in which Raising is Blocked

a.	/ʔakal/	{ʔakal}	(*{ʔikal})	'he ate'
b.	/haʤiin/	{haʤiin}	(*{hiʤiin})	(type of camel)
c.	/ʕazam/	{ʕazam}	(*{ʕizam})	'he invited'
d.	/ħasuud/	{ħasuud}	(*{ħisuud})	'envious'
e.	/ʁaSab/	{ʁaSab}	(*{ʁiSab})	'he forced'
f.	/χazan/	{χazan}	(*{χizan})	'he stored'

Another example of lowering comes from Tiberian Hebrew: the Tiberian epenthetic vowel is lowered immediately preceding a guttural.[14] This is illustrated by the forms in (10), compared to those in (9). These data are from McCarthy (1994:210). (I have added the ungrammatical forms.) The relevant generalisation is: whereas the epenthetic vowel in a CVCC noun stem surfaces predictably as non-low {e} when it does not immediately follow a guttural, it surfaces predictably as low {a} when it does.

(9) Tiberian Hebrew Non-Lowered Epenthetic Vowel

a.	/malk/	{melek}	(*{melak})	'king/my king'
b.	/sipr/	{se:per}	(*{se:par})	'book'
c.	/qudʃ/	{qo:deʃ}	(*{qo:daʃ})	'holiness'

[14]McCarthy (1994:210) shows that the Tiberian epenthetic vowel is realised as a full vowel in closed syllables, as shown also by Prince (1975) and Garr (1989).

(10) Tiberian Hebrew Lowered Epenthetic Vowel

a.	/tuʔr/	{toʔar}	(*{toʔer})	'form/his form'
a.	/lahb/	{lahab}	(*{laheb})	'flame'
b.	/baʕl/	{baʕal}	(*{baʕel})	'master'
c.	/kaħʃ/	{kaħaʃ}	(*{kaħeʃ})	'lying'

McCarthy (1994) does not provide examples of this lowering which involve Tiberian uvulars. However, the further forms in (11) show that the epenthetic vowel does not lower immediately following uvular /q/.[15]

(11) Tiberian Hebrew Epenthetic Vowel in CVCC Nouns with /q/ as C_2

a.	/ʃeqr/	{ʃeqer}	(*{ʃeqar})	'deception, falsehood'
a.	/boqr/	{bo:qer}	(*{bo:qar})	'morning'

The fact that Tiberian /q/ does not trigger this lowering suggests it is not a guttural. As will be evident from the discussion in §1.4.2, the non-guttural status of a /q/ such as that in Tiberian is explicable if it is recognised as emphatic [k̙] instead of a primary uvular like /ʁ/ and /χ/. Alternatively, Tiberian /q/ might be a guttural, and the lowering just discussed might be triggered only by gutturals that are not also stops.

The point about the Semitic lowering cases discussed above is that they require reference to the guttural natural class.

The third set of evidence is from the avoidance of syllable-final gutturals in Negev Bedouin Arabic, Tiberian Hebrew, and Tigre. This is illustrated by the data in (13), compared to those in (12), which are from McCarthy (1994:214). (I have added the

[15]I thank John McCarthy for providing the grammatical surface forms in (11).

ungrammatical forms, and periods to denote the first syllable break in each word.[16] See McCarthy (1994:215-216) for data showing avoidance of syllable-final gutturals in Tiberian Hebrew and Tigre.) The generalisation with respect to (12) and (13) is: Negev Bedouin /CVCC.../ surfaces as {CVC.C...}. By contrast, /CVGC.../ surfaces as {CV.GVC...}, where G is a guttural. That is, the guttural surfaces in syllable-initial rather than syllable-final position.

(12) Negev Bedouin Arabic Plain Roots: {(C)VC.C...}

a.	{jaʃ.rab}	(*{ja.ʃ...})	'he drinks'
b.	{aʃ.rab}	(*{a.ʃ...})	'I drink'
c.	{bnaʃ.rab}	(*{bna.ʃ...})	'we drink'
d.	{taʃ.rab}	(*{ta.ʃ...})	'you drink'

(13) Negev Bedouin Arabic Guttural Roots: *{(C)VG.C...}

a.	{ja.hardʒ}	(*{jah.r..})	'he speaks'
b.	{a.ʕarf}	(*{aʕ.r..})	'I know'
c.	{a.ħalam}	(*{aħ.l...})	'I dream'
d.	{bna.ʁazil}	(*{bnaʁ.z...})	'we spin'
e.	{ta.χabar}	(*{taχ.b...})	'you know'

The point is the need to refer to the guttural class in the statement of the coda condition responsible for the syllabification in (13).

The final set of evidence is from guttural degemination. This is illustrated by the Tiberian Hebrew examples in (15), compared to those in (14), from McCarthy (1994:217). (I have added the ungrammatical forms in (15).[17] See McCarthy (1994:217) for forms showing guttural degemination in Tigre.) The generalisation here is: geminate gutturals

[16]McCarthy (1994) provides no underlying forms for these data, so the underlying/non-underlying status of the vowels in (12) and (13) remains unclarified here.

[17]McCarthy (1994) provides no underlying forms for (14a-b) and (15a-b).

are not observed in contexts where they are expected, based on the gemination observed for non-guttural consonants in parallel forms. This indicates that non-gutturals can geminate in Tiberian, but gutturals cannot.

(14) Tiberian Hebrew Non-Guttural Roots

a.		{dibbe:r}	'he said'
b.		{dalli:m}	'weak ones'
c.	/jinte:/	{jitte:n}	'he gives'

(15) Tiberian Hebrew Guttural Roots

a.		{me:ʔe:n}	(*{meʔʔe:n})	'he refused'
b.		{ra:ʕi:m}	(*{raʕʕi:m})	'evil ones'
c.	/jinħat/	{je:ħat}	(*{jeħħat})	'he marches down'

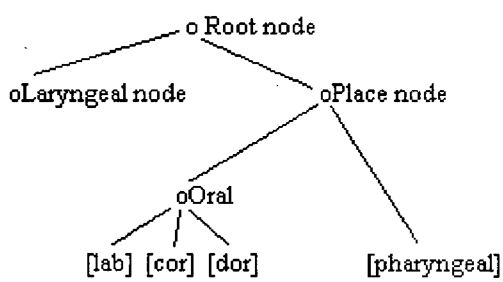
Guttural degemination also requires reference to gutturals as a class.

In sum, Semitic consonant co-occurrence restrictions, vowel lowering, avoidance of syllable-final gutturals, and guttural degemination all require reference to a guttural natural class, as without some formal way of clarifying this group of segments uniquely, a significant set of linguistic generalisations would not be captured.

McCarthy's facts establish that laryngeals are part of the guttural class in both Arabic and Hebrew. This is seen from the forms with laryngeals in (6a-b), (8a-b), (10a-b), (13a) and (15a) as well as from McCarthy's (1994:204) table of roots combining adjacent consonants. The problem he identifies for laryngeal gutturals is that no phonetic basis for their guttural status can be found in the articulatory or acoustic literature. In particular, there is "no evidence for a pharyngeal or uvular constriction accompanying the glottal gesture" (McCarthy (1994:193)). This is troublesome within Articulator Theory, since features and feature groupings are supposed to be articulatorily based. He concludes: "the difference between Arabic and Tigre laryngeals, phonologically important but phonetically invisible, may have shown us a limit in our understanding of the relation between phonetic events and phonological features" (p.225).

As a result, McCarthy (1994) proposes that the feature capturing the guttural class is not an articulator feature like [TR], but an orosensory feature, [PHARYNGEAL]. He defines [PHARYNGEAL] as "the orosensory pattern of constriction anywhere in the broad region of the pharynx" (p.199), after Perkell (1971). His proposed geometry is seen in (16). (As noted in §1.3.1, his proposal for the Oral node under Place will not be discussed or adopted here.)

(16) McCarthy (1994) Geometry With Orosensory [PHARYNGEAL]



1.3.2.2. Another Look at Laryngeal Gutturals

This section first provides a critical examination of the bases for McCarthy's (1994) conclusion that there is no evidence that Arabic laryngeals are tongue root articulated. It will be suggested that the studies on which McCarthy's conclusion is based do not provide conclusive evidence for that conclusion. Finally and most significantly, this section summarises new acoustic findings of this thesis, to be presented in chapter 2, which support an assumption that laryngeal gutturals are tongue root articulated.

McCarthy (1994:193), noting first that there is no articulatory (*viz.*, x-ray, fibreoptic, EMG, etc.) data on Arabic laryngeals, bases his conclusion on the fact that no acoustic data have shown that Arabic laryngeals have "formant transition or other effects on adjacent vowels". He cites the findings of Klatt and Stevens (1969) on Arabic laryngeals and Younes's (1982) use of Palestinian laryngeals as the 'neutral context' as evidence for this.

Klatt and Stevens (1969) examined tokens of Arabic laryngeals, pharyngeals, and uvulars followed by tokens of the short vowels /I/, /Æ/, and /U/, with each consonant-vowel sequence forming a single open syllable. They describe their subjects as speakers of various Arabic dialects, and identify one of the dialects as Lebanese. They report: "[t]he /h/ and the glottal stop /ʔ/... differ from the pharyngeals in that there are <u>no</u> formant transitions at the vowel onsets" (p.211, underlining in the original).

However, I suggest that no general conclusion with respect to Arabic laryngeals can be based on Klatt and Stevens' finding. This is because the vowel in a token of /hI/, /hÆ/, /hU/, /ʔI/, /ʔÆ/, or /ʔU/ occurs in stem-final position. In chapter 2 it will be shown that Palestinian laryngeals trigger tongue root retraction harmony on short vowels, resulting in a raised F_1 and lowered F_2 for the vowels (except for tokens of the low short vowel, /Æ/, which show no F_1 and F_2 effects). However, this harmony is not observed if the vowels are stem-final because stem-final short vowels do not undergo the harmony.

In the (Beirut) Lebanese Arabic data in (17), short vowels occur in stem-final position. (My transcriptions in this thesis follow the notational conventions of the International Phonetic Alphabet (IPA), which is reproduced in Appendix I. As an exception, '˔', which denotes tongue root retraction in the IPA, will be used to denote 'emphasis', that is, simultaneous pharyngealisation and uvularisation; see §1.4.2 for further discussion of these secondary articulations. The symbol '-' will denote a morpheme boundary; '#' will denote a word boundary.)

(17) (Beirut) Lebanese Arabic Forms

a. /b-j-IʁlI/	{ˈb-j-ɪʁ.li}	(*{ˈb-j-ɪʁ.lɪ})	'he boils (something)'
b. /ħIlU/	{ˈħɪ.lu}	(*{ˈħɪ.lʊ})	'pretty (masc. sg.)'
c. /sÆmm-U/	{ˈsam.m-u}	(*{ˈsam.m-ʊ})	'they (masc.) named (someone, something)'; 'they (masc.) said the words: *bi-sm-illāh ir-rahmān ir-rahīm* 'in the name of God, the Gracious, the Merciful' '

The stem-final short vowels in (17) surface non-tongue root retracted ('non-rtr'). They do not surface rtr, as would be expected if they harmonised with the guttural (17a-b) and/or rtr vowel (17a-c) in the word. (The expected harmony in the two contexts just mentioned is based the behaviour of short vowels in Palestinian, which will be detailed in §2.3 and §2.4. In the surface form in (17c), {a} is rtr.) This indicates that stem-final vowels in Lebanese, like stem-final vowels in Palestinian, do not undergo tongue root retraction harmony.

The foregoing observations with respect to Palestinian and Lebanese suggest that Klatt and Stevens searched for acoustic effects from laryngeals in a context where none would be found for independent reasons.

An examination of Younes' (1982) use of laryngeals as the 'neutral context' shows that his usage is based on the findings of Stevens and House (1963).[18] The finding of Stevens and House (1963:116) with respect to laryngeals was that "comparison of the average data for the /h-d/ and the /#-#/ [isolation] environments shows that there is no significant difference between the values of F_1 and F_2 for these two environments." Based on this finding, they conclude (*ibid.*) that "the vowel in the context /h-d/ is generated with essentially the same articulatory configuration as the vowel in isolation" and that /h-d/ and /#-#/ are both 'null' contexts for vowels.

However, Stevens and House analysed *English* laryngeals — they describe their speech material [p.112] as "common vowels of American English and... consonants that can appear both initially and finally in American English" — and English laryngeals are not gutturals. As stated by Klatt and Stevens (1969:207), "[i]n English all of the consonants are produced with a constriction in the oral cavity between the velum and the lips"; thus, English has no guttural class. The point here is: given McCarthy's (1994) phonological evidence that Arabic laryngeals do systematically behave as gutturals, Arabic laryngeals

[18]See Younes' (1982:2) description of the procedures for his acoustic experiment.

cannot be considered a 'neutral' context like English laryngeals unless they are established as such.

Based on the foregoing review of Klatt and Stevens (1969) and Younes (1982), there is as yet no clear evidence that Arabic laryngeals are *not* tongue root articulated.

The investigation of Palestinian postvelar harmony to be presented in chapter 2 will show that Palestinian laryngeals, like the other gutturals, trigger tongue root retraction harmony, which will be labelled 'pharyngealisation harmony'. Acoustic data showing the effect of this harmony on vowel formants will be presented. The finding is that pharyngealisation harmony results in a raised F_1 and lowered F_2 for tokens of the harmonising vowel. Important to the point at hand, the formant effects are observed even when the harmony trigger is a laryngeal. This means that Palestinian laryngeals have acoustic effects on vowel formants. Since a raised F_1 and lowered F_2 are expected for segments which are produced with pharyngealisation articulation, as will be discussed in §1.4.3, the effects are consistent with an assumption that Palestinian laryngeals are tongue-root articulated.

An alternative suggestion, that the raised F_1 effect from Palestinian laryngeals might result from some completely non-tongue root articulation, is rejected here. This is because Palestinian laryngeals, pharyngeals, and uvulars constitute a guttural class and in Articulatory Theory, phonological classes are assumed to be based on some shared articulatory implementation.

Note that the present assumption that Palestinian laryngeals are tongue-root articulated predicts, e.g., that tokens of Palestinian /h/ will have some first formant resonance that is not observed for tokens non-guttural /h/ in a language such as English. Experimental investigation of this prediction remains for work outside the context of this thesis.

In summary, this section has presented arguments for assuming that gutturals are all produced with a single articulator: the tongue root. On the basis of those arguments, I propose that all gutturals are specified for [TR] For this reason, [PHARYNGEAL], representing an orosensory region, does not appear in (3), but is replaced by the articulator feature [TR].

1.3.3. Other Representational Assumptions

Privative features, which are traced to Trubetskoy's (1939) privative oppositions between sounds, as discussed by Hyman (1975:27), are assumed.[19] It is assumed that [CONS], and [SON] characterise the root node, as proposed by Schein and Steriade (1986) and Halle (1988); see McCarthy (1988) for further discussion. Given Shaw's (1991b) evidence that the phonological continuancy feature is one that represents no continuancy, the feature [STOP] is assumed. Following Shaw (1989, 1991b) and La Charité (1993),

[19]For examples of previous works which assume privitive features, see Goldsmith (1985), Rice and Avery (1989), and Steriade (1995). See also Schane (1984), Anderson, Ewen, and Staun (1985), van der Hulst and Smith (1985), Kaye, Lowenstamm, and Vernaud (1985), and Schane (1987) on similar unary-value assumptions.

[STRID] is assumed to be a daughter of [COR], rather than of the root node. Given the substantial evidence for phonological fronting rather than backing (e.g., umlaut, palatalisation), the feature [FRONT], as used by McCarthy (1997), rather than [BACK], is assumed. Given the crosslinguistic evidence that coronals are subclassified for a feature representing non-anteriority,[20] the feature [POST], as the privative expression of [-ANTERIOR], is assumed. Finally, following Selkirk (1993), it is assumed that the feature [ROUND] does not exist. This is based on Selkirk's argument that a rounded interpretation of secondary-[LAB] is always predictable and thus belongs in the phonetics.

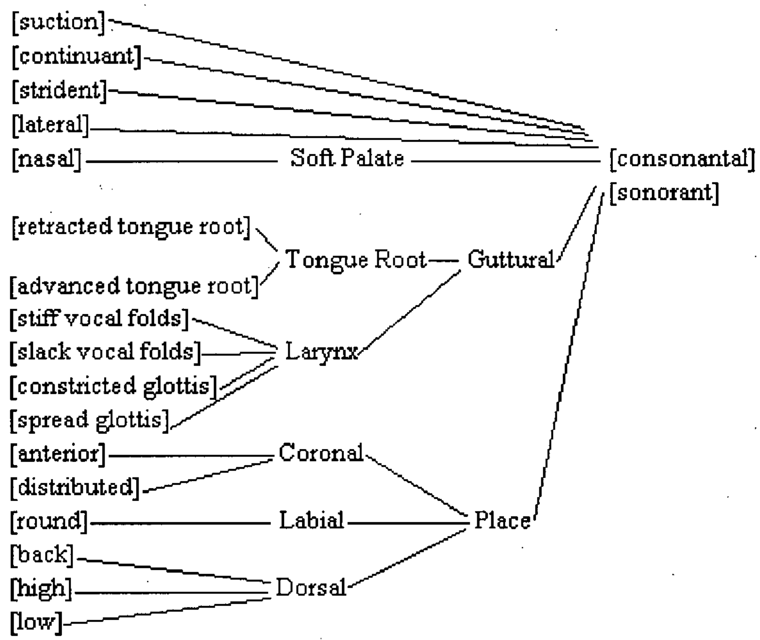
1.3.3.1. Laryngeal Specifications

Following several previous works, it is assumed that the Laryngeal node, dominating the features [VOICE], [SG], and [CG] is directly dominated by the root node,[21] not deeply embedded in the geometry, as proposed by Halle (1995) and assumed by Halle and Vaux (1994) and Vaux (1994.) Halle's (1995) geometry is seen below:

[20]See, e.g., Sagey's (1986:132-135) discussion of n-retroflexion in Sanskrit, as documented by Steriade (1986), and Hirose (to appear) on palatalisation in Plains Cree.

[21]For examples of previous works which assume the Laryngeal node to be directly dominated by the root node, see Sagey (1986), Cole (1987), Archangeli and Pulleyblank (1994a), McCarthy (1994), and Clements and Hume (1995).

(18) The Halle (1995) Feature Geometry



Halle (1995:18) bases the grouping of laryngeal and tongue root features on the finding of several previous studies that laryngeal characteristics frequently correlate with tongue root activity. E.g., Czaykowska-Higgins (1987:2), based on data in Gregerson (1976), reports that Mon Khmer rtr vowels are systematically accompanied by breathy voice, higher pitch, and voiceless initial consonants; the atr vowels are accompanied by creaky voice, lower pitch, and voiced initial consonants.[22] In the model in (18), this correlation is assumed to have a structural basis: Tongue Root and Larynx are dominated by the same node, Guttural.

I suggest, however, that the relation between laryngeal and tongue root features can be understood as a grounded relation. Under this view, the f_0/tongue root correlations

[22]For further discussion of larynx-tongue root correlations, see Hayward and Hayward (1989), Trigo (1991), Meechan (1992), and Vaux (1994).

observed in Mon Khmer indicate paradigmatic grounded constraints like RTR/SG ('If [RTR], then [SG]') and ATR/CG ('If [ATR], then [CG]'). I propose that such constraints are paradigmatically grounded in the anatomical interconnectedness of the lower vocal tract structures: the tongue root, suprahyoid muscles, hyoid bone, thyroid and cricoid cartilages, and the laryngeal muscles — especially the cricothyroid (primary controller of longitudinal tension in the vocal folds, which determines pitch) and the lateral cricoarytenoid (primary controller of medial compression, which determines breathy or creaky voice); see Saunders (1964) and Zemlin (1988).[23] The breathy voice which is sytematically observed for rtr vowels in Mon Khmer indicates that RTR/SG is highly ranked in that language. Further development of this grounded account is deferred for work elsewhere.

The position of laryngeal features under the root node, structurally distant from all articulator features (that is, laryngeal features are not sisters to any articulator feature) follows from the fundamental source/filter distinction in the acoustic signal. After Fant (1960), the speech signal is produced when the glottis provides a source wave and the vocal tract filters that wave.[24] Four articulators can affect the transfer (filter) function: the lips, tongue tip/blade, tongue dorsum (sometimes referred to as the 'tongue body'), and

[23]See Laufer and Condax (1979), Denning (1989), Meechan (1992), Hirai et al. (1993), Honda et al. (1993), and McCarthy (1994) for relevant articulatory findings and discussion.

[24]Fant (1960) also considers the 'radiation' function, which is the final modification of the signal caused by outward radiation from the lips. This will not be discussed here because it applies after the source and filter functions.

tongue root. These four can articulate at specific places. Although there is convincing argumentation that it is not 'place of articulation', but 'articulator' that is phonologically real, as discussed by McCarthy (1988), a node labelled 'Place' is retained in the tree. The Place node corresponds to the representation of a filter. By definition, Place dominates features that implement the four articulators: [LAB], [COR], [DOR], and [TR].

The larynx, by contrast, does not filter the speech signal. Rather, it provides a source wave and passes it on for potential articulatory modification by one or more of the four articulators. For this reason, (non-guttural) laryngeals, which are produced with only vocal fold adjustment, are placeless. Their placelessness has been expressed in several phonological analyses.[25] Vocal fold adjustments that effect voicing, glottalisation, implosion, or aspiration are adjustments of the source, not of the filter. Consider Ladefoged's (1993) classsification of glottalisation under 'airstream meachanisms',[26] not under 'secondary articulation'. His classification is consistent with the source/filter distinction. The definition of 'articulation' assumed in this thesis (see §1.3.1) also reflects the source/filter distinction.

The position of the laryngeal node in (3) encodes the physical distinctions just discussed.

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[25]See, e.g., Clements (1985), Sagey (1986), Steriade (1987), Bessell and Czaykowska-Higgins (1991), and Bessell (1992).

[26]After Pike (1943) 'airstream mechanism' refers to the movement of a body of air for speech, corresponding to Catford's (1977) 'initiation' function. Airstream mechanisms are characterised according to whether the body of air is pulmonic, glottalic, or velaric, and whether the air is moved upward/outward or downward/inward.

1.3.3. Other Representational Assumptions

Cases of debuccalisation, in which all Place specifications of a segment are lost, and laryngeal or nasal specifications remain (see Clements (1985), McCarthy (1988), Trigo (1991)) are relevant to the issue at hand, in a manner to be explained shortly. Forms illustrating word-final obstruent debuccalisation in Kelantan Malay, from Trigo (1991:124), are presented in (19). (The surface form status of these data is inferred from Trigo's discussion.) After Halle (1995:16-17), it is assumed that Malay stops are redundantly assigned [CG] and that the continuants are redundantly assigned [SG], presumably enhancing the continuancy distinctions. The examples below show retention of these laryngeal specifications.

(19) Kelantan Malay Debuccalisation

	Standard Malay	Kelantan	
a.	{ʔasap}	{ʔasaʔ}	'smoke'
b.	{kilat}	{kilaʔ}	'lightning'
c.	{balas}	{balah}	'finish'
d.	{negatif}	{negatɨh}	'negative'

The final Kelantan consonants in (19) have all the feature specifications of the corresponding Standard consonants, minus all Place specifications. This indicates that, for the final Kelantan consonants, the phonological representation of a filter has been removed. What is left is the representation of a source, *viz.*, the laryngeal node.

A final discussion concerns the glottal stop. Ladefoged and Maddieson (1996:38) state:

> The larynx, among its many other functions, can also serve as place of articulation for stops. Glottal stops occur in many languages. They frequently pattern with other consonants... making it clear that glottal gestures must be taken into consideration when discussing places of articulation that are possible for stop consonants.

Based on this, they conclude [p.11] that "the glottis has to be recognized as an articulator in some circumstances, forming Glottal articulations."

While the existence of glottal stops is clear, their existence is here not considered to indicate that the larynx is an articulator but, rather, that the phonological representation of stop manner, *viz.*, the feature [STOP], is implemented in association with features which implement either laryngeal or articulator gesture (producing laryngeal or supralaryngeal constrictions, respectively). This is encoded by the geometry in (3), in which [STOP] is immediately dominated by the root node.

1.3.3.2. The Representation of Secondary Articulation

Selkirk's (1988) representation of secondary articulation is assumed, in which a primary articulation feature is immediately dominated by the Place node. A secondary articulation feature is one that is dominated by a primary articulation feature, assuming Mester's (1986, 1988) head- vs. dependent-feature distinction. For example, the representation of the labialised labial /p^w/ is as seen in (20).

1.3.3. Other Representational Assumptions

(20)

$/p^w/$

[CONS]

|

οPlace

|

[LAB]

|

[LAB]

Sagey's (1986) pointer system for the representation of secondary articulation is not adopted. The reason for this is that it cannot represent a primary and a secondary instance of the same feature on a single segment. As discussed by Selkirk (1993), this representational capacity is necessary for segments, like a labialised labial, that have both primary and secondary specification for one feature. Another such case is a uvularised velar (i.e., a dorsal emphatic), which will be argued in this thesis to be specified for both primary- and secondary-[DOR]. In Sagey's system, a pointer points to a primary articulation feature; no pointer points to a secondary articulation feature. A segment with dual specification for one feature requires that a pointer both point and not point to the feature, something that is impossible in Sagey's one-level representation. (Once a two-level representation is adopted, the primary vs. secondary distinction is captured and the additional pointer device is unnecessary.)

Trigo's (1991) 1Place/2Place representation of secondary articulation is not adopted because it posits two new nodes in the geometry: a '1Place' node, which dominates primary articulation features, and a '2Place' node, which dominates secondary articulation features. This enriches the geometry, an undesirable result.

A Padgett (1991, 1994) (see also Walli-Sagey 1986) stricture-under-Place representation of secondary articulation is also not adopted. Padgett proposes this representation on the basis of several cases of place harmony with contingent stricture harmony. Stricture-under-Place is not adopted here because, like Sagey's pointer system, it cannot represent a primary and secondary specification for a single feature on one segment: in Padgett's system, a primary articulation feature dominates stricture features; a segment with dual specification for one feature would require, impossibly, that stricture features both appear and not appear under one articulator feature.

Stricture-under-Place is generally rejected on three other grounds. First, in Padgett's geometry, multiple instances of the stricture features occur, one set under each articulator feature. This presents a redundancy which has no parallel elsewhere in the geometry. That is, no other set of features displays such structural properties. Second, Stricture-under-Place does not capture all place harmony facts: cases of non-stricture-contingent place harmony exist; e.g., in Sanskrit (Steriade (1986)) and Tahltan (Shaw (1991b)). Third, cases of non-stricture-contingent place harmony involving [COR] force Padgett (1991) to propose a distinct node called 'Site' under [COR], a type of node unparalleled elsewhere in the geometry.

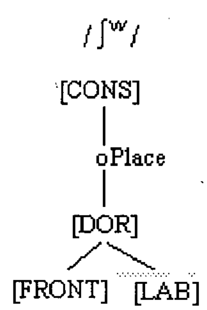
Selkirk (1993) proposes a 'feature-node' theory of primary and secondary specification. Feature-node theory presumes the representation of Selkirk (1988) as illustrated in (20) but, in addition, claims that each articulator feature is associated with a node. The features are understood as labelling the nodes. Selkirk (1993) proposes this system primarily to permit representation of null primary place. She cites [p.82] the Irish consonant lenition described by Ní Chiosáin (1991) as indicating a need for such a representation. Feature-node theory is not adopted here for two reasons. First, by positing new nodes, one for each articulator feature, it entails an enrichment of the geometry. Second, its theoretical implications are unclear: for example, is a Place node dominating only an unlabelled node a well-formed representation?

Finally, under Articulator Theory, a V-Place representation of secondary articulation, after Clements (1989, 1991), is not an option. This is because the elements in a V-Place representation are not necessarily anatomically grounded, that is, based on some anatomical characteristic of the vocal tract. Articulator Theory holds that such a basis is necessary. Thus, Articulator Theory cannot be maintained where a V-Place representation of secondary articulation is adopted.

It is assumed here that primary articulation features are in the universally-fixed hierarchical arrangement of the feature geometry, but that the head-dependent relations of primary and secondary articulation features are not universally-fixed. This is implicitly assumed by Selkirk (1993), but differs from Mester's (1986) original proposal, that the head/dependent relation characterises all features. Reserving this relation for the representation of secondary articulation captures the fact that secondary articulation features are dependent on primary articulation features for realising their secondary status.

The head/dependent relation means, for example, that secondary-[LAB] can occur under primary-[LAB] (as for /p^w/) or primary-[DOR] (as for /k^w/), but that, by stipulation, the lack of a common head has no ramifications for the ability of the two instances of secondary-[LAB] to function together as a class. For complex representations, such as primary-[DOR]/[FRONT] + secondary-[LAB], it is assumed that the secondary articulation feature is immediately dominated by the primary articulation feature. This is illustrated in (21).

(21)



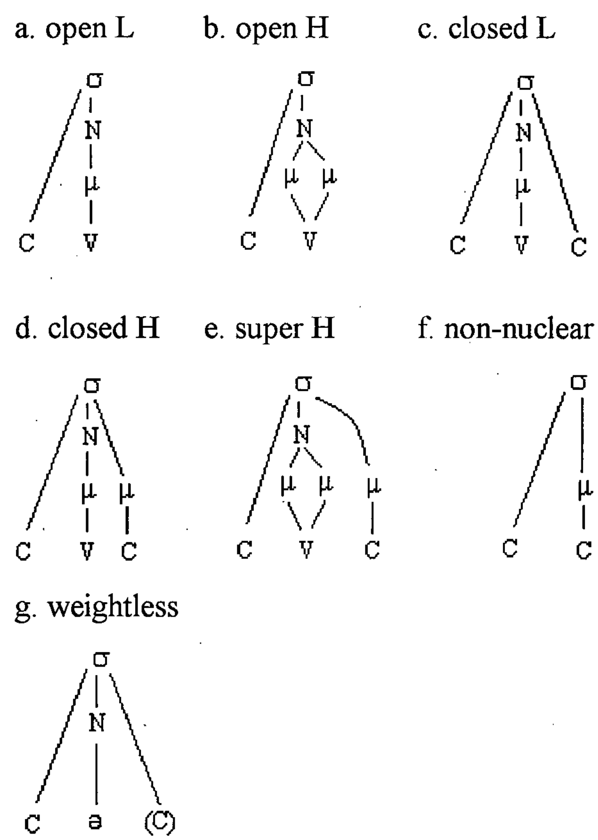
1.3.3.3. Prosodic Representations

A final body of background assumptions concerns the representation of prosodic structure. Shaw's Nuclear/Moraic theory of prosodic representations will be assumed. This theory was first motivated on the basis of templatic facts; see Shaw (1992, 1993). It has been shown to also provide an explanatory account of syllabification, including the intricate syllabification of languages like Mon Khmer, St'át'imcets Salish, and Berber; see

Shaw (1994, 1996a, 1996b). Further support for Nuclear/Moraic theory has been found in Niger-Congo prosodic minimality (Ola (1995)), Spanish segmental alternations (Valerga (1995)), and Chinese tone-vowel interaction (Jiang-King (1996)).

In this theory, a segment is either moraic or non-moraic, nuclear or non-nuclear, where the mora ('μ') is a unit of prosodic weight and the nucleus ('N') is the head of a syllable ('σ'). A segment can be both nuclear and moraic, but nuclear status does not entail moraic status. The reverse is also true. The Nuclear/Moraic prosodic hierarchy is seen in (22). In (22), 'L' abbreviates 'light syllable' and 'H' abbreviates 'heavy syllable'.

(22) The Prosodic Hierarchy in Nuclear/Moraic Theory ((a-f) are from Shaw (1992, 1993); (g) is from Shaw (1996a, 1996b))



1.4. Postvelars

Postvelars are of central interest in this thesis because, it will be argued, they are the segmental source of postvelar harmony in Palestinian Arabic and St'át'imcets Salish. Bessell and Czaykowska-Higgins (1991:1) define postvelars as "sounds articulated wholly or partly in the postvelar region of the vocal tract." This definition identifies gutturals and emphatics. Gutturals include the consonants /(ʔ h) ʕ ħ ɢ q ʁ χ/, where parentheses around ʔ and h indicate that laryngeals can be, but are not necessarily, gutturals; see §1.3.2.1. Emphatics are consonants like /ð̙ s̙ r̙ k̙/. Gutturals are articulated wholly in the postvelar region of the vocal tract (McCarthy (1994)). Non-guttural laryngeals, such as the laryngeals of Interior Salish, Tigre, and English, as discussed in §1.3.2.1, §1.3.2.2, are excluded from the postvelar class because (having no articulation) they lack postvelar articulation. Emphatics are postvelars because they are partly articulated in the postvelar region of the vocal tract.

This section first details the articulation of gutturals and emphatics, as shown by the articulatory literature. 'Articulation' is used here in a static sense to refer to the position of some articulator, in an overall vocal tract configuration, by which some articulatory constriction is produced. The aim is to identify just how gutturals are wholly articulated, and emphatics partly articulated, in the postvelar region of the vocal tract. The focus will be on data from Arabic[27] since, as noted by Bessell (1992), there are no

[27]On the historical treatment of Arabic gutturals and emphatics, see, e.g., Mattsson (1911), Lehn (1963), Bonnot (1977), Ghazeli (1977), and Card (1983).

articulatory (*viz.*, x-ray, fibreoptic, EMG, etc.) data on Salish. The predicted acoustic effects of guttural and emphatic articulation will then be discussed. The acoustic discussion will be primarily in terms of the model of Stevens and House (1955); the models of Fant (1960) and Lindblom and Sundberg (1971) will also be discussed. The predictions of those models, as applied to postvelar articulations, will provide a means of interpreting the acoustic findings on Palestinian and St'át'imcets to be reported in the next two chapters.

The diagram of the vocal tract in Figure 1:1, which is from Ladefoged (1993:4), will serve as reference for the discussion to follow.

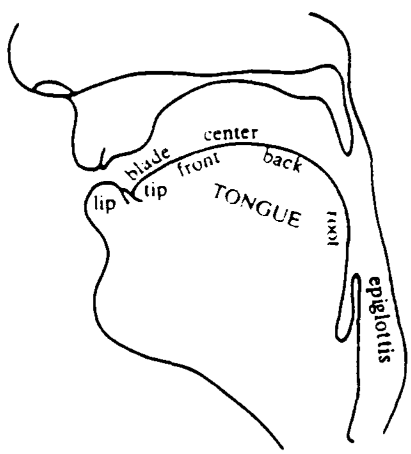


Figure 1:1 Diagram of the vocal tract (from Ladefoged (1993:4))

1.4.1. The Articulation of Gutturals

X-ray data on gutturals from three articulatory studies will be presented below. This excludes data on laryngeals: as noted in §1.3.2.2, there are no articulatory data on laryngeal gutturals.

The first set of data, seen in Figure 1:2, are x-ray tracings of tokens of the pharyngeals /ʕ ħ/ in Modern Standard Arabic as spoken by an Iraqi speaker, from Al-Ani (1970). (Al-Ani provides no tracings of tokens of uvular gutturals. He uses the symbol 'ε' to denote ʕ.) As seen, these tracings do not show the position of the epiglottis nor the very base of the tongue root; these structures are also lacking from Al-Ani's identification template [p.27]. I have added the label 'pharyngeal constriction' to the tracings. In other figures to be presented in this section, I have added the label 'uvular constriction'. These labels will be discussed shortly.

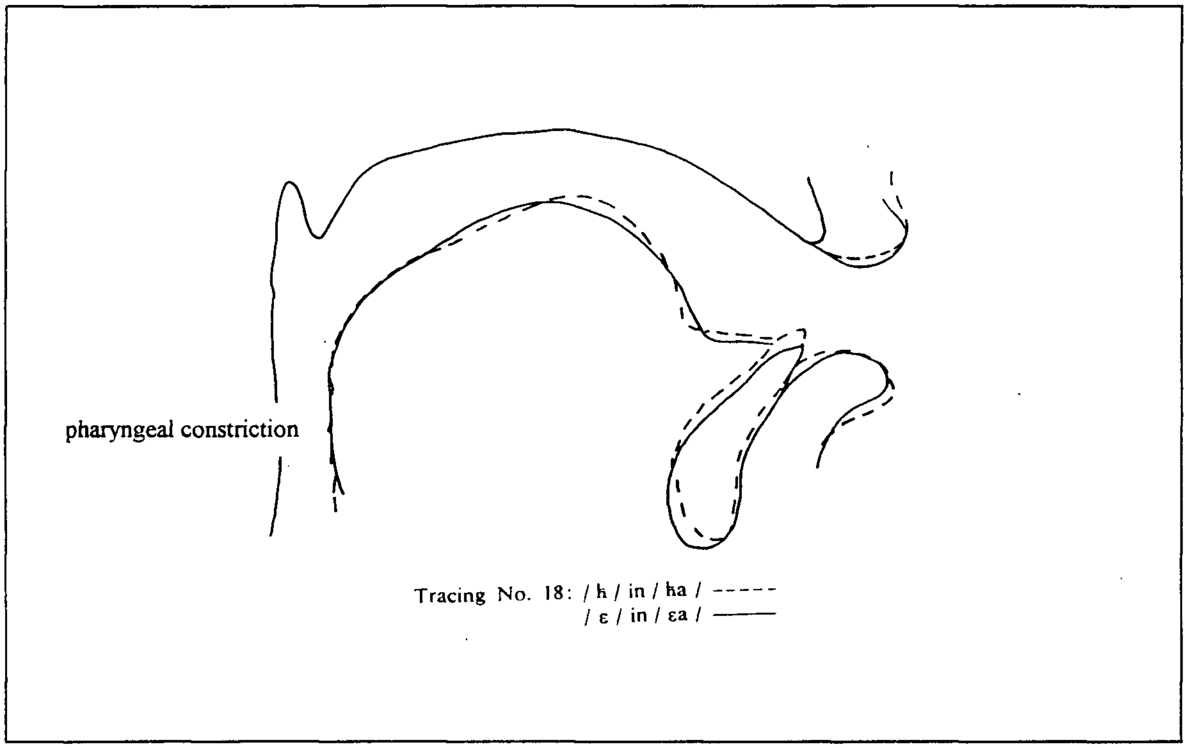


Figure 1:2 X-ray tracings of [ʕ] and [ħ] (from Al-Ani (1970:74))

Figure 1:3 shows sagittal sections based on x-ray tracings of tokens of pharyngeal and uvular gutturals in Lebanese Arabic, from Delattre (1971). (Delattre denotes ħ as 'ḥ', ʁ as 'Ṛ'. In the figure, his shading, which indicates the area of the lower pharyngeal cavity, is retained.)

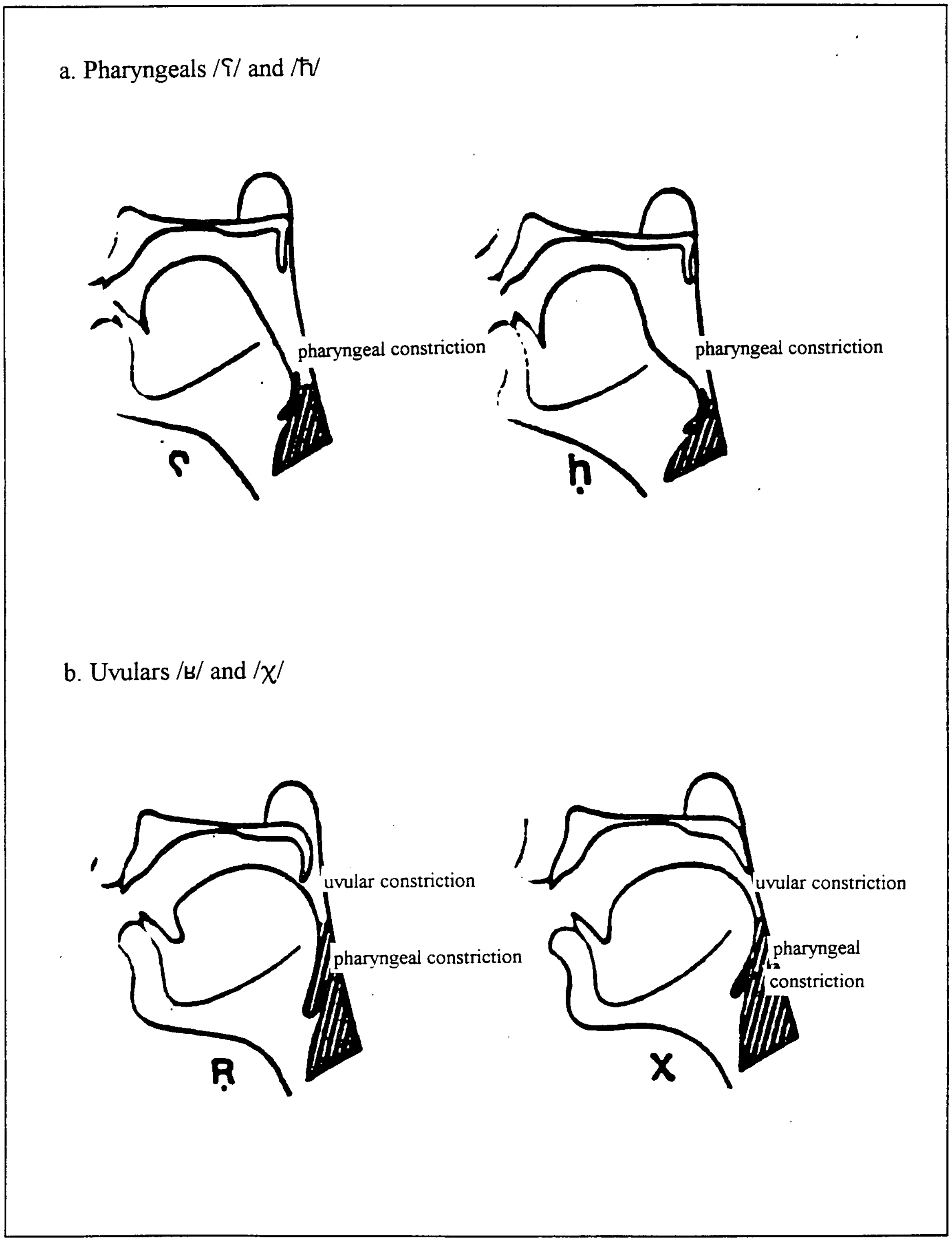
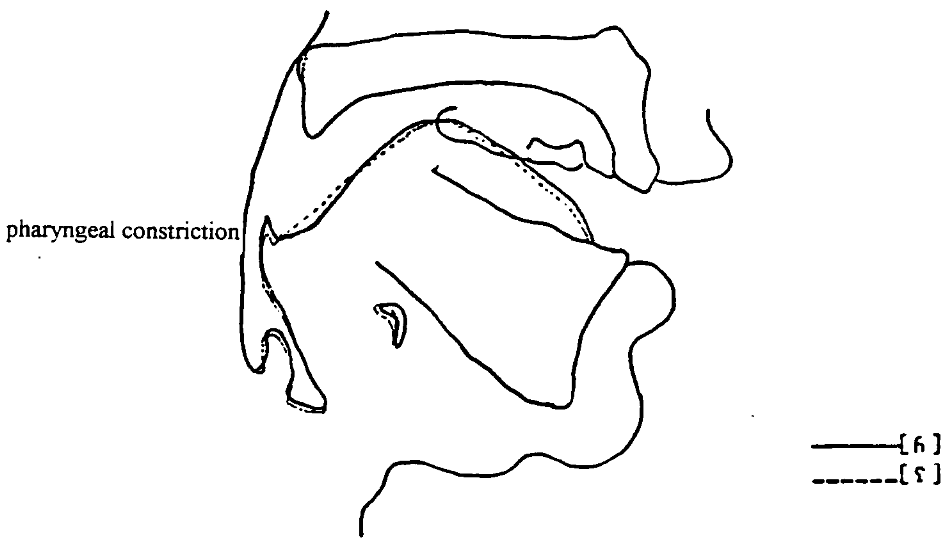


Figure 1:3 Sagittal sections based on x-ray tracings of [ʕ], [ħ], [ʁ], and [χ] (from Delattre (1971:130))

1.4.1. The Articulation of Gutturals

Figure 1:4 shows tracings of tokens of the same four consonants in Tunisian Araabic, from Ghazeli (1977). Ghazeli (1977:30) notes that his subject exhibits a lingual tonsil. The location of the tonsil is seen from Ghazeli's identification template, which is presented in Figure 1:5. (Figure 1:5 will be properly introduced below.) Because of the tonsil, the epiglottis and tongue root are not independent structures for his subject. This means that the position of the tongue root must be inferred in each of Ghazeli's tracings.

a. Pharyngeals /ʕ/ and /ħ/



b. Uvulars /ʁ/ and /χ/

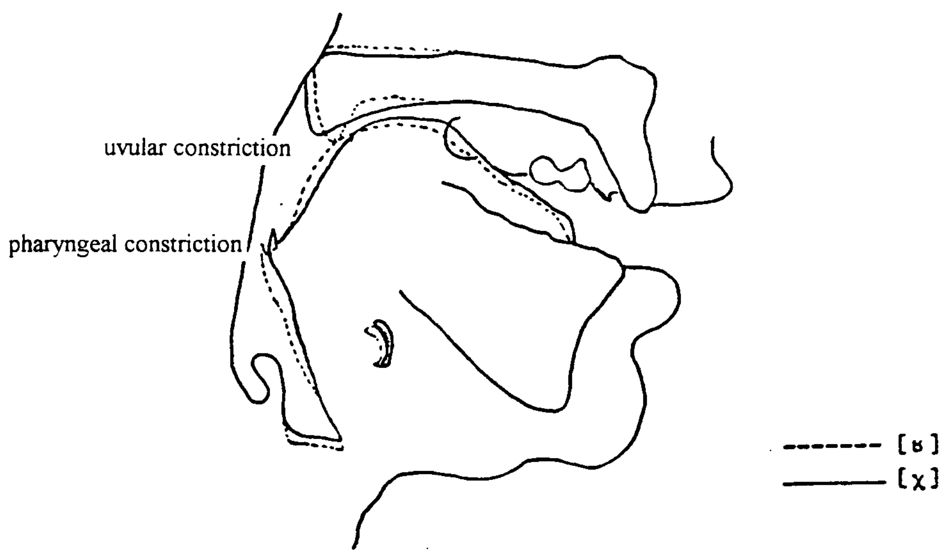


Figure 1:4 X-ray tracings of [ʕ], [ħ], [ʁ], and [χ] (from Ghazeli (1977:40,57))

1.4.1. The Articulation of Gutturals

From Figures 1:2 - 1:4, the articulation of guttural consonants can be identified. To aid in this, Ghazeli's identification template, which he describes [p.29] as showing a "rest position", is presented in Figure 1:5. Compared to this rest position, the tracings in Figures 1:2 - 1:4 indicate (i) tongue root retraction for both the pharyngeal and uvular gutturals and (ii) tongue back retraction for the uvulars. The first articulation produces a constriction between the tongue root and the rear pharyngeal wall in the lower pharynx. The second articulation produces a constriction between the tongue back and the uvula. The labels 'pharyngeal constriction' and 'uvular constriction' added to the tracings in Figures 1:2 - 1:4 identify these constrictions.

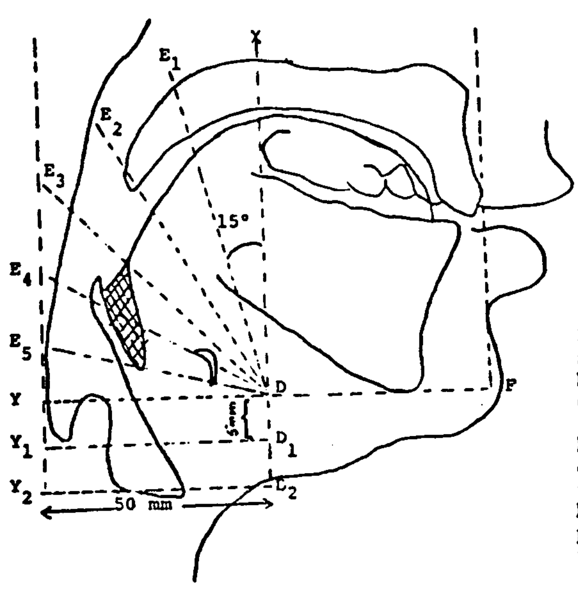


Fig. 2-1.
Diagram of the template used for measurements of the cinefluorograms. Notice that the subject used for this experiment exhibits a lingual tonsil. therefore, there is little space visible between the epiglottis and the root of the tongue. The shaded area anterior to the epiglottis, and which will not be indicated in later tracings, represents a laryngologist's estimate of the location of the lingual tonsil.

Figure 1:5 Ghazeli's (1977:30) identification template showing the position of his subject's tongue at rest

1.4.1. The Articulation of Gutturals

Other structures besides the tongue root and tongue back have been shown to be involved in the production of gutturals. Ladefoged and Maddieson (1996:168-169) find evidence for involvement of the epiglottis in the Al-Ani and Ghazeli tracings, also in Arabic data from Boff-Dkhissi (1983), Bukshaisha (1985), and Laufer (cited as p.c.), and Hebrew data in Laufer and Condax (1981). Ghazeli (1977:37) reports inward displacement of the pharyngeal wall for the pharyngeals. Lee (1995:355-356) reports a low and retracted jaw position for the pharyngeals and uvulars. It is assumed here that epiglottal, pharyngeal wall, and jaw gesture, to the extent that they occur for a given guttural token, co-operate with the tongue, but that gutturals can be defined in terms of two main articulations: tongue root retraction and tongue back retraction. For tokens of Arabic /ʕ ħ/ that might have only epiglottal articulation, such as those described by Ladefoged and Maddieson (1996:169), it is assumed here that the epiglottal articulation of such tokens simply shows the range of phonetic implementation of the phonological specification [TR]/[RTR].

Catford (1983) documents contrasting epiglottals and pharyngeals in Caucasian languages, e.g., epiglottal /ʜ/ vs. pharyngeal /ħ/ in Agul; see also Ladefoged and Maddieson (1996) for discussion. This is evidence that, besides tongue root retraction and tongue back retraction, gutturals can also be defined in terms of epiglottal articulation. The featural basis for a phonological distinction between epiglottals and pharyngeals will not be discussed in this thesis. For discussion of phonetic epiglottalisation of vowels in St'át'imcets, see §3.2.2.

Finally, McCarthy (1994), citing several studies, notes that a raised larynx has been documented for pharyngeal and uvular gutturals, and creaky voice for /ʕ/.[28] With McCarthy (1994:195), it is here assumed that laryngeal involvement in the production of gutturals is a "superficial mechanical effect", where the phrase just quoted is interpreted to mean 'phonetic effect'. This is because, to my knowledge, there are no phonological phenomena involving gutturals that require reference to some feature representing larynx height or laryngeal gesture. (This excludes glottalised gutturals such as /ʁ' ʁ'ʷ/ in St'át'imcets Salish, for which the laryngeal gesture is due to their phonemic contrast with non-glottalised /ʁ ʁʷ/; see §3.2.1.)

The articulation of pharyngeal and uvular gutturals will now be more closely defined. To enable this, a distinction between primary and secondary articulation will first be drawn, based on the assumption in (23) and the criteria in (24).

(23) A segment has a maximum of one primary articulation (Anderson (1976), Selkirk (1993)).

[28]On this laryngeal involvement, McCarthy (1994) cites Delattre (1971), Ladefoged (1975), Ghazeli (1977), Laufer and Condax (1979), Sasse (1979), Hayward (1989), and Hayward and Hayward (1989).

1.4.1. The Articulation of Gutturals

(24) a. Primary Articulation:

the only articulation (Selkirk 1993:7) or

the articulation with the tightest constriction (Selkirk 1993) at at which the stricture features of the segment are realised (Sagey 1986).

b. Secondary Articulation:

the articulation made by two organs of speech that are not involved in the primary articulation (Ladefoged (1993:296)).

A procedure for determining the 'tightest constriction' will now be outlined. 'Tightest constriction', for a given vocal tract configuration, is defined here as the point along the vocal tract with the smallest cross-sectional area. However, no radius of constriction from which the cross-sectional area at a specific point can be determined, is apparent from an x-ray tracing because an x-ray tracing shows only the midsagittal plane. From the two dimensions of an x-ray tracing, the tightest constriction can only be guessed. Additional information regarding the cross-sectional area function of the vocal tract is required for an exact determination. In the absence of such information, it can be "guesstimated" from a tracing as the point along the vocal tract at which the upper and lower vocal tract surfaces connect, otherwise as the point at which they are closest together. (For the upper surface, the connection will be at some point along the inferior edge of the upper lip, upper incisors, alveolar ridge, soft palate, velum, uvula, or along the pharyngeal wall. For the lower surface, the connection will be at some point along the superior edge of the lower lip, lower incisors, tongue tip, tongue blade, tongue dorsum, tongue back, tongue root, or epiglottis.) The points just described can usually be identified by eyeballing the tracing.

The assumption that the primary articulation is the one with the tightest constriction results in problematic cases like Ngbaka /k͡p/. Treatment of such cases will not be undertaken here; see Selkirk (1993:7) and Halle (1995:8) for further discussion.

Based on (23) and (24) and on the procedure for identifying the tightest constriction shown by an x-ray tracing, described above, the data in Figures 1:2 - 1:4 show that [ʕ ħ] have primary pharyngeal articulation. Their pharyngeal articulation is primary because it is their only articulation. Because the tightest constriction for [ʁ χ] is at the uvula, and their frication is achieved at the uvular constriction, [ʁ χ] have primary uvular articulation. They also have secondary pharyngeal articulation, which will here be referred to as 'pharyngealisation'. (The suffix '-isation' encodes the secondary nature of the articulation.) Primary uvular articulation and pharyngealisation are ascribed to [ʁ χ] also by Trigo (1991:122).

Since neither pharyngeal(-isation) or uvular articulation produces a constriction between the velum and the lips, gutturals are wholly articulated in the postvelar region of the vocal tract.

As a final point, the articulatory data examined in this section indicate that uvular articulation does not occur without pharyngealisation. (See also Bothorel et al. (1986) for x-ray tracings showing uvular articulation with pharyngealisation for French /ʀ/.) The pharyngealisation of uvular segments is considered here to be an automatic consequence of the primary uvular articulation. In the terminology of Fujimura (1990), it is a 'resultant' gesture of the uvular 'control' gesture. This is assumed to follow from the anatomical proximity of the tongue back and root.

1.4.2. The Articulation of Emphatics

In this section, x-ray tracings of emphatic consonants from three sources will be presented. A first tracing, from Al-Ani (1970), is seen in Figure 1:6. This figure shows a token of emphatic /ṭ/ and a token of non-emphatic /t/. (Al-Ani denotes emphatic ṭ as 't̲'. He notes [p.21] that his emphatic data were provided by both Iraqi and Jordanian consultants.)

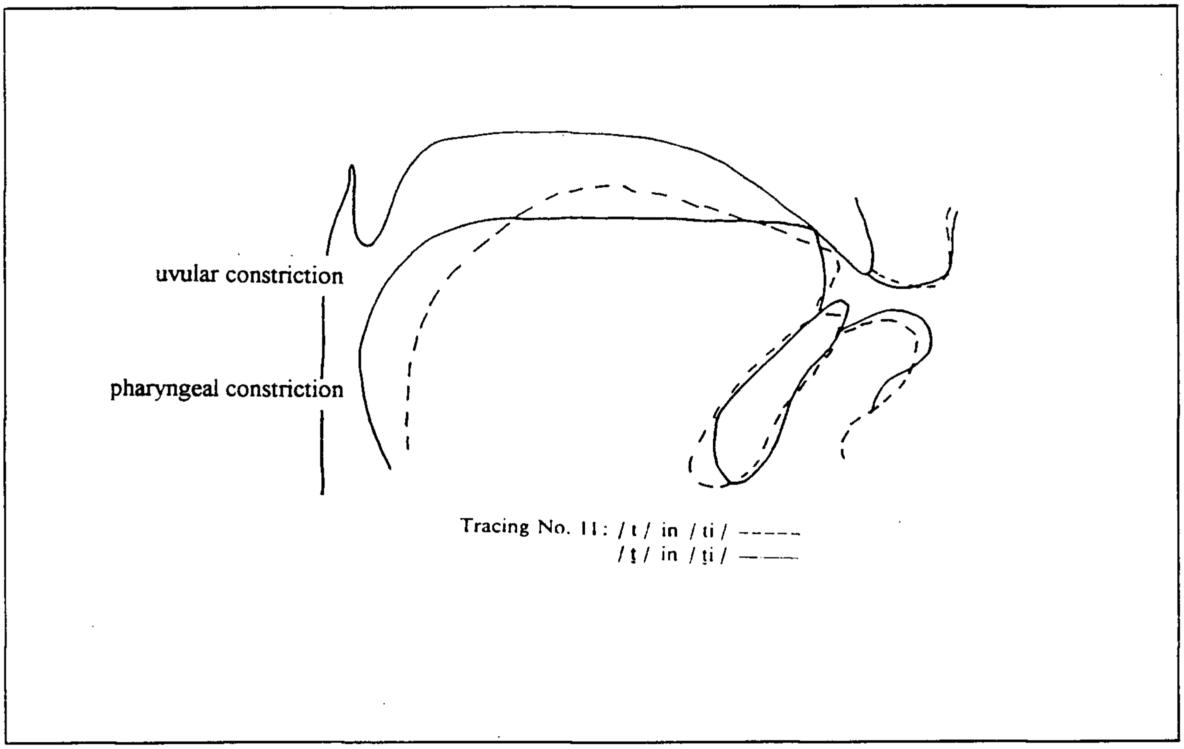


Figure 1:6 X-ray tracings of [t̡] and [t] (from Al-Ani 1970:57)

Figure 1:7 shows a tracing of a token of emphatic /t̡/ in Classical Arabic as spoken by a Saudi speaker, from Bonnot (1977). (Bonnot denotes emphatic t̡ as 'ṭ'.) The figure also shows a tracing of a token of non-emphatic /t/.

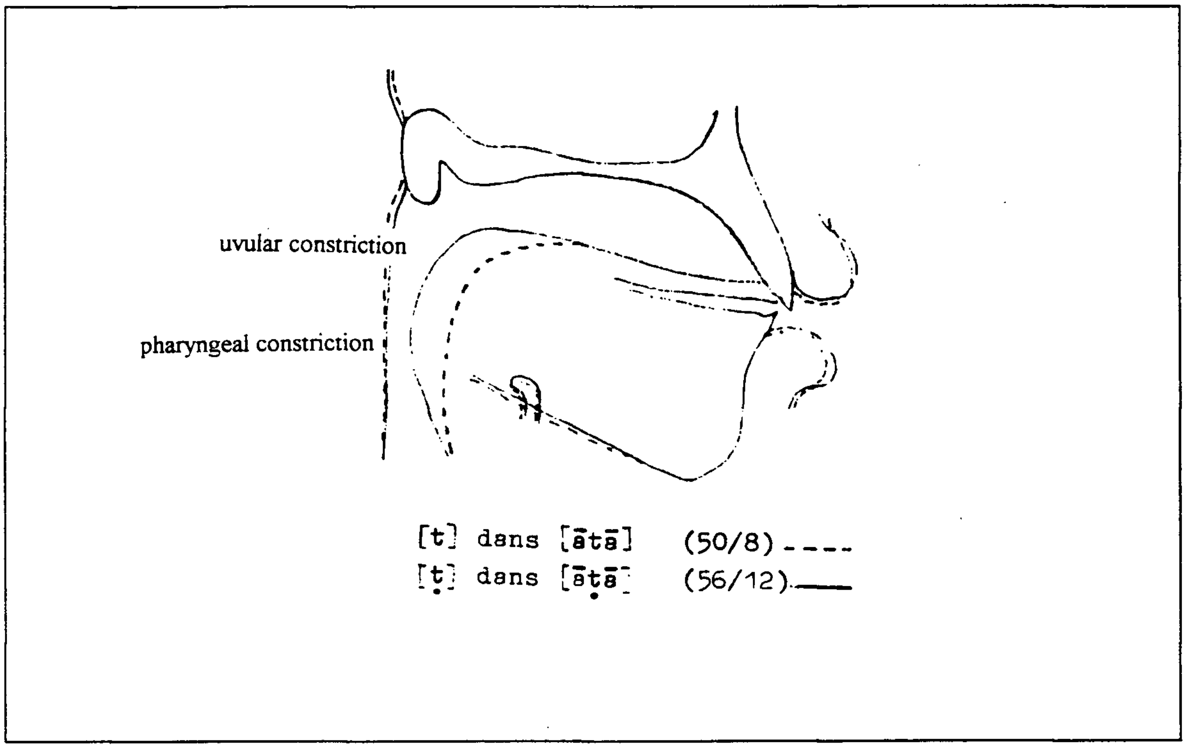
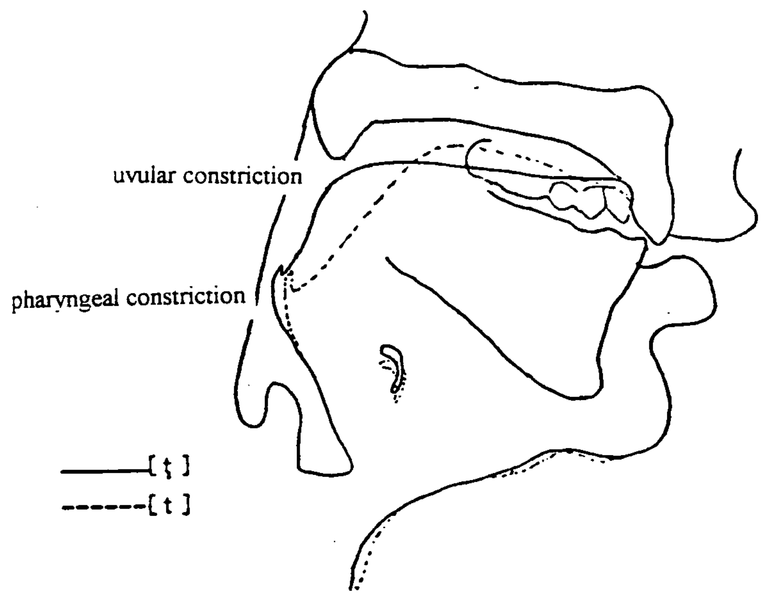


Figure 1:7 X-ray tracings of [ṭ] and [t] (from Bonnot (1977:85))

Further tracings, from Ghazeli (1977), are presented in Figure 1:8: a token of emphatic /ṭ/ is seen alongside a token of non-emphatic /t/ in (a), a token of emphatic /ṣ/ alongside a token of non-emphatic /s/ in (b). (Ghazeli denotes emphatic ṭ and ṣ as ‘ṭ’ and ‘ṣ’, respectively.)

1.4.2. The Articulation of Emphatics

a. Emphatic /ṭ/



b. Emphatic /ṣ/

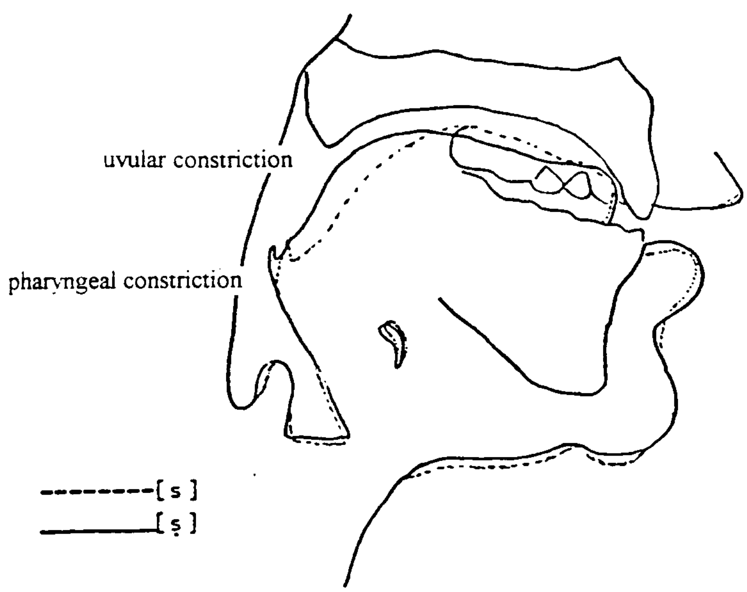


Figure 1:8 X-ray tracings of [ṭ], [t], [ṣ] and [s] (from Ghazeli (1977:69,70))

1.4.2. The Articulation of Emphatics

The tracings in Figures 1:6 - 1:8 show that emphatics are produced with (i) a non-postvelar articulation, (ii) tongue back retraction, and (iii) tongue root retraction. Articulation (i) produces a constriction between the velum and the lips; (ii) produces a constriction between the tongue back and the uvula; (iii) produces a constriction between the tongue root and the rear pharyngeal wall in the lower pharynx. I have added labels to the tracings in Figures 1:6 - 1:8 to identify the constrictions resulting from articulations (ii) and (iii). Emphatic /ḳ/, however, is produced with only articulations (ii) and (iii). The exceptional articulation of /ḳ/ will be discussed shortly.

Articulation (i) is uncontroversial. The non-postvelar articulation identifies the emphatic as the emphatic counterpart of some non-emphatic segment (e.g., /ṭ/, emphatic counterpart of /t/, etc.). As seen from segments like /ð̣ ṣ ṛ ḳ/, the non-postvelar articulation produces a constriction which varies both in place and manner.

Emphatics differ from their non-emphatic counterparts by having the postvelar articulations (ii) and (iii). Both these articulations have been identified in previous studies. Articulation (ii) is described by Herzallah (1990:2), who states that emphatic articulation involves "the back of the tongue body". Similarily, Ghazeli (1977:72) refers to "rearward movement of the back of the tongue". Younes (1982:216) describes emphasis as "a secondary articulation involving the back of the tongue". In earlier studies, this articulation was labelled 'velarisation' (see, e.g., Obrecht 1968) or described as similar to velarisation (see Lehn 1963:20). But it is identified more precisely as uvularisation by Dolgopolsky (1977:1), who states: "In Arabic, the 'emphatics' are pronounced as uvularized consonants. Uvularization is the modification of consonants or vowels by moving back the rear part of the tongue towards the uvula and the back wall of the pharynx." In a footnote on the same page, he continues: "I prefer to call it 'uvularization' and not 'velarization' (which is obviously wrong, because even the velar *k*, when emphasized, becomes uvular)." Articulation (ii) is identified as uvularisation also by Czaykowska-Higgins (1987:2), who uses 'emphatic' and 'uvularised' synonymously, and by McCarthy (1994:219), who states: "The so-called pharyngealized consonants of Arabic should really be called uvularized."

Previous studies have also identified articulation (iii). E.g., Obrecht (1968:20) refers to emphatics as "velarized or pharyngealized"; Al-Ani (1970) refers to them as 'pharyngealised'. Lehn (1963:31) lists "faucal and pharyngeal constriction (pharyngealization)" as an articulatory feature of emphatics, distinct from their 'velarisation'. Neither Obrecht nor Lehn explicitly refer to the tongue root. However, the tongue root is explicitly identified as an articulator for emphatics by Ali and Daniloff (1972:98), who state, "the tongue dorsum and/or tongue root... is the primary articulator for emphatic sound production", and by Woldu (1981:117), who descries emphatic production as involving "retracting of the tongue root towards the pharyngeal wall". This tongue root retraction is supported by the EMG findings of Kuriyagawa et al. (1986), who report no posterior genioglossus (GGP) activity for Jordanian Arabic /ṣ/ and /ṭ/, but GGP activity for non-emphatic /s/ and /t/. They interpret this [p.25] as showing that "activity of the

GGP is supressed when the retraction of the tongue occurs and the root of tongue [sic] is brought back toward the wall of the pharynx."

Emphatic /ḳ/ differs from all other emphatic in that it is produced with only tongue back retraction and tongue root retraction. It lacks non-postvelar articulation. A sagittal section showing this, from Delattre (1971), is seen in Figure 1:9. (Delattre denotes this segment as 'q'.)

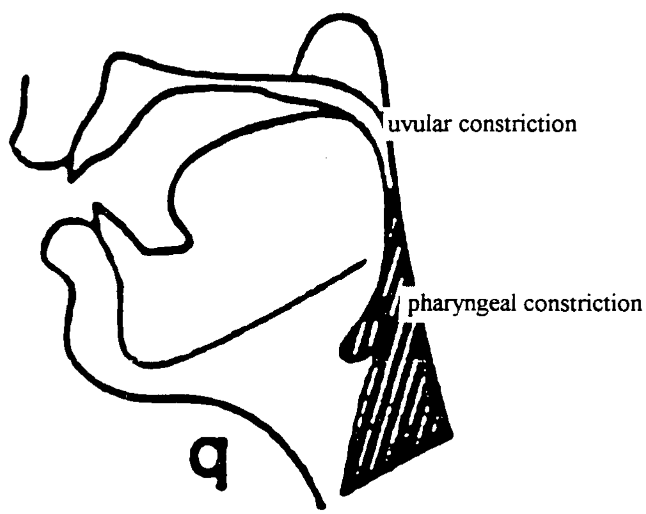


Figure 1:9 Sagittal section based on an x-ray tracing of [ḳ] (from Delattre 1971:130)

1.4.2. The Articulation of Emphatics

There are two points of view on this uvular stop. The first considers it to be an emphatic /ḳ/, the emphatic counterpart of non-emphatic velar /k/.[29] The second considers it to be simply a uvular stop, that is, not an emphatic /ḳ/.[30] In studies with the first opinion, the segment under discussion is usually usually denoted as 'q' (It is denoted as 'q' in studies with the second opinion.) In the present study, following Harrell (1957), it is denoted as 'ḳ' in order to be explicit that, for Palestinian Arabic, it is analysed as an emphatic, the emphatic counterpart of non-emphatic /k/.

The primary argument for considering the uvular stop to be simply a uvular stop is that it has no non-postvelar articulation; see discussion in Alioua (1993). However, after Dolgopolsky (1977:1) it is assumed here that, for Palestinian Arabic, the segment lacks non-postvelar articulation because its velar and uvular articulations are phonetically realised together to produce a single uvular articulation. That is, its articulations (i) and (ii) are phonetically fused.

The main argument for recognising the uvular stop as emphatic /ḳ/ in Palestinian Arabic is its phonological behaviour. In Palestinian, this segment functions phonologically as an emphatic: it patterns with the other emphatics in triggering uvularisation harmony, a.k.a 'emphasis harmony'. This will be shown in chapter 2. However, crosslinguistic evidence indicates that the uvular stop is not an emphatic in all Arabic dialects: Ghazeli

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[29]See, e.g., Harrell (1957), Lehn (1963), Trubetzkoy (1969), Delattre (1971), Dolgopolsky (1977), and Jakobson (1978).

[30]For the second point of view, see, e.g., Bonnot (1977), Ghazeli (1977), Giannini and Pettorino (1982), and Alioua (1993).

(1977:59-65) presents data which support recognising the uvular stop as non-emphatic in Tunisian Arabic.

Previous studies have also mentioned involvement of the lips in the production of non-velar emphatics, for either protrusion or rounding; see Mitchell (1960), Lehn (1963), and Uldall (1992). This labialisation receives partial support from the EMG study of Kurijagawa et al. (1986:27), who report orbicular oris activity for activity for /ð̣/, but not for /ṣ/. Lee (1995:356) reports a retracted and lowered jaw position for the uvular stop. A higher degree of muscular tension in the mouth and throat has been mentioned for emphatics (see Lehn (1963), Bonnot (1977)), although Woldu (1981:116) observes that there is no EMG data to support this. Finally, Ghazeli (1977:73) notes a raised larynx for /ṣ/ but not for the other emphatics. He ascribes the raised larynx of /ṣ/ to its oral cavity articulation because he found a raised larynx also for non-emphatic /s/, a finding consistent with those of Perkell (1969).

After Ali and Daniloff (1972), emphatic articulation is here ascribed primarily to the tongue. The foregoing discussion indicates that emphatics can be defined in terms of two main articulations (besides their non-postvelar articulation): tongue back retraction and tongue root retraction. The additional articulatory properties discussed above, to the extent that they might characterise a given emphatic token, are assumed only to co-operated with the tongue in the production of emphatics.

The articulation of emphatics is more closely defined as follows: based on (23) and (24), the data in Figures 1:6 - 1:8 show that the non-postvelar articulation of emphatics is their primary articulation. This is because it produces the tightest constriction and is the constriction at which the segment's stricture features are realised. The uvular and pharyngeal articulations are both secondary. Emphatics, thus, are uvularised and pharyngealised. Although emphatics have non-postvelar articulation, they qualify as postvelars because they are partly articulated in the postvelar region of the vocal tract.

The exception to this is /ḳ/. The data in Figure 1:9 indicate that /ḳ/ has no non-postvelar articulation but is produced with primary uvular articulation and pharyngealisation. This was explained above as due to the fact that its primary velar and uvularisation articulations are phonetically fused, yielding a phonetically primary uvular articulation.

1.4.3. Postvelar Acoustics

The aim of this section is to identify the expected acoustic effects of primary pharyngeal and uvular articulation, and pharyngealisation and uvularisation, as identified by the articulation-to-acoustics model of Stevens and House (1955). Similar models by Fant (1960) and by Lindblom and Sundberg (1971) will also be discussed.

All three models view the vocal tract as a sequence of cylindrical tubes of unit length, excited by an acoustic source at one end and open at the other. The variable cross-sectional area of the tract is small enough for assuming plane wave propagation. Stevens and House proposed that the resonances of such a model can be predicted if the values of three parameters are known. The parameters are (i) the radius r_0 of the tube at the point of the narrowest constriction, (ii) the distance d of the narrowest constriction from the glottis, and (iii) the ratio A/l of the cross-sectional area of the front tube of the vocal tract divided by its length. The value for r_0 corresponds to the cross-sectional area at the constriction in the manner schematised in Figure 1:10. The front tube of the vocal tract is that portion in front of the teeth, for which the cross-sectional area is controlled primarily by the lips and the mandible.

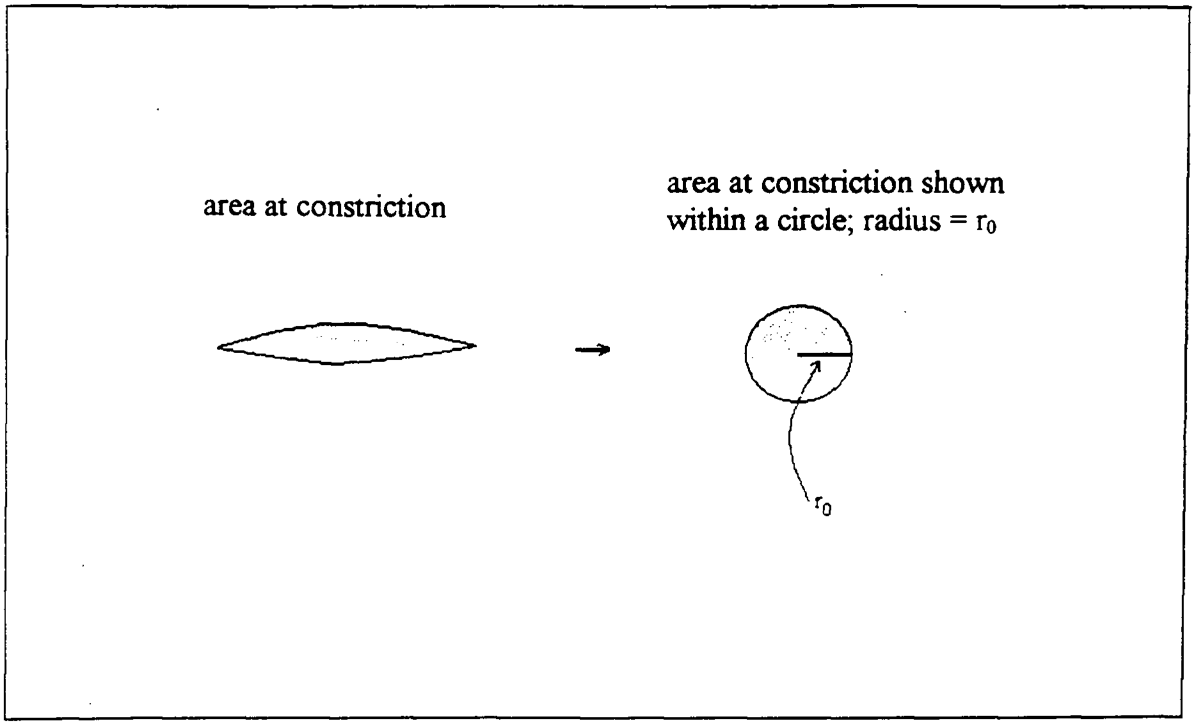

Figure 1:10 Conversion of area at constriction to area within a circle

Stevens and House varied the values of the three parameters between 0.3 and 1.2 cm for r_0, between 4 and 13 cm for d, and between 0.1 and 20 cm for A/ℓ,[31] thus corresponding to 306 distinct configurations. Their schematisation [p.486] of the vocal tract configuration for four sets of values of r_0, d, and A/ℓ is presented in Figure 1:11. I have added on the right transcriptions of the sounds, all of them vowels, which the configurations in the figure would produce.

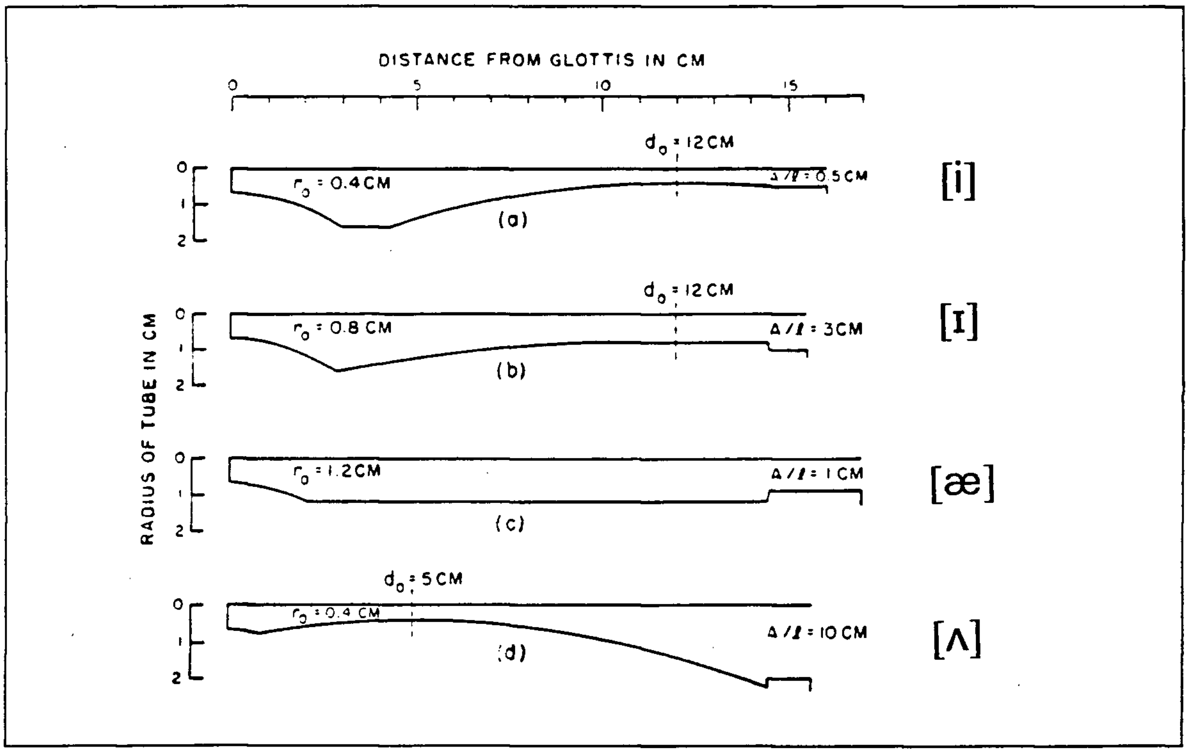

Figure 1:11 Schematisation of vocal tract configurations for four sets of values of r_0, d, and A/ℓ (from Stevens and House 1955:486)

[31]See Stevens and House (1955) for justification of these values and further explication of the model and its calculations.

1.4.3. Postvelar Acoustics

Stevens and House implemented their model using an electrical analog, i.e., each tube element was represented by its analog electrical circuit. Each one of the 306 vocal tract configurations yielded a spectrum from which three formant frequencies were obtained and plotted in several ways, as a function of the three articulatory parameters, r_0, d, A/ℓ. They found the output signal obtained from their model to match the expected output, both acoustically and perceptually.

The model of Fant (1960) predicts the resonances of the vocal tract from values of parameters similar to those of Stevens and House. By result, the two models are very similar. Lindblom and Sundberg's (1971) model predicts the resonances of the vocal tract from five parameters: state of the lip muscles, position of the jaw, shape of the tongue body, position of the tongue body, and larynx height. Since a change in tongue body shape and/or in jaw position results in a change in degree of constriction and a change in degree of constriction results in a change in r_0, their model ultimately considers the effect of a change in r_0. The acoustic predictions of the Fant (1960) and Lindblom and Sundberg (1971) models are in general agreement with the predictions to be identified in this section based on the model of Stevens and House (1955).

It is important to note that the Stevens and House (1955) model, and the other two models, consider only vocal tract configurations with a single constriction. They do not consider configurations with a second constriction. Additional constrictions are of interest here because some postvelars are presumed to be produced with simultaneous primary and secondary articulations, resulting in two constrictions in the vocal tract; see

Figures 1:3 - 1:4 and Figures 1:6 - 1:8. A means of circumventing this limitation will be suggested below. But first, the Stevens and House model will be applied to primary postvelar articulations.

The values in Table 1:1 will be assumed for r_o, d, and A/ℓ for vocal tract configurations with primary pharyngeal and uvular articulations.

Table 1:1

Values of r_o, d, and A/ℓ for vocal tract configurations with primary pharyngeal and uvular articulations

Articulation	r_o (cm)	d (cm)	A/ℓ (cm)
primary pharyngeal	0.4	4	7
primary uvular	0.3	7	7

The r_0 values in Table 1:1 are estimates based on the x-ray tracings of gutturals in Figures 1:3 - 1:4. Those tracings indicate that r_0 is smaller for a primary uvular constriction than for a primary pharyngeal constriction.

It is assumed that a range of 3 - 7 cm defines d for postvelar articulations. This range is assumed by Klatt and Stevens (1969) for the constriction sites of pharyngeal and uvular gutturals. A 3 - 7 cm range is also indicated by Ghazeli's (1977) x-ray template, presented earlier in Figure 1:5 and again in Figure 1:12. I have added cm measurements to the template, assuming a vocal tract length of 17 cm. Based on Figure 1:12, d = 4 for a pharyngeal constriction and d = 7 for a uvular constriction.

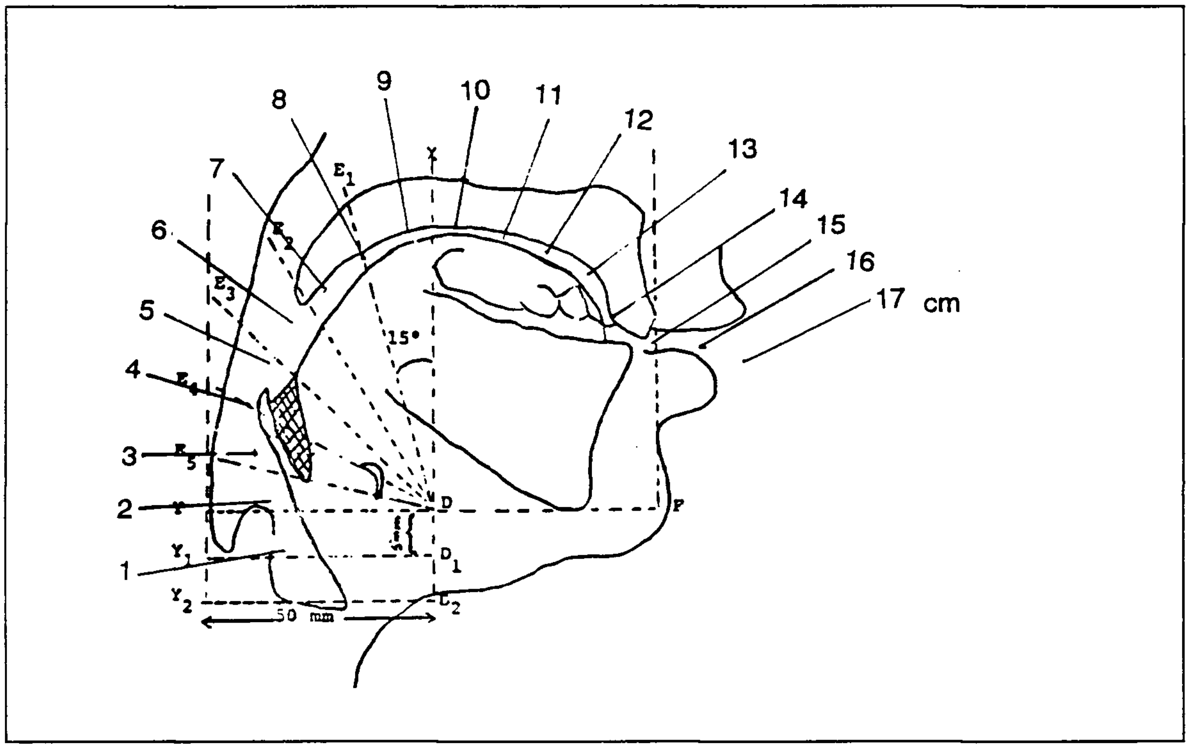

Figure 1:12 Ghazeli's (1977) identification template with cm measurements

The A/ℓ values in Table 1:1 are estimates based on the articulatory findings pertaining to the cases of retracted and lowered jaw position for gutturals, as discussed in §1.4.1.

The resonances predicted by the Stevens and House model for the vocal tract configurations defined by the values in Table 1:1 will now be discussed. The predicted resonances are given in Fig. 3 of their paper. Their Fig. 3 presents six graphs in which formant frequency is plotted vs. d for different A/ℓ; r_0 is held constant. These graphs can be thought of as a stack of graphs, each horizontal layer corresponding to the graph of a given r_0 value. Figures 1:13 - 1:17 are derived from that Fig. 3 (*ibid.*) and correspond to vertical slices in the stack at specific values of d, the abscissa in the six graphs of the stack.

In the figures presented here, the ordinate represents formant frequency (in Hz) and the abscissa the radius r_0 (in cm) at the constriction point.

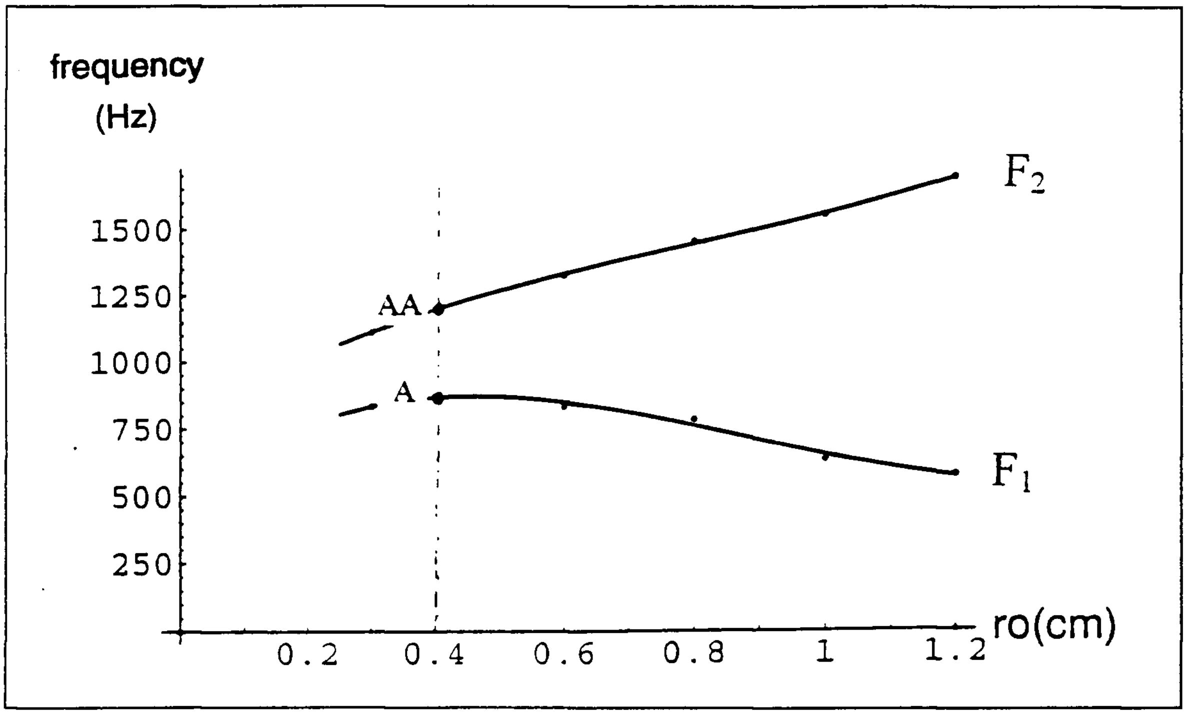

Figure 1:13 F_1 and F_2 predicted by Stevens and House (1955) for vocal tracts of d = 4, $A/\ell = 6.7$, and varying r_0 (points for primary pharyngeal articulation plotted)

Figure 1:13 shows formant frequency vs. r_0 for primary pharyngeal articulation, i.e., d = 4, A/ℓ = 7.[32] Figure 1:14 shows formant frequency vs. r_0 for primary uvular articulation, i.e., d = 7, A/ℓ = 7. Each of figures 1:13 - 1:14 shows two curved lines, the bottom one for F_1, the top one for F_2.[33] Along dashed vertical lines in Figure 1:13, point

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[32]Fig. 3 of Stevens and House (1955) does not provide data for configurations of A/ℓ = 7 cm. Figures 1:13 and 1:4 show the data for their A/ℓ value closest to 7 cm.

[33]The curves in Figures 1:13 - 1:14 (and Figures 1:15 - 1:17) are fitted. As seen, each curve fits closely with the points along it.

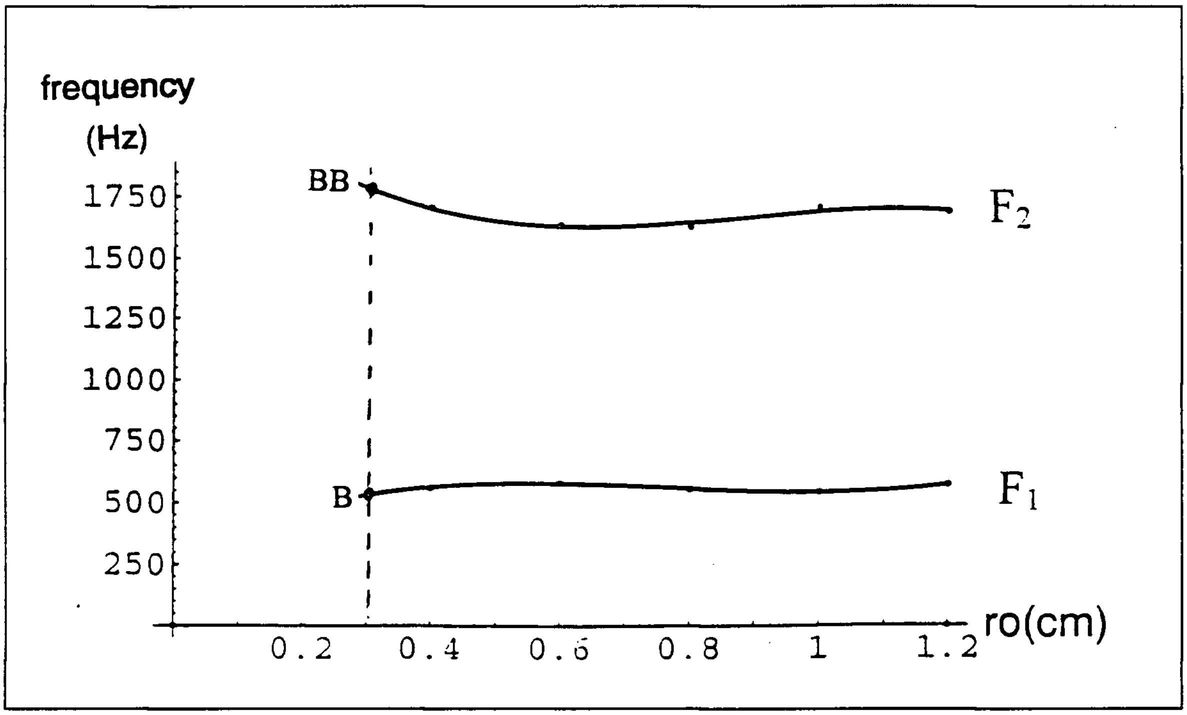

Figure 1:14 F_1 and F_2 predicted by Stevens and House (1955) for vocal tracts of d = 7, $A/l = 6.7$, and varying r_0 (points for primary uvular articulation plotted)

A marks F_1 and AA marks F_2 for primary pharyngeal articulation. In Figure 1:14, point B marks F_1 and BB marks F_2 for primary uvular articulation.

Given the degree of approximation reflected by the values in Table 1:1, precise acoustic predictions will be avoided here. Rather, the general F_1 and F_2 effects predicted for the two primary articulations under discussion will be identified. The effects are summarised in Table 1:2.

Table 1:2

Predicted acoustic effects of primary pharyngeal and uvular articulations

Articulation		F_1		F_2
primary pharyngeal	A	high	AA	low
primary uvular	B	medium	BB	medium

The descriptions of F_1 and F_2 as 'high' and 'medium' above are based on comparison of the frequency at each point A(A) and B(B) in Figures 1:13 - 1:14 with the F_1 and F_2 ranges predicted by the Stevens and House model, over all r_0, d, and A/ℓ. Those ranges, delimited by their maxima and minima, are given in Table 1:3.

Table 1:3

F_1 and F_2 ranges predicted over all r_0, d, and A/ℓ by the model of Stevens and House (1955)

F_1 (Hz)		F_2 (Hz)	
min	max	min	max
200	950	700	2500

Peterson and Barney (1952) studied the formant frequencies of English vowels produced by 76 speakers of which 33 were adult males, 28 adult females, and 15 children of unspecified age. The ranges in Table 1:3 closely match the ranges of F_1 and F_2 found by Peterson and Barney for their 33 male speakers, as shown in Table 1:4.

Table 1:4

F_1 and F_2 ranges of Peterson and Barney data

	F_1 (Hz)		F_2 (Hz)	
	min	max	min	max
ranges of Peterson and Barney (1952) average values	270	730	840	2290
ranges of Peterson and Barney individual values[34]	190	840	650	2700

Based on Table 1:3, F_1 ranges between 200 and 950 Hz. F_2 ranges between 700 and 2500 Hz. Dividing each of these ranges by 3 gives the sub-ranges seen in Table 1:5. The acoustic effects identified in Table 1:2 refer to the ranges in Table 1:5.

Table 1:5

Low, medium, and high ranges for F_1 and F_2

	F_1 (Hz)	F_2 (Hz)
low	200 - 450	700 - 1300
medium	450 - 700	1300 - 1900
high	700 - 950	1900 - 2500

Finally, the articulatory data discussed in §1.4.2 indicate that velar emphatics, like uvular gutturals, are produced with primary uvular articulation. The acoustic effects identified for primary uvular articulation in Table 1:2 thus apply to both uvular gutturals and velar emphatics.

[34]The individual value ranges in Table 1:4 were obtained from Peterson and Barney's raw data, which are not available in their paper, but are available on the Internet.

1.4.3. Postvelar Acoustics

The expected acoustic effects of secondary postvelar articulations will now be addressed. The x-ray tracings in Figures 1:3 - 1:4 and Figures 1:6 - 1:8 indicate that uvular gutturals and emphatics are produced with the secondary postvelar articulations listed in Table 1:6.

Table 1:6

Secondary postvelar articulations of uvular gutturals and emphatics

Segment	Secondary Postvelar Articulation(s)
uvular gutturals	pharyngealisation
velar emphatics	pharyngealisation
non-velar emphatics	uvularisation, pharyngealisation

The values in Table 1:7 will be assumed for r_o, d, and A/l for vocal tract configurations with secondary pharyngeal and uvular articulations. As seen, two vocal tracts are defined for pharyngealisation. The first has a large A/l,, i.e., no rounding, and is appropriate for uvular gutturals and velar emphatics. The second one has a small A/l, i.e., rounding, and is appropriate for non-velar emphatics. This will be explained shortly. The two vocal tract configurations for pharyngealisation are distinguished because the F_1 and F_2 effects predicted for pharyngealisation potentially vary depending on the value of A/l.

Table 1:7

Values of r_o, d, and A/ℓ for vocal tract configurations with pharyngealisation and uvularisation articulations

Articulation	r_o (cm)	d (cm)	A/ℓ (cm)
pharyngealisation (appropriate for uvular gutturals and velar emphatics)	0.6	4	7
pharyngealisation (appropriate for non-velar emphatics)	0.6	4	2
uvularisation	0.6	7	2

The r_0 values in Table 1:7 are estimates based on the x-ray tracings in Figures 1:3 - 1:4 and Figures 1:6 - 1:9, which indicate: r_0 is larger for secondary pharyngeal and uvular articulations than it is for the corresponding primary articulations; the secondary vs. primary difference is greater for uvular constrictions than it is for pharyngeal constrictions. The values for d for pharyngeal and uvular articulation, and the large A/ℓ for uvular gutturals and velar emphatics, were explained earlier. The smaller A/ℓ for non-velar emphatics reflects their lip protrusion and/or rounding.

A dynamic view of pharyngealisation and uvularisation is assumed, that is, these secondary articulations result from a decrease in r_0 from 1.2 (reflecting no constriction) to 0.6. This corresponds to the change in r_0 at d = 4 (for pharyngealisation) and d = 7 (for uvularisation) for $A/\ell = 7$ (for uvular gutturals and velar emphatics) and $A/\ell = 2$ (for non-velar emphatics), which occurs when a secondary pharyngeal or uvular gesture is added to a segment. In this manner, the Stevens and House model, which considers only vocal tract configurations with a single constriction, is here applied heuristically to configurations with a second constriction. The relevant data derived from Stevens and House (1955:487 Fig.3) are presented in Figures 1:15 - 1:17.[35]

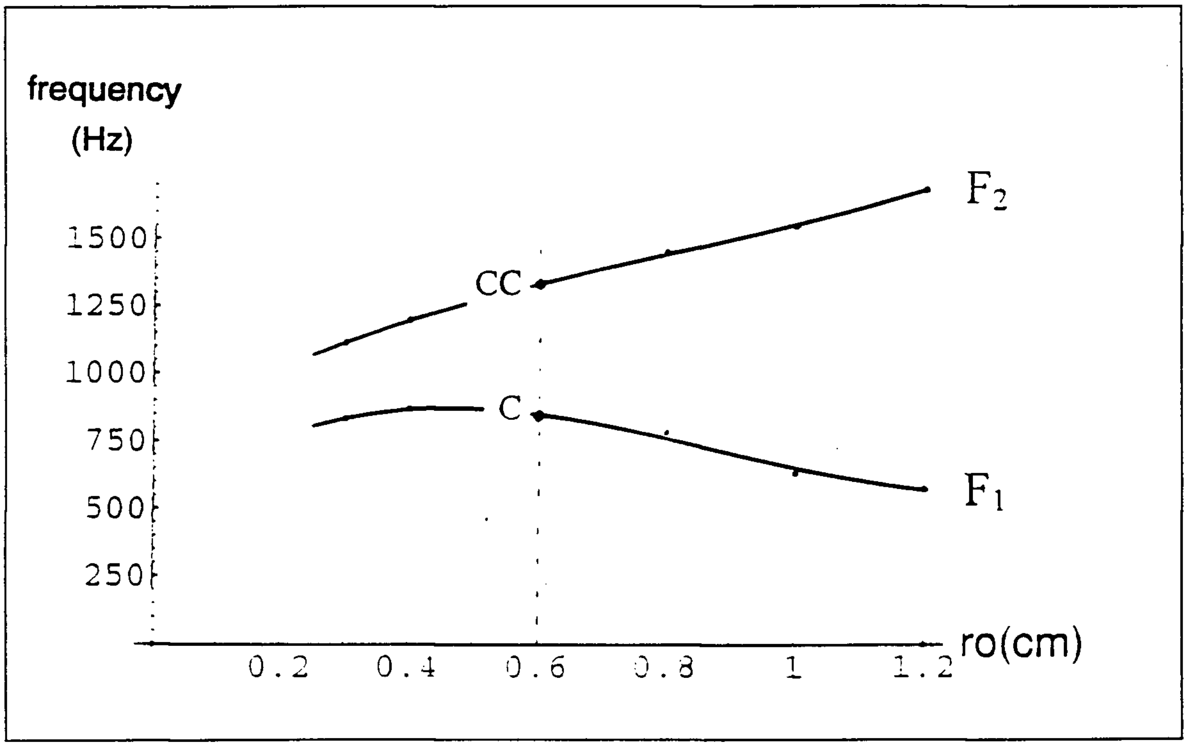

Figure 1:15 F_1 and F_2 predicted by Stevens and House (1955) for vocal tracts of d = 4, $A/\ell = 6.7$, and varying r_0 (points for pharyngealisation plotted)

[35]Figures 1:16 - 1:17 show the data from Stevens and House (1955:487) for their A/ℓ value closest to 2 cm.

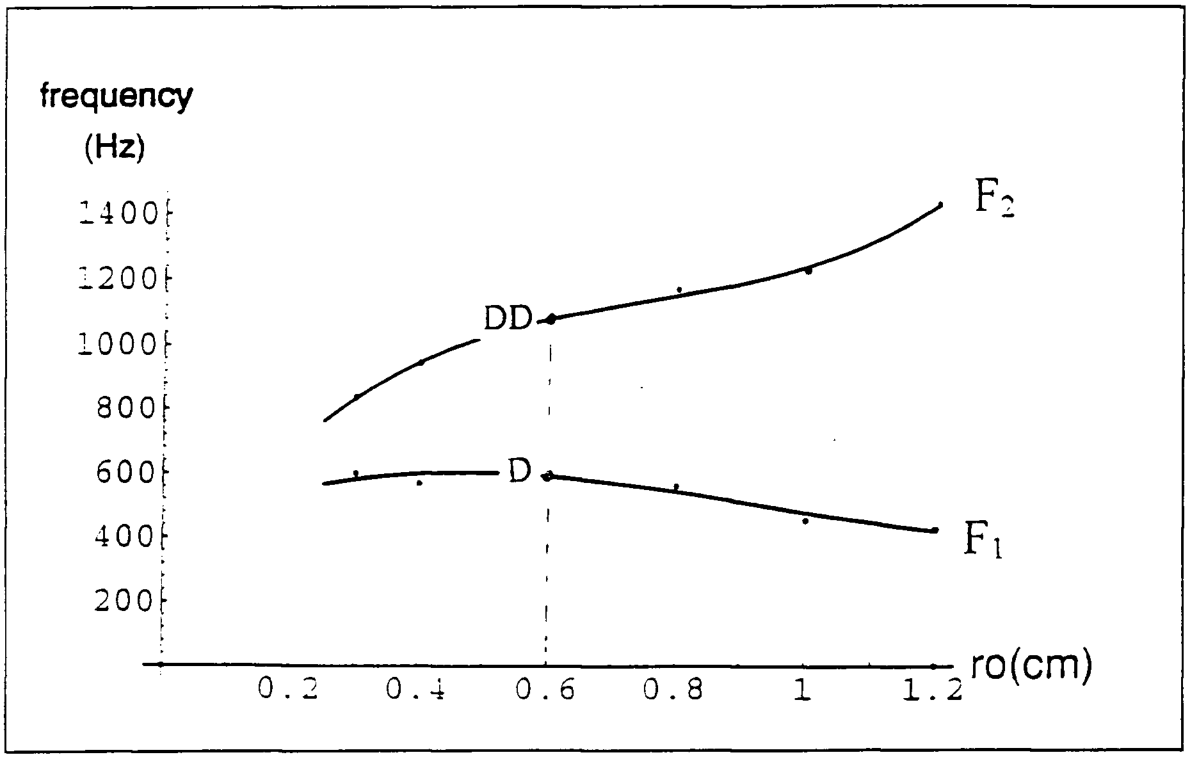

Figure 1:16 F_1 and F_2 predicted by Stevens and House (1955) for vocal tracts of d = 4, A/l = 1.1, and varying r_0 (points for pharyngealisation plotted)

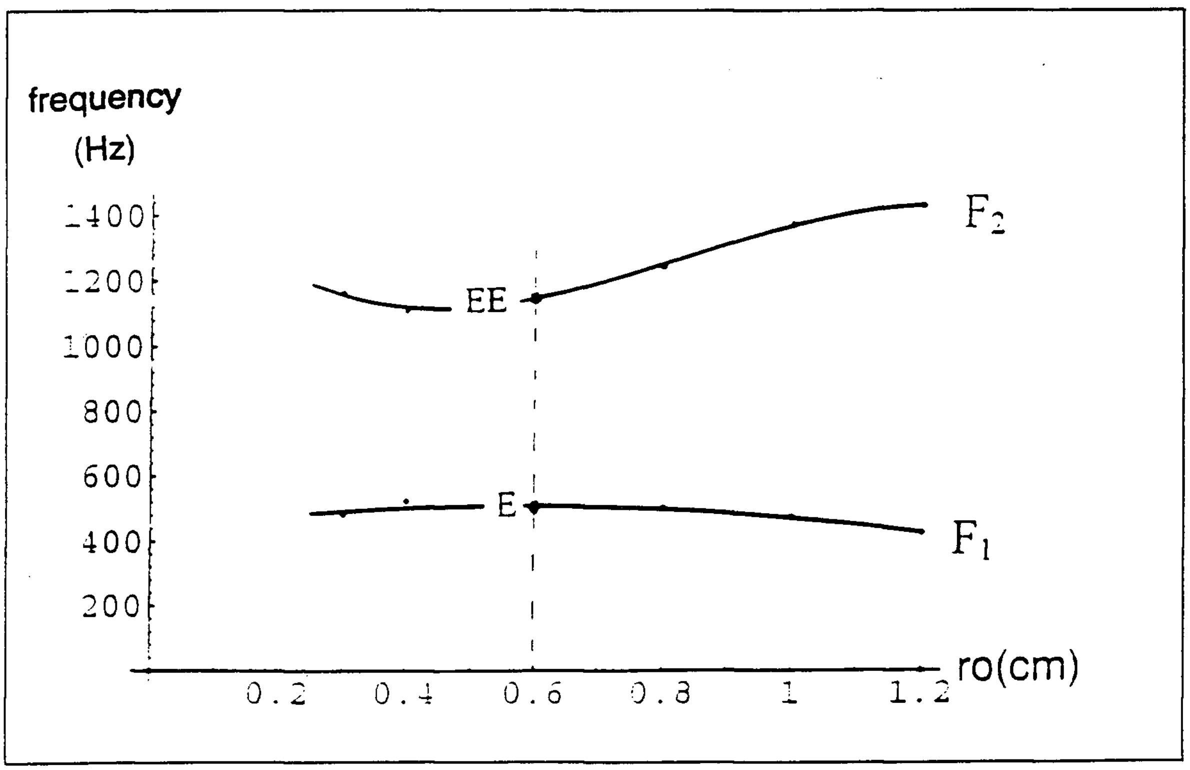

Figure 1:17 F_1 and F_2 predicted by Stevens and House (1955) for vocal tracts of d = 7, A/l = 1.1, and varying r_0 (points for uvularisation plotted)

Under the dynamic view just explained, the F_1 and F_2 effects predicted for pharyngealisation and uvularisation are identified as the formant changes seen in Table 1:8. The direction and size of each change were determined from the nature of the curved lines in each graph for the r_0 interval starting at 1.2 and ending at 0.6. For example, the bottom curved line in Figure 1:17, which represents F_1 for uvularisation, rises 70 Hz over the r_0 interval starting at 1.2 and ending at 0.6 (that is, ending at point E). This is recorded in Table 1:8 as a small rise. The procedure by which each change was identified as small, medium, or large will be explained next.

Table 1:8

Predicted acoustic effects of pharyngealisation and uvularisation

Articulation		F_1		F_2
pharyngealisation of uvular gutturals and velar emphatics	C	large rise	CC	medium drop
pharyngealisation of non-velar emphatics	D	medium rise	DD	medium drop
uvularisation	E	small rise	EE	medium drop

The size of each formant change was identified by first determining the difference between the formant frequency at $r_0 = 1.2$ and $r_0 = 0.6$ in each of Figures 1:15 - 1:17. (For example, in Figure 1:17, the difference between F_1 at $r_0 = 1.2$ cm and F_1 at $r_0 = 0.6$ cm is 70 Hz.) Each difference was then compared with the maximum difference predicted for the formant by the Stevens and House model, between $r_0 = 1.2$ and some other r_0

value, over all d and A/ℓ. Those maximum differences are presented in Table 1:9.[36] They represent the maximum changes predicted for F_1 and F_2.

Table 1:9

Maximum F_1 and F_2 changes predicted by the model of Stevens and House (1955)

F_1 (Hz)	F_2 (Hz)
300	600

Dividing each of these maximums by 3 gives the three ranges for F_1 and F_2 change seen in Table 1:10. The degrees of change identified in Table 1:8 refer to the ranges in Table 1:10.

Table 1:10

Ranges of degrees of change for F_1 and F_2

	F_1 (Hz)	F_2 (Hz)
small	< 100	< 200
medium	100 - 200	200 - 400
large	200 - 300	400 - 600

Based on the effects in Tables 1:2 and 1:8, the predicted cumulative effects of the postvelar articulations of gutturals and emphatics are identified as those in Table 1:11.

[36]Based on Fig. 5 of Stevens and House (1955:487), the maximum F_1 difference predicted by their model is between $r_0 = 1.2$ and $r_0 = 0.4$ at $d = 4$ and $A/\ell = 20$. The maximum F_2 difference is between $r_0 = 1.2$ and $r_0 = 0.3$ for $d = 6$ and $A/\ell = 0.11$.

1.4.3. Postvelar Acoustics

Table 1:11

Predicted cumulative acoustic effects of the postvelar articulations of gutturals and emphatics

	Postvelar Articulation	Prediction	
		F_1	F_2
GUTTURALS			
Pharyngeal Gutturals:	primary pharyngeal	high	low
Uvular Gutturals:	primary uvular, pharyngealisation	medium or high	low or medium
EMPHATICS			
Velar Emphatics:	primary uvular, pharyngealisation	medium or high	low or medium
Non-velar Emphatics:	uvularisation, pharyngealisation	medium or large rise	large drop

The cumulative effects were identified as follows: as pharyngeal gutturals have no secondary postvelar articulation, the A(A) effects in Table 1:2 transfer unmodified to the first line of Table 1:11. For uvular gutturals and velar emphatics, the B(B) effects in Table 1:2 and the C(C) effects in Table 1:8 combine: the medium F_1 for B + the large rise for C results in a final prediction in Table 1:11 of either a medium or high F_1. The medium F_2 for BB + the medium drop for CC results in a final prediction in Table 1:11 of either a low or a medium F_2. (Whether the final F_1 is medium or high, and the final F_2 low or medium, will depend on whether F_1 and F_2 for the primary articulation are at the low or high end of the F_1 and F_2 medium ranges in Table 1:5.)

For non-velar emphatics, the D(D) and E(E) effects in Table 1:8 combine in Table 1:11: for F_1, the medium rise for D + the small rise for E results in a final prediction of a medium or large rise. For F_2, the medium drop for DD + the medium drop for EE yield a final prediction of a large drop. No final F_1 or F_2 range (low, high, or medium as defined in Table 1:5) is predicted here for non-velar emphatics because their final F_1 and F_2 ranges will depend on the F_1 and F_2 ranges predicted for their primary (non-postvelar) articulation, which were not discussed in this section.

In sum, the predictions are: 1) pharyngeal gutturals will have a high F_1 and a low F_2; 2) uvular gutturals will have a medium or high F_1 and a low or medium F_2; 3) velar emphatics will have a medium or high F_1 and a low or medium F_2; 4) non-velar emphatics will a medium or large rise in F_1 and large drop in F_2.

The effects just summarised generally agree with the findings of previous acoustic studies of gutturals and emphatics. For example, a high F_1 and a medium or low F_2 for pharyngeal gutturals is reported by Butcher and Ahmad (1987), cited by McCarthy (1994). A medium F_1 and low F_2 for uvular gutturals is reported by Ghazeli (1977). ('High', 'medium', and 'low' are used here as defined in Table 1:5.) A rise in F_1 for non-velar emphatics (or for vowels in contact with non-velar emphatics) is reported by Bonnot (1977, 1979), Woldu (1981), and Younes (1982). A drop in F_2 for non-velar emphatics is a standard finding.[37]

In this thesis, tokens of gutturals and emphatics in Palestinian and St'át'imcets will be examined to see if their formant frequencies show the expected F_1 and F_2 effects

[37]See, e.g., Obrecht (1968), Ghazeli (1977), Woldu (1981), Younes (1982), and Card (1983).

identified in this section. Should they match, they will be taken as acoustic support for assuming that the analysed tokens were produced with the corresponding postvelar articulation(s) in Table 1:11.

Tokens of consonants and vowels which undergo phonological postvelar harmony will also be examined. Where the harmony is presumably implemented with secondary pharyngeal articulation, the tokens will be examined to see if their formant frequencies show the general effects for pharyngealisation, *viz.*, C(C) and D(D) in Table 1:8: a medium or large rise in F_1 and a medium drop in F_2. Where the harmony is presumably implemented with both secondary uvular and secondary pharyngeal articulation, the tokens will be examined for the effects predicted for both those articulations, *viz.*, the effects for non-velar emphatics in Table 1:11: a medium or large rise in F_1 and a large drop in F_2. If the formant frequencies of the tokens of harmonising segments are found to match these predictions, they will be taken as acoustic support for assuming that the tokens were produced with the corresponding secondary pharyngeal and uvular articulations.

As a final note, the findings will be interpreted as support under a hypothesis that the tokens were not produced with, instead of the postvelar articulation(s), some completely non-postvelar articulation which might result in the F_1 and F_2 effects identified in this section, e.g., a lowered jaw and concomitant wide mouth opening, which has been shown to raise F_1, or lip rounding, which has been shown to lower F_2. This hypothesis is stated here because it is important to note that, while the articulation-to-acoustics mapping is one-to-one, the reverse mapping is one-to-many. That is, a specific vocal tract configuration will always have the same and unique set of formant frequencies, but a given set of formant frequencies will not in general correspond to a unique vocal tract configuration. This was shown by Stevens and House (1955), and later and in more detail by Atal et al. (1978). See Figures 13 - 15 and 21 - 25 in Atal et al. (1978:1548-1554), which show multiple area functions (configurations) with identical values for the first three formant frequencies for /i/, /a/, and /u/. While it is true that many possible articulations can be excluded for a given segment token, the point here is that particular acoustic effects cannot be considered actual evidence for a particular articulation.

1.4.4. Summary

This section has examined the articulatory nature of guttural and emphatic postvelars. The pharyngeal gutturals /ʕ ħ/ are produced with only primary pharyngeal articulation. Tokens of /ʕ ħ/ are predicted to have a high F_1 and a low F_2. Uvular gutturals such as /ʁ χ/, and the emphatic velar /k̙/, are produced with primary uvular articulation and pharyngealisation. Tokens of uvular gutturals and emphatic velars are predicted to have medium or a high F_1 and a low or medium F_2. Non-velar emphatics, such as /t̙ s̙ r̙/, are produced with a primary non-postvelar articulation and uvularisation and pharyngealisation. Tokens of non-velar emphatics are predicted to have a medium or large rise in F_1 and large drop in F_2.

1.5. A Harmony Typology

The harmony typology in (25) will be assumed. In (25), 'x' denotes the feature for which harmony is observed. After Shaw (1991b), 'harmony' is used here to refer to both assimilatory and dissimilatory phenomena.

(25) Harmony Typology

a. Primary Articulation (AP) Harmony: only primary instances of x are involved.
b. Secondary Articulation (AS) Harmony: only secondary instances of x are involved.
c. Articulation (A) Harmony: both primary and secondary instances of x are involved.

This typology is based on Selkirk's (1993:6) identification of three natural classes relevant to multiply-articulated segments: (i) the class of segments for which feature$_x$ is a primary specification; (ii) the class of segments for which feature$_x$ is a secondary specification; (iii) the class of segments for which feature$_x$ is either a primary or a secondary specification. See Selkirk (1993:5-20) for discussion of these classes in Ngbaka and Berber.

This dissertation will argue that Palestinian pharyngealisation harmony is A harmony, involving Selkirk's natural class (iii). St'át'imcets pharyngealisation harmony and uvularisation harmony in both Palestinian and St'át'imcets will be argued to be AS harmony, involving Selkirk's natural class (ii). The data to be examined happen not to exemplify AP harmony, involving Selkirk's natural class (i). See Selkirk (1993:8-29) for an example of AP Dissimilation in Tashlhyt Berber.

1.6. Optimality Theory

In the next two chapters, a theoretical account of pharyngealisation and uvularisation harmonies in Palestinian and St'át'imcets will be developed within the framework of Optimality Theory (OT) (McCarthy and Prince 1993a, Prince and Smolensky 1993). In OT, phonological alternations are standardly assumed not to result from serially ordered rules, as assumed in generative phonology since Chomsky and Halle (1968). Rather, they are the surface effect of the interaction of ranked constraints. The ranked constraints are violable. They are universal, but their ranking is language-specific. A function *GEN* is assumed to generate candidate surface ('output') forms from a single underlying ('input') form. A function *EVAL* then evaluates the candidate outputs with respect to the constraint ranking of the language. Candidates are evaluated simultaneously and in parallel, in a one-step mapping from input to output. The candidate with the least serious constraint violations is the 'winner' and emerges as the actual output form.[38]

This parallel grammar is illustrated by the 'tableau' in (26), from McCarthy and Prince (1993a:6).

(26)

	A	B
☞ candidate 1		*
candidate 2	*!	

[38]Note that a theory of ranked and violable constraints need not be implemented in parallel. See Prince and Smolensky (1993) for discussion of a non-parallel version of OT.

The tableau in (26) shows two constraints, A and B, ranked A >> B, where '>>' denotes 'is more highly ranked than'. In the tableau, domination order of the constraints is reflected by the left-to-right column order. There are two candidate outputs: candidate 1, which violates Constraint B; candidate 2, which violates Constraint A. Constraint violation is marked by '*'. The higher the ranking of a constraint, the more serious is a violation of it. Thus, given the ranking A >> B, candidate 1, marked by '☞', is the winner and actual output form because its violation of Constraint B is less serious than the violation of Constraint A by candidate 2. Candidate 2's fatal violation of the higher-ranked Constraint A is marked by '!'. Satisfaction of a constraint is indicated by a blank cell. Shading means the constraint does not choose between viable candidates.

In OT, cross-linguistic variation is the result of constraint reranking. This is illustrated by the tableau in (27), which should be compared with the tableau in (26).

(27)

	B	A
candidate 1	*!	
☞ candidate 2		*
candidate 3		**!

In (27), the constraints are the same as those in (26), but the ranking of the constraints is reversed. As seen, candidate 2 is the winner under this reranking. This is because it violates only Constraint A, which is more lowly ranked than Constraint B in this new grammar. In (27), an additional candidate 3 shows that constraint violations can accrue:

candidate 3 violates Constraint A twice while candidate 2 violates it only once. The more a single constraint is violated, the more serious is the violation. Thus, candidate 2 emerges the winner because it incurs fewer violations of Constraint A than does candidate 3.

This thesis will argue that three types of constraints figure crucially in Palestinian and St'át'imcets postvelar harmony: Correspondence, Alignment, and Grounded constraints. These constraint types are explained below.

1.6.1. Correspondence Constraints

A fundamental issue in OT is the faithfulness between related representations. In its original formulation (McCarthy and Prince 1993a, Prince and Smolensky 1993), OT approached faithfulness between input and output forms in terms of a class of Faithfulness constraints which consisted of PARSE and FILL constraint families. Under this approach, deleted elements (PARSE violations) or inserted elements (FILL violations) were the primary focus. McCarthy and Prince (1995) propose that the PARSE/FILL system be replaced with Correspondence Theory. This newer theory considers input and output forms to be in a relation of correspondence. Where the structure of the input and output is viewed as a string, Correspondence is defined by McCarthy and Prince (1995:262) as:

(28) Correspondence (McCarthy and Prince 1995:262)

Given two strings S_1 and S_2, correspondence is a relation $\mathcal{R}$ from the elements of S_1 to those of S_2. Elements of $\alpha \ni S_2$ and $\beta \ni S_2$ are referred to as correspondents of one another when $\alpha \mathcal{R} \beta$.

1.6.1. Correspondence Constraints

In this thesis, it will be argued that the DEP and MAX families of Correspondence constraints, proposed by McCarthy and Prince (1995), play a central role in the surface realisation of the features responsible for postvelar harmony in Palestinian and St'át'imcets. MAX subsumes the former PARSE. DEP subsumes the former FILL. MAX and DEP are defined by McCarthy and Prince (1995:264) as:[39]

(29) The MAX Constraint Family (McCarthy and Prince 1995:264)
General Schema
Every segment of S_1 has a correspondent in S_2.
Specific Instantiation
MAX-IO
Every segment of the input has a correspondent in the output.
(No phonological deletion.)

(30) The DEP Constraint Family (McCarthy and Prince 1995:264)
General Schema
Every segment of S_2 has a correspondent in S_1.
Specific Instantiation
DEP-IO
Every segment of the output has a correspondent in the input.
(Prohibits phonological epenthesis.)

MAX and DEP are here assumed to govern features as well as segments. They are also assumed to govern the associations ('links') between features and segments. That is, besides MAX-IO and DEP-IO, the further instantiations in (31) are also assumed.

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[39]McCarthy and Prince (1995) provide base-reduplicant MAX and DEP correspondence as further instantiations of MAX and DEP. Because reduplicative correspondence will not be discussed in this thesis, those further instantiations are omitted in (29) and (30).

1.6.1. Correspondence Constraints

(31) a. MAX-F

Every feature in the input corresponds to a feature in the output.
(No feature is deleted.)

b. MAX-LINK

Every association in the input corresponds to an association in the output.
(No link is deleted.)

c. DEP-F

Every feature in the output corresponds to a feature in the input.
(No feature is added.)

d. DEP-LINK

Every association in the output corresponds to an association in the input.
(No link is added.)

The tableau in (32) illustrates the satisfaction and violation of these constraints. (In (32), they are equally ranked. Constraints of equal rank are separated by a dotted column border.)

(32)

input: [DOR] | α β	MAX-F	MAX-LINK	DEP-F	DEP-LINK
(a) [DOR] | α β				
(b) α β	*	*		
(c) [DOR] | \\ α β — [RTR]			*	**

The candidate outputs in (32) are evaluated as follows: candidate (a) has all the features and links that the input has, so it satisfies MAX-F and MAX-LINK. It has no feature or link that the input does not have, so it also satisfies DEP-F and DEP-LINK. Candidate (b) does not have all the features and links that the input has: the underlying [DOR] is absent, as is its underlying link to α. The missing [DOR] violates MAX-F; the missing link violates MAX-LINK. However, candidate (b) has no feature or link that the input does not have, so it satisfies both DEP-F and DEP-LINK. Candidate (c) has all the features and links that the input has, so it satisfies MAX-F and MAX-LINK. However, it has an added feature, [RTR], and two added links, *viz.*, the link of [DOR] with β and the link of [RTR] with β. This means that candidate (c) violates DEP-F once and DEP-LINK twice.

In chapters 2 and 3, the MAX and DEP constraints in (31) will be argued to have a crucial role in Palestinian and St'át'imcets postvelar harmony. For example, it will be argued that MAX-RTR ('Every [RTR] in the input corresponds to an [RTR] in the output') and MAX-LINK are highly ranked in the grammar of both languages. The observed effect is that [RTR] 'stays' on the segment to which it is underlyingly linked, in order to serve as a source of [RTR] harmony in the string. It will be further argued that DEP-LINK is more lowly ranked than MAX-RTR and MAX-LINK in both languges. The observed effect is that new [RTR] associations, the manifestations of the harmony, occur in the output with little penalty. The role to be identified for DEP-RTR ('Every [RTR] in the output corresponds to an [RTR] in the input') mirrors that argued by Pulleyblank

(1994a) for a functionally equivalent constraint, REC-F ('RECOVER-F'), in Yoruba and Wolof. Pulleyblank argues that the ranking of REC-F with respect to certain Alignment and Grounded constraints derives the effects of opacity and transparency in Yoruba and Wolof '[-ATR]' harmony. E.g., it will be argued that in Palestinian, DEP-RTR is ranked above certain Grounded constraints but below certain others, where some of the Grounded constraints are Alignment constraints. This ranking derives the observed pattern of opacity in Palestinian pharyngealisation harmony.

1.6.2. Alignment Constraints

Generalized Alignment, proposed by McCarthy and Prince (1993b), is a constraint schema governing the coincidence of categories at constituent edges. It is formulated by McCarthy and Prince (1993b:2) as:

(33) Generalized Alignment (McCarthy and Prince 1993b:2)

Align(Cat1, Edge1, Cat2, Edge2) $=_{\text{def}}$

$\forall$ Cat1 $\exists$ Cat2 such that Edge1 of Cat1 and Edge2 of Cat2 coincide.

Where

Cat1, Cat2 $\in$ PCat $\cup$ Gcat

Edge1, Edge2 $\in$ {Right, Left}

PCat and GCat refer to prosodic and grammatical (morphological or syntactic) categories, respectively. Generalized Alignment provides a uniform expression for constraints that reference a constituent edge; see McCarthy and Prince (1993b) for several examples of such constraints. An example of a particular parameterisation of Generalized Alignment, from McCarthy (1993b:2) is:

(34) English Stress

Align(PrWd, L, Ft, L)

This requirement is satisfied in [(Tàta)ma(góuchee)], since the left edge of the Prosodic Word coincides with the left edge of a foot.

In chapters 2 and 3 it will be argued that Alignment constraints on the features [RTR] and [DOR] are the basic force driving postvelar harmony in Palestinian and St'át'imcets. It will be further argued that certain of those Alignment constraints are syntagmatically grounded, as discussed below.

1.6.3. Grounded Constraints

Grounded constraints provide phonological evidence for the Grounding Hypothesis of Archangeli and Pulleyblank (1994a). The Grounding Hypothesis says that featural relations are "rooted in the physical properties of the vocal tract or speech signal" (Archangeli and Pulleyblank 1994a:172). That is, featural constraints must observe, and not contradict, the phonetic basis of speech.

1.6.3. Grounded Constraints

Grounding can be either paradigmatic or syntagmatic. Paradigmatic grounding relations, proposed by Archangeli and Pulleyblank (1994a), hold of featural relations within a segment. An example of a paradigmatic grounding relation is that holding between the features [HI] and [RTR]: in several languages, a segment specified for [HI] cannot also be specified for [RTR]; see Archangeli and Pulleyblank (1994a) for further discussion. (Here it is assumed, after Pulleyblank (1994a:3), that [RTR] as just referenced corresponds to Archangeli and Pulleyblank's '[-ATR]'. The reasons for assuming this are discussed in chapter 4.) This prohibition is grounded in the anatomical proximity of the tongue body and tongue root. Given the proximity of those structures, tongue body and tongue root interaction are such that raising the body makes it difficult to simultaneously retract the root. It is also based on acoustic effects: raising the tongue dorsum and retracting the tongue root have been shown to have contradictory F_1 effects. See Archangeli and Pulleyblank (1994a) and Pulleyblank (1994a) for discussion. This grounded relationship is evidence for the paradigmatic grounded constraint HI/*RTR ('If a segment is specified for [HI], it is not specified for [RTR]'), as argued by Archangeli and Pulleyblank (1994a) and Pulleyblank (1994a). (The two studies just cited phrase the constraint as HI/ATR ('If [+high], then [+ATR], not [-ATR]').) In chapters 2 and 3 it will be argued that HI/*RTR is lowly ranked in both Palestinian and St'át'imcets.

Syntagmatic grounding relations hold not within segments, but between them. Shahin (1993) suggested that the physical properties of the tongue root are the phonetic basis for tongue root retraction harmony. Specifically, given the relative large mass and resultant sluggishness of the tongue root, tongue root articulation has a natural tendency to span more than one segment in a word. This was identified as an instance of syntagmatic grounding. Syntagmatic grounded constraints are formulated by Jiang-King (1996) and Pulleyblank (1997). Jiang-King proposes a syntagmatic constraint against a sequence of [HI]-[LOW]. Pulleyblank proposes that place assimilation, observed in several languages, is the effect of highly ranked syntagmatic grounding constraints on Cluster-Identity.

Two syntagmatic grounded constraints to be proposed in this thesis are Align([RTR], L; Wd, L) and Align([RTR], R; Wd, R), which say, respectively, 'The left edge of the word is aligned with the left edge of any [RTR]' and 'The right edge of the word is aligned with the right edge of any [RTR]'. These will be proposed as constraints that are syntagmatically grounded in the sluggishness of the tongue root. It will be argued that they are more lowly ranked in St'át'imcets than in Palestinian. In Palestinian, they interact with a more lowly ranked DEP-LINK to force an expanded distribution of [RTR] in the output. In St'át'imcets, the reverse ranking, DEP-LINK >> Align([RTR], L; Wd, L), Align([RTR], R; Wd, R), results in more restricted postvelar harmony for that language.

1.7. Phonetics and Phonology

This section addresses the distinction between phonetics and phonology, and the use of phonetics in phonology. A phonetics-phonology distinction will first be drawn, based on the various characteristics of sound properties. Building on the conclusions of previous studies, the distinction will then be refined to recognise distinct speech-phonetics vs. language-phonetics, which are both distinct from the phonology. The use of phonetics in phonology will then be discussed.

1.7.1. The Distinction between Phonetics and Phonology

It is assumed here that a sound property can be identified as either phonetic or phonological according to the criteria in (35). (Unless otherwise noted, 'phonological' is used in this thesis to mean part of either the lexical or postlexical phonology. On the distinction between lexical and postlexical phonology, see Mohanan (1982), Kiparsky (1985), and Kaisse & Shaw (1985). For further discussion of criteria 2 - 4 in (35), see Pulleyblank (1986:7-8).)

1.7.1. The Distinction between Phonetics and Phonology

(35) Necessary Criteria for Phonetic vs. Phonological Status

1. Phonological visibility, after Mohanan (1982) and Pulleyblank (1986)

   This means that the property has a phonological effect and is referenced in a constraint. Phonetic properties are not phonologically visible, but phonological properties are. If there is no evidence that a given sound property has phonological visibility, then, based on economy considerations, the property is considered phonetic.

2) Sensitivity to word-internal structure, from Mohanan (1982) and Kiparsky (1985)

   This means that the principles governing the distribution of the sound property refer to word-internal structure. Phonetic properties are not sensitive to word-internal structure, but (lexical) phonological properties can be.

3) Non-discreteness, from Henke (1966), Öhman (1966), Browman and Goldstein (1990), and Keating (1990)

   Phonetic properties are non-discrete, that is, continuous. Because of this, they are necessarily realised with a temporal dimension so that the span of presence of one phonetic property can partially overlap with that of another. By result, it is frequently difficult to group a set of phonetic properties into a larger unit that can be defined by the presence of those properties. From the non-discreteness of phonetic properties, it follows that phonetic properties are gradient, that is, showing change corresponding to distance from a source.

   Phonological properties, by contrast, are discrete. Because they are discrete, they are not gradient. By result, segmentation, e.g., of a consonant or vowel defined by a set of phonological properties, is straightforward (although, as in cases of harmony, distinct phonological segments may share a single instance of a phonological property).

4) Lexical exceptions, from Liberman (1983) and Kiparsky (1985)
Phonetic properties cannot have lexical exceptions, but phonological properties can.

Liberman (1983) suggests another criteria, *viz.*: number of properties. With Liberman, it is assumed that phonological properties are bounded in number. This is based here on the assumption that the human brain has a limited storage capacity. However, in contrast to Liberman, the number of phonetic properties is assumed to be bounded as well, based on the assumption that the properties of the physical world, as determined by forces like pressure, magnetism, viscosity, etc., are bounded, that is, that they are in principle enumerable.

The criteria in (35) imply that there is only one type of phonetics. However, there is evidence, presented, e.g., by Pierrehumbert (1980), Liberman and Pierrehumbert (1982), and Liberman (1983), that some properties which would be classified as phonetic by criteria 1 - 4 nevertheless vary cross-linguistically. That is, some phonetic properties are language-specific. They must, therefore, be cognitive and part of language. Furthermore, Steriade (1995b, 1997) presents evidence that certain language-specific sound phenomena previously assumed to be phonological cannot be given a tenable phonological account. As Steriade argues, such phenomena must be recognised as phonetic. On the basis of these two types of evidence for language-specific phonetic properties, it is here assumed, following several previous works,[40] that language has a

[40]See, e.g., Liberman and Pierrehumbert (1982), Liberman (1983), Pulleyblank (1986), Steriade (1995b), Flemming (1995a, 1995b), and Steriade (1997).

phonetic component. This means there are two types of phonetics: speech-phonetics and language-phonetics.

Recognition of distinct speech- vs. language-phonetics leads to the following phonetics vs. phonology distinctions: speech phonetics is purely physical, that is, it is defined in terms of the physical (anatomical, acoustic, and aerodynamic) properties of speech and lies outside cognition. Language-phonetics, while still defined in terms of the physical properties of speech, is cognitive, that is, it is part of the cognitive representation of the sound structure of language. Finally, all the phonology is cognitive — although it is constrained by the physics of speech, as discussed in §1.6.3.

Table 1:12 summarises the necessary criteria for identifying a sound property as belonging to the speech-phonetics vs. language-phonetics vs. phonology.

1.7.1. The Distinction between Phonetics and Phonology

Table 1:12

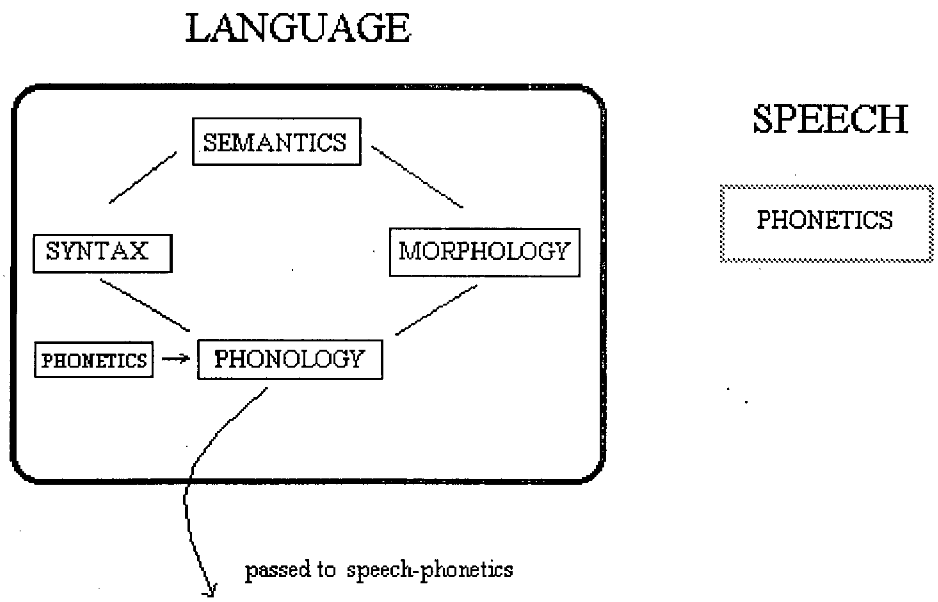
Necessary criteria for speech-phonetic vs. language-phonetic vs. phonological status

	Property Characteristics	Nature
SPEECH-PHONETICS	• not language-specific • no phonological visibility • no reference to word-internal structure • non-discrete • no lexical exceptions	physical
LANGUAGE-PHONETICS	• language-specific • no phonological visibility • no reference to word-internal structure • non-discrete • no lexical exceptions	cognitive
PHONOLOGY	• language-specific • phonological visibility • possible reference to word-internal structure (for the lexical phonology) • discrete • possible lexical exceptions	cognitive

The model of language vs. speech in (36) is assumed. The modular schematisation of language follows Archangeli and Pulleyblank (1994a:5), except that (36) makes the distinction between language- and speech-phonetics explicit. The placement of language-phonetics as feeding into phonology follows the suggestion of Donca Steriade (p.c.). On the interaction between the syntax, semantics, morphology, and phonology modules, see Archangeli and Pulleyblank (1994a:4-5,433).

1.7.1. The Distinction between Phonetics and Phonology

(36)



A final discussion concerns the notational representation of phonological and phonetic data. In this thesis, three types of representations will be used in transcriptions: 1) Underlying phonological form, presented between slashes ('//'). 2) Surface phonological form, presented between the braces '{}'. 3) Phonetic form, presented between square brackets. The three types of representations are explained as follows: the underlying form is the phonological form stripped of its predictable properties. The surface ('output') form is the underlying form + all properties added in the phonology. The phonetic form is the phonological output + additional phonetic properties, but minus any word-internal morphological boundaries. (The absence of word-internal morpheme boundaries follows from criterion 2 in (35).) Selected phonetic properties are included in the transcription of the phonetic form, depending on the point of discussion. This means that a single phonetic form might be represented in various ways, since certain phonetic properties might be included in its transcription on one occasion but not on another.

For example, the Palestinian form meaning 'perfume', represented these three ways, is:

(37) underlying: /ʕUṭṛ/

surface: {ˈʕ̣ʊ.ṭʊṛ}

phonetic: [ˈʕ̣ɔ.ṭɔṛ] or [ˈʕ̣ʊ.ṭʊṛ], etc.

where '⁓⁓' represents phonetic voicing.

The three-way distinction between underlying, surface, and phonetic form is adopted here because it permits transcription in which the claims of the transcriber, with respect to the sound system of the language being transcribed, are made explicit. For example, the representations in (37) make the claims listed below:

(38) In Palestinian,

a. The properties that combine to form the sequence ˈʕ̣ʊ.ṭʊṛ are phonological. That is, they are language-specific, phonologically visible and discrete; they have possible reference to word-internal structure and possible lexical exceptions.
b. The presence of ʕ ṭ ṛ and U in a morpheme is non-predictable.
c. Syllabification, stress assignment, vowel epenthesis, uvularisation of ʕ, and pharyngealisation of U are predictable.
d. The form meaning 'perfume' is monomorphemic.
e. In the form meaning 'perfume', mid vowel height and devoicing of ʕ are phonetic properties. That is, they are phonologically invisible and non-discrete, have no reference to word-internal structure, and no lexical exceptions; they are either Palestinian-specific or non-Palestinin-specific.

In (38e), mid vowel height and devoicing of ʕ in the example form are described as either Palestinian-specific or non-Palestinian-specific. This is because, to my knowledge, there is no study which has determined whether those properties are due to Palestinian or solely to the physics of speech; such a study will not be undertaken in this thesis. However, if they were the former, they would be language-phonetic. If they were the latter, they would be speech-phonetic.

1.7.2. The Use of Phonetics in Phonology

It is assumed that phonetic data can provide crucial support for a phonological account. The support may be articulatory, or both articulatory and acoustic, as follows: let us assume that a phonological analysis claims that a segment is specified for feature F. If articulatory data indicate that the segment is produced with the appropriate articulation(s) (e.g., lip rounding for a segment claimed to be specified for [LAB]), then that articulatory data can be interpreted as phonetic support for the phonological claim that the segment is specified for F. Additionally, the supporting articulatory data can be mapped through a reliable articulation-to-acoustics model, such as the model of Stevens & House (1955), discussed in §1.4.3. If acoustic data from the segment match the predictions of the model (e.g., a lowered F_2 for a segment shown to be produced with lip rounding), then that acoustic data can be interpreted as support for the articulation(s) on which the acoustic predictions were based, strengthening the articulatory support for the phonological claim with respect to F.

1.7.2. The Use of Phonetics in Phonology

In the absence of articulatory data, it is assumed that acoustic data by itself can strengthen presumed articulatory support, but under a hypothesis that leaves the door open for other articulations that could have produced the same acoustic effects; see §1.4.3 for further discussion.

Chapter 2:

Pharyngealisation Harmony and Uvularisation Harmony in Palestinian Arabic

2.1. The Language and the Data

Palestinian Arabic belongs to the Palestine-Jordanian variety of Levantine Arabic; see the dialectal classifications of Cantineau (1940/46) and Eisele (1987). Palestinian dialects can be classified as either *medini* (urban), *fellāhi* (rural) or *bedui* (bedouin), and as either northern, southern, eastern, western, central, or coastal, according to their location in the former Palestine. On the sociolinguistic classification, see Cadora (1992); on the geographical classification, see Shahin (1996). To my knowledge, a complete sociogeographical classification of Palestinian dialects has not been compiled.

Unless otherwise noted, the Palestinian data in this thesis are from the Abu Shusha Palestinian dialect, which is the western central *fellāhi* spoken in the pre-1948 Palestine village of Abu Shusha. For the location of this former village, see Appendix II. In Abu Shusha, Old Arabic /q/ is variously realised as emphatic /ḳ/ or as velar /k/. As a *fellāhi*, Abu Shusha's most salient marker is the affrication of Old Arabic /k/ to /ʧ/; see Fischer and Jastrow (1980) for discussion of this feature. The dialect is also marked as rural by its lack of emphatic /ḍ/: emphatic /ð̣/ occurs in Abu Shusha where /ḍ/ occurs in urban Palestinian dialects; this rural marker is also noted by Card (1983:107).

The data were gathered by the author, most of it during six months of field work in Ramallah on the West Bank, 1994-1995. The consultants were *fellahīn* (villagers, peasants) from Abu Shusha. The primary consultants were a male, aged 58, and a female, aged 45, with whom I lived for the duration of the fieldwork. Frequent daily interaction with these and six other consultants (a male, aged 80, and five females, aged 85, 68, 67, 65, and 28) and periodic interaction with 18 others (eight males, aged approximately 40 - 85, and ten females of approximately the same age range) yielded a large set of lexical items and phrases, which were then tape-recorded from the female consultant of age 45. Subsequent fieldwork was conducted in Vancouver with a male native speaker, aged 32. The total corpus is approximately 1500 words and phrases.

For the acoustic study of Palestinian from which findings will be reported in this chapter, both Abu Shusha and Jafa (northern coastal *medini*) tokens were used. (Only one Abu Shusha speaker was available for the acoustic study.) The original location of the Jafa dialect is also shown in Appendix II. Jafa has the salient *medini* marker of /ḳ/ > /ʔ̣/. Its lacks *fellāhi* affrication, and has /ḍ/ where Abu Shusha has /ð̣/. One dialectal feature directly relevant to postvelar harmony is that in Abu Shusha, stem-final vowels do not pharyngealise, but in Jafa they sometimes do, at least phonetically; this will be discussed in §2.4.5. Data showing this and other dialectal differences appear in Appendix III, which lists the carrier forms for the Palestinian consonant and vowel tokens that were analysed in the acoustic study. (Appendix III will be properly introduced in §2.3.1.) The acoustic data were tape-recorded in Vancouver from the 32-year-old Abu Shusha speaker mentioned above and a male native speaker of Jafa, aged 29.

2.2. Phonemic Inventory

2.2.1. Consonantal Inventory

2.2.1.1. The Palestinian Underlying Consonantal Inventory

The underlying consonantal inventory of (Abu Shusha) Palestinian is presented in (1). The lack of underlying non-emphatic /r/ will be discussed in §2.2.1.3.2.

The Palestinian underlying and surface vowels are presented in (2) and (3). The surface inventory in (3) is the inventory at the output of the phonology. (It is not a phonetic inventory). The vocalic inventories are presented here to provide a frame of reference for the vowels that occur in the data to be given in this section. They will be thoroughly discussed in §2.2.2. Upper case 'I E Æ O U' denote underlying vowels. The featural values represented by 'I E Æ O U' and by the IPA symbols in (3) will discussed in §2.3.3. Palestinian has an epenthetic vowel, which surfaces either high front or high back. Its featural values will be also be discussed in §2.3.3.

2.2.1. Consonantal Inventory

(1) The (Abu Shusha) Palestinian Underlying Consonantal Inventory

	LAB	INTER-DENT	ALV	POST-ALV	VEL	UV	PHAR	GL
OBSTRUENTS								
STOPS:								
			t t̙		k k̙			ʔ
	b b̙		d					
TRILLS:								
			r̙					
AFFRICATES:								
				tʃ				
				dʒ				
FRICATIVES:								
	f	θ	s s̙	ʃ				h
		ð ð̙	z					
RESONANTS								
NASALS:								
	m m̙		n					
APPROXIMANTS:								
	w		l l̙	j		χ	ħ	
						ʁ	ʕ	

(2) The (Abu Shusha) Palestinian Underlying Vocalic Inventory

a. short vowels

	FRONT		BACK
HIGH	I		U
MID	E		O
LOW		Æ	

b. long vowels

	FRONT		BACK
HIGH	I:		U:
MID	E:		O:
LOW		Æ:	

(3) The (Abu Shusha) Palestinian Surface Vocalic Inventory

a. short vowels

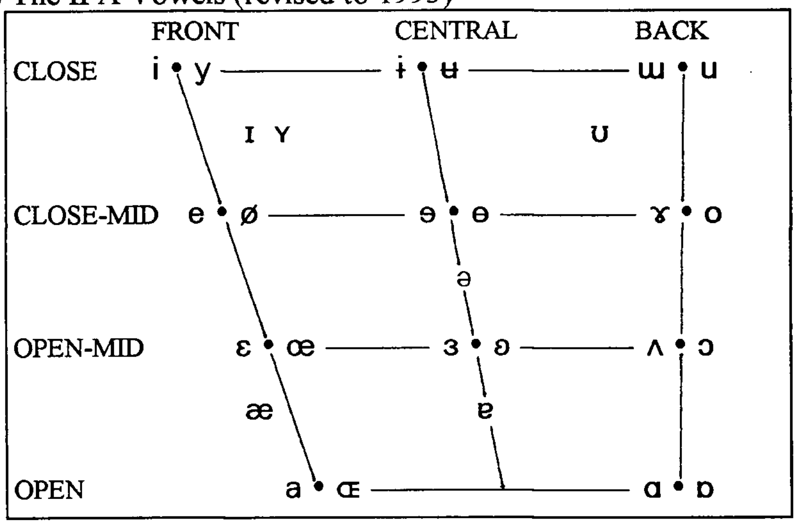
	FRONT		CENTRAL			BACK			
	NON-RTR	RTR	NON-RTR	RTR		NON-RTR		RTR	
						NON-RD	RD	NON-RD	RD
			non-bk	non-bk	bk				
HIGH	i	ɪ					u		ʊ
MID	e	ɛ	ə	ɜ	ɜ˃		o	ʌ	ɔ
LOW	æ	a						ɑ	

b. long vowels

	FRONT	BACK	
	NON-RTR	NON-RTR	
	NON-RD	NON-RD	RD
HIGH	iː		uː
MID	eː		oː
LOW	æː	ɐː	

The IPA vowel chart (revised to 1993) is presented in (4), to show the placement of the Palestinian mid and low surface vowels in the IPA vowel space. ('Mid' in (3) correspond to 'close-mid' or 'open-mid' in (4); 'low' corresponds to 'open'. For symbols that are paired in (4), the one on the left denotes a non-rounded vowel, the one on the right denotes a rounded vowel.)

(4) The IPA Vowels (revised to 1993)



2.2.1.2. The Palestinian Surface Consonantal Inventory

The Palestinian surface consonantal inventory, that is, the consonantal inventory at the output of the phonology, is seen in (5). The surface inventory differs from the underlying inventory in (1) by containing several additional emphatics. All underlyingly non-emphatic consonants, except the post-alveolar obstruents /ʃ ʧ ʤ/, have surface emphatic counterparts which arise through uvularisation harmony. E.g., in {ṇ.ˈð̣iːf̣} 'clean (masc. sg.)' (Adj), underlyingly non-emphatic /n f/ surface as emphatics because they undergo uvularisation harmony with the underlying emphatic /ð̣/. The effects of uvularisation harmony will be detailed in §2.5. Acoustic findings that support recognition of the surface emphatics in (5), including the surface emphatic gutturals, will be presented in §2.5.1. The theoretical reasons for the lack of surface emphatic {ʃ̣ ʧ̣ ʤ̣} will be addressed in §2.3.2 and §2.5.4.

2.2.1. Consonantal Inventory

(5) (Abu Shusha) Palestinian Surface Consonantal Inventory

	LAB	INTER-DENT	ALV	POST-ALV	VEL	UV	PHAR	GL
<u>*OBSTRUENTS*</u>								
STOPS:								
			t t̙		k k̙			ʔ ʔ̙
	b b̙		d d̙					
TRILLS:								
			r r̙					
AFFRICATES:								
				tʃ				
				dʒ				
FRICATIVES:								
	f f̙	θ θ̙	s s̙	ʃ				h h̙
		ð ð̙	z z̙					
<u>*RESONANTS*</u>								
NASALS:								
	m m̙		n n̙					
APPROXIMANTS:								
	w w̙		l l̙	j j̙		χ χ̙	ħ ħ̙	
						ʁ̙ ʁ̙	ʕ ʕ̙	

The surface consonantal inventory also differs from (1) by containing surface non-emphatic {r}. The non-underlying status of non-emphatic {r} in Palestinian is indicated by the findings of Younes (1993, 1994) for a northern Palestinian dialect. Abu Shusha data support Younes' analysis, as will be shown in §2.2.1.3. Finally, in word-initial position, epenthetic {ʔ} is observed. This will be discussed in §2.2.1.4.

2.2.1.3. Postvelars

Palestinian has 14 postvelars: six gutturals, /ʔ h ʕ ħ ʁ χ/, and eight emphatics, /m̙ b̙ l̙ ð̙ s̙ t̙ r̙ k̙/. On the articulatory nature of these segments, see §1.4.1 and §1.4.2. This section addresses certain issues regarding their classification. Theoretical issues pertaining to gutturals and emphatics — their feature specifications, their roles in Palestinian's two postvelar harmonies, and the formal bases for their roles — will be addressed in §2.3 - §2.5.

2.2.1.3.1. Guttural Approximants

As reflected in (1) and (5), Palestinian pharyngeal and uvular gutturals /ʕ ħ ʁ χ/ are analysed here as approximants, not fricatives. This manner identification for gutturals was proposed by Catford (1977) and is pursued by McCarthy (1994:194) and Ladefoged and Maddieson (1996:168). Frication is frequently observed for Palestinian /ʕ ħ ʁ χ/ in voiceless contexts, but the frication is considered here to be a phonetic effect. The change from approximant to fricative manner is explained as a result of the increased rate of airflow in the voiceless context; see Stevens (1971) for a detailed discussion. Observing this, Catford (1977:122) defines 'approximant' as "*non-turbulent* when voiced; but the flow becomes *turbulent* when they are made voiceless" (italics in the original); see Ohala and Ohala (1993:232-233) for a similar description.

2.2.1. Consonantal Inventory

I have examined some 30 Palestinian guttural tokens in both word-initial and word-internal, voiced contexts (where 'voiced context' means that the guttural is flanked by vowels or voiced consonants.) Presentation of that study is deferred for work elsewhere. However, preliminary findings are that word-initial /ʕ ʁ/ are frequently voiceless for most of their duration and are accompanied by frication. In word-medial, voiced context, they are voiced throughout, high amplitude, and drive full formant structure. Further study is necessary to determine the degree of possible frication of /ʕ ʁ/ in the voiced context.

Because the frication of voiceless /ħ χ/ can be attributed to aerodynamic coincidence, as can the frication of voiced /ʕ ʁ/ in voiceless contexts, /ħ χ/ are analysed here as voiceless approximants. The usual frication of voiceless approximants is discussed further by Catford (1977:120). The observations of Esling (1996, 1997) suggest that the frication of Arabic pharyngeals might be produced in the region of the epiglottis rather than the tongue root.

In §2.3.1, it will be proposed that the approximant manner of Palestinian gutturals results from their specification for [SON], and that their [SON] specification is the basis for the phonological distinction between Palestinian pharyngeal gutturals /ʕ ħ/ and laryngeal gutturals /ʔ h/.

2.2.1.3.2. No Underlying Non-emphatic /r/

Younes (1994) argues that surface non-emphatic {r} is not underlying in the Dar Younes (northern *fellāhi*) Palestinian dialect. He argues that {r} is underlyingly emphatic /r̙/ which surfaces 'de-emphaticised'. His evidence for this is that the Dar Younes trill always surfaces emphatic, except in a defined set of contexts. The trill in Abu Shusha displays the contextual alternation described by Younes. Data showing this will be presented below. On the basis of these data, it will be concluded that, like Dar Younes, Abu Shusha lacks underlying non-emphatic /r/.

The data in (6) are Dar Younes forms, from Younes (1994:218), in which the trill surfaces as emphatic {r̙}. (In this section, Younes' transcription of Dar Younes vowel quality will be retained. The surface form status of Younes' data is inferred from his discussion. I have added the ungrammatical forms. Finally, Younes does not mark emphasis for the surface emphatic consonants in his data; their transcription below follows Younes' (1994:218-219) summary of their contexts of occurrence in his dialect.)

(6) Dar Younes Forms

a. {n̙aːr̙}	(*{næːr})	'fire'
b. {ʤ̙aːr̙}	(*{ʤæːr})	'neighbour'

Younes explains that in Palestinian, the occurrence of the back (long or short) low vowel indicates the presence of an emphatic consonant in the word, as does the occurrence of emphatic variants of otherwise non-emphatic consonants; *cf.* {aː}, and {n̙ ʤ̙} in (6). He analyses back {aː} and surface emphatic {n̙ ʤ̙} in (6) as arising through uvularisation harmony triggered by the emphatic {r̙}. (Younes refers to uvularisation harmony as 'emphasis spread'. For acoustic support for emphatic {r̙} in forms such as those in (6), see §2.3.1.1. The properties of uvularisation harmony in the Abu Shusha dialect will be addressed in detail in §2.5.)

Younes (1994:220-221) lists three contexts for /r̙/-de-emphaticisation.[1] He describes the first as "in the neighborhood of a noninflectional, nonepenthetic, nonlow front vowel." This context is here rephrased as: in a word containing a root-internal /I(ː)/ or /E(ː)/. Dar Younes forms showing non-emphatic {r} in this context, from Younes (1994:220), are presented in (7). (I have added the underlying forms.)

(7) Dar Younes Forms

a. /xIr̙fÆːn/	{xir.ˈfæːn}	(*{x̙ir̙.ˈfaːn})	'lambs'
b. /bÆr̙mIːl/	{bær.ˈmiːl}	(*{b̙ar̙.ˈmiːl})	'barrel'
c. /ɣEːr̙-Æk/	{ˈɣeː.r-æk}	(*{ˈɣ̙eː.r̙-ak})	'other than you [masc. sg.]'

As seen the low vowels in (7) surface front, not back. This is evidence for non-emphatic {r} in these forms.

The Abu Shusha cognates of the data in (7) are presented in (8). As seen, the Abu Shusha trill also surfaces non-emphatic in this context. Were the trill emphatic in (8), the low vowels and non-emphatic consonants in each form would surface as seen in the ungrammatical forms provided; this claim will be substantiated in §2.5.[2]

---

[1]The three contexts are also identified in Younes (1993).

[2]The {ɐː} in (8a) is the backed variant of Abu Shusha long /Æː/. Mid {ɜ˃} in (8b-c) is a reduced variant of /Æ/; this will be shown in §2.2.2.5.

(8) Abu Shusha Forms

a. /χIrfÆ:n/ {χɪr.ˈfæ:n} (*{χɪ̝r̝.ˈf̝ɐ:n̝}) 'lambs'

b. /bÆrmI:l/ {bɜr.ˈmi:l} (*{b̝ɜ˃r̝.ˈm̝i̝:l̝}) 'barrel'

c. /ʁE:r-Æk/ {ˈʁe:.r-ɜk} (*{ˈʁe̝:.r̝-ɜ˃k̝}) 'other than you (masc. sg.)'

The second context Younes identifies for /r̝/-de-emphaticisation is immediately before one of /θ ð t d s z n ʃ ʧ ʤ j/ in the same stem. This set of consonants corresponds to the set of (non-emphatic) non-lateral coronals. De-emphaticisation in this context is illustrated by the data in (9), which are from Younes (1994:221).

(9) Dar Younes Forms

a. {bær.ˈd-æ:n} (*{b̝ar̝.ˈd-a:n}) 'cold (masc. sg.)'

b. {ˈdær.s-æk} (*{ˈd̝ar̝.s-ak}) 'your [masc. sg.] lesson'

c. {ˈʔær.næb} (*{ˈʔ̝ar̝.nab}) 'rabbit'

The Abu Shusha cognates of the forms in (9) are presented in (10). As seen, the trill is non-emphatic in this context.[3]

(10) Abu Shusha Forms

a. {bɜr.ˈd-æ:n} (*{b̝ɜ˃r̝.ˈd̝-ɐ:n̝}) 'cold (masc. sg.)'

b. {ˈdar.s-ɜk} (*{ˈd̝ʌ̝r̝.s̝-ɜ˃k̝}) 'your (masc. sg.) lesson'

c. {ˈʔar.nɜb} (*{ˈʔ̝ʌ̝r̝.n̝ɜ˃b̝}) 'rabbit'

Potential counterexamples to Younes' second generalisation are presented by forms

[3] Abu Shusha {a} is the pharyngealised variant of /Æ/ in a closed, that is, CVC, syllable; {ʌ} is a uvularised-pharyngealised variant of /Æ/ in the same context; see §2.2.2.6.

containing /w/. An Abu Shusha example is /wÆṛd-Æ/ {'war.d-ə} 'flower'.[4] In the surface form of this word, the initial-syllable vowel is more similar to back [ʌ] than front [a]. However, forms such as this are here not considered to counter Younes' generalisation because in them underlyingly non-emphatic consonants do not surface emphatic. E.g., in {'war.d-ə}, {w} and {d} are non-emphatic. Were the trill in this word emphatic, surface emphatic {ẉ} and {ḍ} be observed. Because they are not, the non-front quality of the initial-syllable vowel is considered a coarticulatory phonetic effect of the preceding {w}, yielding the transcriptions: /wÆṛd-Æ/ {'war.d-ə} ['wa˞ r.d-ə], where '˞' denotes phonetic backing and raising.

The third context Younes identifies is before a velar in the same root. Forms which show non-emphatic {r} in this context, from Younes (1994:221), are presented in (11).

(11) Dar Younes Forms

a. {'tær.ræx}	(*{'ṭaṛ.ṛax})	'he dated'
b. {'fær.ræɣ}	(*{'f̣aṛ.ṛaɣ})	'he emptied'
c. {'ræː.fæk}	(*{'ṛaː.fæk})	'he befriended'

Abu Shusha has uvular /ʁ χ/ instead of velar /ɣ x/. However, Abu Shusha data with the trill before velar /k/ in the same root are presented in (12). As seen, the trill is non-emphatic in this context.

[4]Mid {ə} is a second reduced variant of /Æ/ (besides the one mentioned in note 2). The reduced variants of /Æ/ will be discussed in §2.2.2.5.

(12) Abu Shusha forms

a. {'ræː.f3k} (*{'r̙ɐː.f̙ɜ˃k̙}) 'he befriended'

b. {'mæ.r3k} (*{'m̙ʌ.r̙ɜ˃k̙}) 'he spoiled (someone/something)'

On the basis of data such as those in (8), (10), and (12), Abu Shusha {r} is here analysed as de-emphaticised /r̙/. For this reason, the underlying inventory in (1) does not include non-emphatic /r/.

2.2.1.3.3. High-frequency vs. Low-frequency Emphatics

In Palestinian, /m̙ b̙ l̙/ occur less frequently than the other emphatics. Forms in which they do occur are seen in (13). Younes (1982:57) identifies (13d) as a borrowing from Italian, (13e) as a borrowing from Classical Arabic.[5]

(13)	a. {m̙aij̙j̙}	'water'	d. {'b̙ɑ.b̙ə}	'daddy'
	b. {'ʕ̙ʌm̙.m̙-o̙}	'paternal uncle'	e. {'ʔ̙ʌl̙.l̙ɜ˃h̙}	'God'
	c. {'m̙ɑ.m̙ə}	'momma'	f. {'j̙ɪl̙.l̙ə}	'let's go!'

The segments {m̙ b̙ l̙} have been called 'secondary emphatics' while {ð̙ s̙ t̙ r̙ k̙} have been called 'primary emphatics'; see, e.g., Younes (1994). In this thesis, the first set will instead be referred to as 'low-frequency emphatics', the second set as 'high-frequency

[5]Younes (1982:57) and Herzallah (1990:39) record the initial-syllable vowel in (13c-d) as long in the Dar Younes and Yaʕbad dialects, respectively. (Yaʕbad is a northern *fellāhi* very similar to Dar Younes; see note 18.) However, in Abu Shusha, it is short.

emphatics', to avoid confusion with the terms 'primary articulation' and 'secondary articulation'.

An issue with respect to the two sets of emphatics is whether or not {ṃ ḅ ḷ} should be recognised as underlying /ṃ ḅ ḷ/; see, e.g., Younes (1994) for discussion. With regard to this issue, the differences between the two sets, which are solely distributional, are usually discussed. Maamouri (1967), Younes (1982, 1994), and Herzallah (1990) observe that there are more restrictions on the occurrence of the low-frequency emphatics than on high-frequency emphatics. Younes (1994) shows that the latter (i) have minimal lexical contrasts with non-emphatic counterparts (e.g., /tI:n/ {ti:n} 'figs' vs. /ṭI:n/ {ṭi:ṇ} 'mud), (ii) have a high frequency of occurrence, and (iii) occur in all positions and adjacent to all vowels.

These properties are not shared by the low-frequency emphatics. As Younes discusses, there are no lexical contrasts between emphatic {ṃ ḅ ḷ} and non-emphatic {m b l}; that is, there are no minimal pairs like {ˈṃɑ.ṃə} vs. *{ˈmæ.mə}). Furthermore, {ṃ ḅ ḷ} occur only in a handful of forms, several of them borrowings. (This is presumably why there are no lexical contrasts between {ṃ ḅ ḷ} and {m b l}.) As for vowel contexts, Younes (1994:216) describes {ṃ ḅ ḷ} as occurring only with low vowels. Maamouri (1967:49) says they occur "almost exclusively with low vowels." More study is needed to determine whether Abu Shusha data match Younes' or Maamouri's generalisation on this last point.

Regardless of the distributional limitations on {m̙ b̙ l̙}, there is a strong argument for recognising them as underlying /m̙ b̙ l̙/, *viz.*: the uvularisation of {m̙ b̙ l̙} in forms like those in (13) but not in forms like those in (14) is unpredictable.

(14)	a. {maʕ}	(*{m̙ʌʕ̙})	'with'
	b. {ˈða.ħɪb}	(*{ˈð̙ʌ.ħ̙ɪb̙})	'gold'
	c. {ˈħæː.l-i}	(*{ˈħ̙ɐː.l̙-i})	'myself'

This unpredictability indicates that their uvularisation is underlying. For this reason, /m̙ b̙ l̙/ are included in the underlying inventory in (1).

After Card (1983:106-107), the following procedure will be used for identifying underlying emphatic /m̙ b̙ l̙/: if a high-frequency emphatic occurs in a word containing one of surface emphatic {m̙ b̙ l̙}, it will be assumed that {m̙ b̙ l̙} are underlyingly non-emphatic /m b l/, and that surface {m̙ b̙ l̙} are derived in such words by uvularisation harmony. Example transcriptions illustrating this procedure are: /bÆlÆːt̙/ {b̙ɜ̙˃.ˈl̙ɐ̙ːt̙} 'tiles', and /mÆr̙Æ/ {ˈm̙ɑ.r̙ə} 'woman, wife'.

2.2.1.4. Epenthetic Word-initial {ʔ}

It is assumed here that most word-initial glottal stops in Palestinian are epenthetic. The evidence for this is that word-initial glottal stop is not observed when another consonant is present to serve as onset of the word-initial syllable. This is seen from the data in (15), compared with those in (16). (Palestinian verbs glossed as infinitives are in the colloquial citation form, which is the root + imperfect vocalism.)

(15)	a. /b-Itʃ͡ðIb/	{ˈb-ɪtʃ.ðɪb}	(*{bɪ.-ˈʔɪtʃ.ðɪb})	'he lies'
	b. /b-IktIb/	{ˈb-ɪk.tɪb}	(*{bɪ.-ˈʔɪk.tɪb})	'he writes'
(16)	a. /Itʃ͡ðIb/	{ˈʔɪtʃ.ðɪb}	(*{ˈɪtʃ.ðɪb})	'to lie' ('to tell an untruth')
	b. /IktIb/	{ˈʔɪk.tɪb}	(*{ˈɪk.tɪb})	'to write'

Forms such as those in (17) are an exception to this generalisation. (An epenthetic vowel occurs in the initial syllable of the grammatical surface forms in (17). The Palestinian epenthetic vowel will be discussed in §2.3.3.3)

(17)	a. /b-ʔÆbÆːt̙/	{b̙ɪ.-ʔ̙ɜ˃.ˈb̙ɐːt̙}	(*{b̙-ɜ˃.ˈb̙ɐːt̙}	'he hugs'
	b. /b-ʔÆχχIr̙/	{bɪ.-ˈʔaχ.χɪr}	(*{ˈb-aχ.χɪr})	'he causes (someone, something) to be late'

In (17), {ʔ} is observed despite the {b} that is available to serve as onset of the initial syllable. To rephrase the analysis of (15) and (16), epenthetic {ʔ} occurs at a left word edge in words which would otherwise contain no word-initial consonant. Since the {ʔ}s in (17) do not occur at a left word edge, they are unexpected and so require an explanation. The explanation adopted here is: the {ʔ}s in (17) are unexpected because they are unpredictable. That is, they are underlying (C_1 of the lexical root). On this basis, it is concluded that Palestinian has both an underlying /ʔ/ and an epenthetic {ʔ}.

Word-internally, however, glottal stop does not occur to provide an onset for a vowel-initial syllable. That is, word-internal vowel hiatus occurs. Forms showing this are:

(18) a. /fÆːð̙I-Æ/	{ˈf̙ɐ̙ː.ð̙i.-ə}	(*{ˈf̙ɐ̙ː.ð̙i.-ʔ̙ə})	‘empty (fem. sg.)’ (Adj)
b. /mÆʃI-Iːn/	{mə.ʃi.-ˈiːn}	(*{mə.ʃi.-ˈʔiːn})	‘walking (masc. pl.)’ (Adj)
c. /fÆr̙U-I/	{ˈf̙ɑ.r̙u.-i}	(*{ˈf̙ɑ.r̙u.-ʔ̙i})	‘my fur’
d. /mÆrIUːl/	{mə.ri.-ˈuːl}	(*{mə.ri.-ˈʔuːl})	‘apron’
e. /wIt̙I-Æt/	{ˈw̙ɪ.t̙i.-ɜ˃t̙}	(*{ˈw̙ɪ.t̙i.-ʔ̙ɜ˃t̙})	‘lowered (fem. sg.)’ (Adj)

The hiatus forms in the Palestinian corpus of this study involve the vowel sequences {i.iː}, {i.ə}, {i.uː}, {eː.i}, {uː.i}, and {u.eː}. None involve short {e}, short {o}, or long {oː}. This is presumably a coincidental result of the general lower frequency of the mid vowels. The lack of hiatus involving two long vowels is expected, since a long vowel is shortened before another long vowel in the word; see Abdo (1969) and Abu-Salim (1986) for discussion.

In Abu Shusha hiatus forms, glide formation does not occur. It does occur in the Dar Younes dialect, as seen from the Dar Younes forms: {ˈf̙aːð̙.j-i} and {mæʃ.ˈj-iːn}.[6] In the spectrogram of an Abu Shusha hiatus form, acoustic support for a syllable boundary between the two vowels is a brief pause at the point of hiatus. In a form like {mə.ʃi.-ˈiːn}, f_0 is higher for the stressed, final-syllable {iː} than for the unstressed, penultimate-syllable {i}.

[6]I thank Munther Younes for these data.

Hiatus does not occur in all contexts. Prefixal vowels are elided before a stem-initial vowel. This is seen from comparing forms such as {mɜ.-ʃʊf-t.-ˈhæː-ʃ} 'I didn't see her' (no elision) and {m-ə.ˈʤæː-ʃ} 'he didn't come' (elision; cf. {ˈʔæ.ʤə} 'he came'). More study is needed to determine the full range of contexts in which hiatus is and is not allowed.

Important to the issue at hand is that in Abu Shusha a glottal stop is not inserted to break up hiatus, so that surface forms such as *{mə.ʃi.-ˈʔiːn}, *{ˈf̙ɐː.ð̙i.-ʔ̙ə}, *{ˈw̙ɪ.t̙i.-ʔ̙ɜt̙}, etc., are ungrammatical. Based on this finding, and on the evidence that onsetless syllables are crosslinguistically highly disfavoured (see, e.g., McCarthy and Prince 1993a, Prince and Smolensky 1993), Palestinian word-initial {ʔ} is here analysed not as a phonetic effect but as a default consonant epenthesised in the phonology to provide an onset for a word-intial syllable. The same is assumed for word-initial glottal stop in Classical Arabic by Prince and Smolensky (1993).

Palestinian word-initial {ʔ} is assumed to be imposed by the constraint 'ONSET' ('ONS': 'Syllables must have onsets'; McCarthy and Prince, 1993a, Prince and Smolensky 1993). Hiatus data such as those in (18) indicate that ONS has the decompositions 'ONS-$_{Wd}[\sigma$' ('Word-initial syllables have onsets') and 'ONS-σ' ('Syllables have onsets') which are ranked in Palestinian: ONS-$_{Wd}[\sigma$ >> ONS-σ.

Finally, the data in this section have shown that in Abu Shusha Palestinian, onsetless syllables are illicit word-initially, but licit word-internally. This counters the usual assumption, expressed, e.g., by Majdi and Winston (1994:186) and Lee (1995:359), that all Arabic syllables must begin with a consonant.

2.2.2. Vocalic Inventory

Palestinian's underlying vocalic inventory is presented in (19). It has a length distinction and three degrees of height. There is no underlying low front vs. low back distinction.

(19) The (Abu Shusha) Palestinian Underlying Vocalic Inventory

a. short vowels

	FRONT		BACK
HIGH	I		U
MID	E		O
LOW		Æ	

b. long vowels

	FRONT		BACK
HIGH	I:		U:
MID	E:		O:
LOW		Æ:	

The surface vocalic inventory is presented in (20).

2.2.2. Vocalic Inventory

(20) The (Abu Shusha) Palestinian Surface Vocalic Inventory

a. short vowels

	FRONT		CENTRAL			BACK			
	NON-RTR	RTR	NON-RTR	RTR		NON-RTR		RTR	
						NON-RD	RD	NON-RD	RD
			non-bk	non-bk	bk				
HIGH	i	ɪ					u		ʊ
MID	e	ɛ	ə	ɜ	ɜ˃		o	ʌ	ɔ
LOW	æ	a						ɑ	

b. long vowels

	FRONT	BACK	
	NON-RTR	NON-RTR	
	NON-RD	NON-RD	RD
HIGH	iː		uː
MID	eː		oː
LOW	æː	ɐː	

The surface inventory differs from the underlying inventory by containing several more short vowels. The surface short vowels comprise non-retracted-tongue-root ('non-rtr')/retracted-tongue-root ('rtr') pairs: {i} vs. {ɪ}, {e} vs. {ɛ}, {æ} vs. {a}, {ə} vs. {ɜ}, {o} vs. {ɔ}, and {u} vs. {ʊ}. In the low back position, however, only rtr {ɑ} occurs. The reason for the lack of a non-rtr low back short vowel will be discussed in §2.5.2. Two additional short vowels are mid central backed {ɜ˃} and mid back {ʌ}.

The surface inventory also contains two diphthongs: {ai} and {au}, which are here analysed as arising from underlying /Æ/-glide sequences because they always occur followed by ⟨j⟩ and ⟨w⟩, respectively; *cf.*, e.g., ⟨ˈṣ̙aij̙.j̙ɪḍ̙⟩ 'to hunt', ⟨kau.ˈwæːm⟩ 'quickly'.

Finally, the surface inventory differs from the underlying inventory by containing two long low vowels instead of one.

The claim that the Palestinian vocalic system has three degrees of height is controversial. To my knowledge, there has been no thorough analysis of the surface short system, and no systematic investigation of the vowel reduction. In the discussion that follows, previous treatments of the Palestinian/Levantine vocalic system will first be summarised. Justification of the inventories in (19) and (20) will then be presented.

2.2.2.1. Previous Analyses of the Palestinian/Levantine Vocalic System

2.2.2.1.1. Non-generative Analyses

Non-generative analyses typically define the Levantine vowels in terms of the Classical Arabic system of three long, three short, and no mid height.[7] Although no underlying vs. surface inventories are typically posited in such studies, an underlying inventory is usually implied. Non-generative studies of Arabic have usually implied that the back low vowels result from emphasis harmony in the context of an emphatic

[7]See, e.g., Schmidt and Kahle (1918/30), Bauer (1926/70), Cantineau (1960), Grotzfeld (1964, 1965), Palva (1988), and Nishio (1992).

consonant. In so doing, they imply the distinct underlying vs. surface inventories seen below:

(21) The Vocalic System of Palestinian/Levantine Arabic
Implied by Non-Generative Studies

a. underlying inventory

	FRONT		BACK
HIGH	I: I		U: U
LOW		Æ: Æ	

b. surface inventory

	FRONT	BACK
HIGH	iː i	uː u
LOW	æː æ	ɑː ɑ

The non-generative studies note that long mid [eː] and [oː] occur in forms where Classical Arabic has the diphthongs /ai/ and /au/. (In this section, where previous studies either implicitly or explicitly ascribe underlying, surface or phonetic status to a vowel, the status will be indicated by the vowel transcription presented; e.g., I interpret the studies just mentioned as implying that the long mid vowels are phonetic.) They record occurrences of short mid [e] and [o] but analyse them as lowerings of /i/ and /u/, respectively, conditioned by gutturals and emphatics. For example, Cantineau (1960:110-111) states:

> Dans les dialectes modernes de l'arabe, les timbres vocaliques semblent à première vue nombreux et variés... De fait les sujets parlants, dans la plus grande partie du monde arabe, ne distinguent actuellement comme autrefois que trois timbres phonologiques de voyelles brèves, timbres susceptibles de diverses réalisations phonétiques suivant la nature des phonèmes voisins...

2.2.2. Vocalic Inventory

> Les pharyngales *ḥ* et *ᵋ*, parfois les vélaires *ḫ* et *ġ* attirent vers *ɑ* le timbre des voyelles voisines... Les consonnes emphatiques ou *mufahhama*, parfois les vélaires *ḫ*, *ġ* et *q*, reportent en arrière le point d'articulation des voyelles voisines. [Cantineau denotes 'ʕ ħ ʁ χ' as 'ᵋ *ḥ ġ ḫ*', respectively.]

Bauer (1926/70:11) remarks: "Unter dem Einfluss eines umgebenden ḥ ḫ ᶜ ṛ wird kurzes i — seltener langes î — zu e getrübt... u ... [w]ird durch umgebende Kehllaute ziemlich nach o, auch ö." (Bauer denotes 'ʕ ħ χ ṛ' as 'ᶜ ḥ ḫ ṛ', respectively.)

Rtr short vowels are usually unmentioned. As an exception, Bauer (1926/70:11) describes [ɪ] and [ʊ], which he assumes to be the invariant values of /i/ and /u/, respectively. He states: "i = kurzes i in Sinn {zɪn}, z.B. *bint* Tochter... u = kurzes u in Mutter {ˈmʊ.tɚ}, z.B. *kutub* Bücher" (italics and German transcriptions are mine/KNS).

Note that rtr short vowels are recorded for Classical Arabic. Gairdner (1978:194) quotes the traditional Arabic grammarian Ibn As Sarraj as stating: "The tongue sinks lower with the kasra, *i* (short *i*), than it does with the *ye*, long *ī*. Gairdner explains: "In other words, *i* was wider than *ī*, which latter was the narrow or extreme *i*. We have here, apparently, the same distinction between English 'bit' and 'beat'; and we may reasonably assume that the same distinction held good in the *u* family, namely that short *u* was wider than *ū*, as in the difference between English 'foot' and 'school'."

As a variation on (21), Palva (1988) recognises mid long {eː} and {oː}, stating [p.228] that they are "most often the reflexes of /ay/ and /aw/ respectively". Nishio (1992) asserts long mid vowels for Jbāli (Sinai) Arabic, but provides no comment.

2.2.2. Vocalic Inventory

Nishio's short vowel inventory includes {e} and {o}. He states [p.xiv] that short {e} and {o} "...can be regarded as having some relevant status, at least at the surface representation", but concludes (*ibid.*): "[p]honologically speaking, this dialect has a familiar functionally triad system of short vowels". By this, he implies the underlying short set: /I Æ U/.

Reduced vowels are documented by Mattsson (1911), Grotzfeld (1964, 1965) and Nishio (1992). Mattsson (1911) documents short high vowel reduction for Beirut Lebanese. Grotzfeld (1965:12-13) describes it for Damascus Syrian, citing forms like /min/ > {mən} 'from', /yiktubu/ > {yəktbu} 'they write', /kutub/ > {kətob} 'books'. (Groztfeld's transcription is retained here.) Such high vowel reduction does not occur in Abu Shusha: the Abu Shusha cognates of the Damascas data just cited are {mɪn}, {'b-ɪ.kɪt.b-u}, and {'kʊ.tʊb}.

Nishio (1992) describes both high and low short vowel reduction for Jbāli, noting that low vowel reduction is the less frequent of the two. For the low vowel, he states [p.xvi]: "in the unstressed syllable, particularily at the beginning of a word, /a/ is reduced to [ə] in casual speech as in e.g. [ràwwáhtu ~ rəwwáhtu] (= "you (pl.m.) went" Pf. 2 pl.m.)." Short low vowel reduction occurs in Abu Shusha, as will be discussed in §2.2.2.5.

2.2.2.1.2. Generative Analyses

Previous generative studies which explicitly address the Palestinian vowel system include Johnson (1979, 1982), Younes (1982), Card (1983), Herzallah (1990), and Younes (1993). The moderate analysis, represented by Younes (1993), is seen in (22). As seen, Younes (1993) does not recognise mid height for the short vowels. Rtr short vowels and reduced vowels are not mentioned in that study.

(22) Previous Moderate Generative Analysis of the Palestinian Vocalic System (Younes 1993)

a. underlying inventory

	FRONT		BACK
HIGH	I: I		U: U
MID	E:		O:
LOW		Æ: Æ	

b. surface inventory

	FRONT	BACK
HIGH	i: i	u: u
MID	e:	o:
LOW	æ: æ	ɑ: ɑ

Herzallah (1990) argues for a smaller inventory than that in (22). For the Yaʕbad (northern *fellāhi*) dialect, she does not recognise the underlying long mid vowels, /E: O:/, nor underlying short /U/. For the former, she cites [p.146] the historical diphthong argument, but does not investigate the issue further. For the latter, she argues that historical /U/ has merged with /I/ and /Æ/, and that surface {u} is derivable from either /I/ or /Æ/ by morphological or phonological conditioning.

Herzallah's evidence for the lack of underlying short /U/ in YaʕBad is extensive, and is the focus of chapter 3 of her dissertation. The discussion that follows will review a portion of her evidence. It will be shown that the same evidence is not always found in Abu Shusha. On this basis, it will be concluded that, unlike Yaʕbad, Abu Shusha has underlying /U/.

A first type of evidence which Herzallah discusses is the levelling of historical /U/ with /I/ or /Æ/ in historical CUCV(V)C nouns: Yaʕbad {u} does not occur in such a noun where it did historically. Yaʕbad data showing this, from Herzallah (1990:161), are presented in (23). (Herzallah's transcriptions will be retained in this section. Their surface form status is inferred from her discussion. A word-final {t} is included in (23a). In Arabic in general, a final {t} is observed for feminine nouns which otherwise end in a vowel. Theoretical issues surrounding this {t} will not be examined in this thesis.)

(23) Yaʕbad Forms

a. {dikkaani(t)}	'shop' (N)	(compare Classical Arabic: {dukkaan})
b. {zinnaar}	'belt'	(compare Classical Arabic: {zunnaar})

The Abu Shusha cognates of the Yaʕbad forms in (23) are presented in (24). As seen, the vowel of interest surfaces as {ʊ} in Abu Shusha, indicating no levelling of historical /U/ in Abu Shusha CUCCV(V)C nouns. (Abu Shusha {ʊ} is the rtr counterpart of non-rtr {u}; this will be shown in §2.2.2.6 and §2.4. Non-rtr vs. rtr variants of the short vowels are not distinguished in Herzallah's transcriptions.)

(24) Abu Shusha Forms

a. {dʊʧ.ˈʧæːn} (*{dɪʧ.ˈʧæːn}) 'shop' (N)

b. {z̙ʊn̙.ˈn̙ɐːr̙} (*{z̙ɪn̙.ˈn̙ɐːr̙}) 'belt'

A second type of evidence that Herzallah discusses is dorso-pharyngeal phonological conditioning in a/i imperfectives: in Yaʕbad, stem {u} occurs in roots with one of /t̙ s̙ z̙ ð̙ r̙ x ɣ K/, but not in roots without one of those consonants. (Herzallah describes 'K' as a back velar. It is cognate to Abu Shusha emphatic /k̙/.) The set of segments just listed is here analysed as the class of segments which are specified for either primary- or secondary-[DOR]; see §2.3.1 for the basis for this analysis.

Dorso-pharyngeal conditioning in a/i imperfectives is illustrated by the Yaʕbad data in (25), from Herzallah (1990:167,169). In each form in (25), the stem vowel is the final-syllable vowel.

(25) Yaʕbad Forms

a. {yinbuɣ} ~ {yunbuɣ} 'he excels'

b. {yišṭub} ~ {yušṭub} 'he crosses out'

(compare Yaʕbad: {yimlis} 'he smooths' and {yiftim} 'he bewitches', which contain none of /t̙ s̙ z̙ ð ð̙ r̙ x ɣ K/ and have a front stem vowel)

2.2.2. Vocalic Inventory

In Abu Shusha, {i}/{ɪ} can occur in a/i imperfectives with one of /t̙ s̙ z̙ ð ð̙ r̙ χ ʁ k̙/, indicating no general dorso-pharyngeal conditioning in such forms. This is seen from the data in (26). (Uvular /χ ʁ/ are the Abu Shusha cognates of YaʕBad /x ɣ/. Surface {ɪ} is the rtr counterpart of non-rtr {i}.)

(26) Abu Shusha Forms

a. {ˈb̙-ɪb̙.s̙ɪt̙} (*{ˈb̙-ɪb̙.s̙ʊt̙}, *{ˈb̙-ʊb̙.s̙ʊt̙}) 'he gets happy'

b. {ˈb̙-ɪs̙.r̙ɪk̙} (*{ˈb̙-ɪs̙.r̙ʊk̙}, *{ˈb̙-ʊs̙.r̙ʊk̙}) 'he steals'

A third type of evidence that Herzallah discusses is dorso-pharyngeal phonological conditioning in biliteral roots: in Yaʕbad, stem {u} occurs in roots with one of /t̙ s̙ z̙ ð̙ r̙ x ɣ K/, but not in roots without one of /t̙ s̙ z̙ ð̙ r̙ x ɣ K/. This is seen in the forms in (27), from Herzallah (1990:171).

(27) Yaʕbad Forms

a. {ys̙uff} 'he lines up'

b. {yð̙umm} 'he annexes'

(compare Yaʕbad: {ybizz} 'he comes out' and {yðimm} 'he dispraises', which contain none of /t̙ s̙ z̙ ð ð̙ r̙ x ɣ K/ and have a front stem vowel)

In this case, the distribution of Abu Shusha {u}/{ʊ} seems to follow the distribution Herzallah identifies for Yaʕbad. This is illustrated by the Abu Shusha data (28), which are cognates of the Yaʕbad forms in (27).

(28) Abu Shusha Forms

a. {b̘ɪ.-ˈs̘ʊf̘f̘} 'he lines up'

b. {b̘ɪ.-ˈð̘ʊm̘m̘} 'he annexes'

(compare Abu Shusha: {bɪ.-ˈbɪzz} 'he squeezes (something) out' and {bɪ.-ˈðɪmm} 'he dispraises (someone/something)')

Despite the finding with respect to biliteral roots, data such as those in (24) and (26) indicate that the contexts of {u}/{ʊ} in Abu Shusha are not reducible to those described by Herzallah. That is, {u}/{ʊ} are not always derivable from /I/ or /Æ/. On this basis, Abu Shusha {u}/{ʊ} are analysed as underlying /U/, and /U/ is included in the underlying vowel inventory in (19).

Herzallah's evidence for the lack of /U/ in Yaʕbad indicates that the underlying or non-underlying status of surface {u}/{ʊ} is a matter of analysis for each Palestinian dialect. Further research should reveal which dialects follow Yaʕbad in the distribution of {u}/{ʊ} and which do not. Stuart Davis (p.c.) reports that underlying /U/ must be recognised for the southern Palestinian dialect of Davis (1993, 1995).

The three theoretical studies remaining to be discussed are Johnson (1979, 1982) and Card (1983). Johnson and Card present expansionist variants of (22).[8] They assume three degrees of height for both underlying and surface inventories. For the surface inventory, they recognise some rtr short vowels: Johnson (1982:63) describes /E/ and /O/ as basically

[8]The analyses of the vocalic inventory in Johnson (1979) and (1982) are essentially the same.

{ɪ} and {ʊ}, respectively, with "lower allophones next to a pharyngeal or in a final syllable"; Card recognises {ɪ} and {ʊ} as surface variants of underlying /I/ and /U/, respectively. (Both Johnson and Card refer to the rtr vowels as 'lax'. In this thesis, 'lax' is equated with 'rtr'; see §2.4.2 for discussion.) For the vowels for which they posit rtr surface variants, they do not recognise non-rtr surface variants. That is, Johnson does not recognise non-rtr {e} and {o} as surface variants of /E/ and /O/, respectively. (Johnson assumes that short /I/ and /U/ always surface, respectively, as {i} and {u}.) Card does not recognise non-rtr {i} and {u} as surface variants of /I/ and /U/, respectively.

Finally, Herzallah (1990), Johnson (1979, 1982) and Card (1983) do not mention vowel reduction.

2.2.2.1.3. Summary

In summary, there has been considerable confusion over just what the Palestinian/Levantine vowel system is. The uncertainty is not confined to Levantine, as summarised by Norlin (1987:50-51):

> A comparison between the studies of Egyptian Arabic and other dialects in the eastern dialect area shows that the phonemic analysis of the short vowel systems is uncertain and surrounded by guarded arguments. It seems as if the short vowel system is in a state of flux and that phonemic oppositions are under development and not yet quite established. Another explanation of the vagueness might be the weakness in many presentations of the various phonological vowel systems in so far that they seldom go into

> phonetic details nor present examples of minimal pairs where the contrastive function of the phonemes is obvious. As a result, the same dialect can be said to have a different number of short vowels, depending on the author. Many dialects in the neighboring countries seem to have developed more short vowels than the classical three. Card (1983) identifies five short vowel phonemes in her investigation of the Palestinian dialect, but does not go into detail. Rice and Said (1960:xx) also recognize five short vowels in the same dialect. None presents minimal pairs.

The following sections (§2.2.2.2 - §2.2.2.7) will present data which support the analysis of the Palestinian vocalic system in (19) and (20). This will include minimal pairs, with the aim of following also the advice of Bouquiaux and Thomas (1992:97):

> Many studies show only a table summarizing the phonemes of the language with a few supplementary remarks. For us, defining each phoneme is a small problem to be resolved. Data must be presented and a solution proposed. This is the only scientifically valid procedure, we feel, since it allows the reader to verify the results. Some arbitrariness is unavoidable, but at least we limit it to the selection of data. A linguist who simply gives a list of phonemes adds the arbitrariness of his interpretations, which are not open to evaluation.

2.2.2.2. Underlying Length

An underlying length distinction in Palestinian is supported by the minimal/near-minimal pairs in (29). The corpus of this thesis contains no pairs for /E:/ vs. /E/ and /O:/ vs. /O/. However, the mid vowels occur with general lower frequency than the high and low vowels. It is assumed here that the lack thus far of pairs for /E:/ vs. /E/ and /O:/ vs. /O/ is due to the lower frequency of the mid vowels, and that further fieldwork might yield pairs showing the /E:/ vs. /E/ and /O:/ vs. /O/ contrasts. Finally, in each pair in (29), it is the underlying vowels that are in contrast, regardless of observed differences in surface vowel quality, e.g., non-rtr {i} vs. rtr {ɪ} in (29a). This is because those differences are due to the phonology, as will be shown in §2.3 and §2.4.

(29) Data Pairs Showing Underlying Length Distinction

a. /I:/ vs. /I/

i. /zI:ṛ/	{ziːr}	'large water urn'
ii. /zIṛṛ/	{zɪrr}	'button'

b. /E:/ vs. /E/

(none found)

c. /Æ:/ vs. /Æ/

i. /ʕÆ:lÆm/	{ˈʕæː.lɜm}	'world'
ii. /ʕÆlÆm/	{ˈʕa.lɜm}	'flag'

d. /O:/ vs. /O/

(none found)

e. /U:/ vs. /U/

i. /kU:ṛÆ/	{ˈḳuː.ṛə}	'forehead'
ii. /kUṛÆ/	{ˈḳʊ.ṛə}	'ball'

2.2.2.3. Three Underlying Degrees of Height For the Long Vowels

Minimal/near-minimal pairs showing three degrees of height for the underlying long vowels are presented below:

(30) Data Pairs Showing Three-way Height Distinction for the Long Vowels

a. /I:/ vs. /E:/

i. /ʧI:f/	{ʧi:f}	'how'
ii. /ʧE:f/	{ʧe:f}	'mood'

b. /I:/ vs. /Æ:/

i. /bÆṛI:d/	{bə.ˈri:d}	'mail' (N)
ii. /bÆṛÆ:d/	{ḅɜ˃.ˈṛɐ:ḍ}	'coolness'

c. /I:/ vs. /O:/

i. /dI:ṛ/	{di:r}	'to pour'
ii. /dO:ṛ/	{ḍo:ṛ}	'turn' (as in a game; N)

d. /I:/ vs. /U:/

i. /bÆṛI:d/	{bə.ˈri:d}	'mail' (N)
ii. /bÆṛU:d/	{ḅɜ˃.ˈṛu:ḍ}	'gunpowder'

e. /E:/ vs. /Æ:/

i. /dE:ṛ/	{de:r}	'Christian parochial school'
ii. /dÆ:ṛ/	{ḍɐ:ṛ}	'house'

f. /E:/ vs. /O:/

i. /bE:t/	{be:t}	'home'
ii. /bO:t/	{bo:t}	'shoe'

g. /E:/ vs. /U:/

i. /sE:f/ {se:f} 'summer'

ii. /sU:f/ {su:f} 'wool'

h. /Æ:/ vs. /O:/

i. /dÆ:r/ {dɐ:r} 'house'

ii. /dO:r/ {do:r} 'turn' (as in a game; N)

i. /Æ:/ vs. /U:/

i. /bÆrÆ:d/ {bɜ˃.ˈrɐ:d} 'coolness'

ii. /bÆrU:d/ {bɜ˃.ˈru:d} 'gunpowder'

j. /O:/ vs. /U:/

i. /rO:ħ/ {ro:ħ} 'spirit'

ii. /rU:ħ/ {ru:ħ} 'to go'

2.2.2.4. Three Underlying Degrees of Height For the Short Vowels

This section presents evidence for underlying short /I/ vs. /E/ vs. /Æ/ vs. /O/ vs. /U/. However, arguments for recognising a phonetic high vowel lowering will first be given. It will be argued that the lowering cases must be discriminated and filtered out before true data pairs showing three degrees of height for the short vowels can be identified.

Mid vowels are consistently observed in words that contain a postvelar. This is illustrated by the forms in (31), in which '‿' identifies the second half of a phonetic diphthong.

(31) a. [ˈħɛ.lɛ̯ɪm] 'dream' (N)   b. [ˈʕɛ.ʤɛ̯ɪl] 'calf'   c.[m̞ɔr̞r̞] 'bitter (masc. sg.)'

After Bauer (1926/70:11) and Cantineau (1960:111), the mid height in such words is analysed as the result of lowering in the context of the guttural or emphatic.

In lowering forms, the farther the high vowel is from the postvelar, the less the vowel is lowered. This is illustrated by (31a-b): in those forms, while the first-syllable vowel is mid [ɛ], the second-syllable vowel is perceptually a short diphthong from mid [ɛ] to high [ɪ]. In other words, in a form containing a postvelar, high vowels are gradiently mid and their degree of mid-ness depends on the degree of proximity between the vowel and the postvelar. In short, the lowering is gradient.

Criteria by which a sound property can be identified as either phonetic or phonological were proposed in §1.7.1. One criterion is non-discreteness: phonetic properties are non-discrete; phonological properties are discrete. As explained in §1.7.1, gradience follows from non-discreteness. Gradience, then, characterises phonetic properties, not phonological properties. Because Palestinian high vowel lowering is gradient, it is here assigned phonetic status. Complete transcriptions of the forms in (31) are presented in (32). These transcriptions encode the phonetic status of the high vowel lowering. (In (32a-b), the Palestinian epenthetic vowel is observed. It is epenthesised for syllabification of the CVCC nouns, as discussed by Abu Salim (1980, 1987a) and Herzallah (1990); see §2.3.3. for further discussion of the epenthetic vowel.)

(32) a. /ħIlm/ {ˈħɪ.lɪm} [ˈħɛ.lɛ̯ɪm] ‘dream’ (N)
b. /ʕIʤl/ {ˈʕɪ.ʤɪl} [ˈʕɛ.ʤɛ̯ɪl] ‘calf’
c. /mUṛṛ/ {ṃuṛṛ} [ṃɔṛṛ] ‘bitter (masc. sg.)’,

The lowering in (32) contrasts with the lack of lowering observed in (33). The lack of lowering is expected for (33), since neither form contains a postvelar.

(33) a. /fIlm/ {ˈfɪ.lɪm} [ˈfɪ.lɪm] (*[ˈfɛ.lɪm], *[ˈfɪ.lɛm], [ˈfɛ.lɛ̯ɪm], *[ˈfɛ̯ɪ.lɪm], etc.) ‘movie’
b. /fIʤl/ {ˈfɪ.ʤɪl} [ˈfɪ.ʤɪl] (*[ˈfɛ.ʤɪl], *[ˈfɪ.ʤɛl], [ˈfɛ.ʤɛ̯ɪl], *[ˈfɛ̯ɪ.ʤɪl], etc.) ‘radishes’

Support for a phonetic analysis of the postvelar-induced lowering comes from the fact that, to my knowledge, there is no evidence that the lowered height is phonologically visible, that is, referred to in the phonology. By the criteria outlined in §1.7.1, phonological properties are phonologically visible, but phonetic properties are not.

Phonetic status for Palestinian high vowel lowering means that certain forms that appear to show three degrees of height for the short vowels must be disregarded. Examples are presented in (34).

(34) Faux Amis for Three-way Three-way Height Distinction for the Short Vowels

a.	i. /IħÆff/	{I.'ħaff}	[ḷ.'ħaff]	'heavy cotton cover'
	ii. /ħUff/	{ħʊff}	[ħɔff]	'bare foot'
b.	i. /ħÆll/	{ħall}	[ħall]	'it (masc.) bled' (as a dye bleeds)
	ii. /ħIll/	{ħɪll}	[ħɛll]	'to bleed' (as a dye bleeds)

The pairs in (34) are labelled 'faux amis' because in each mid-vowel form, (34a.ii) and (34b.ii), the mid height can be attributed to the phonetic lowering just discussed. Underlying mid height is not impossible in forms like each (ii) datum, above. However, if it were underlying, it could not be established as such because it would be phonetically neutralised with a phonetically lowered height in each form. Thus, no mid height is posited as underlying in (34) because there is no clear evidence that it is underlying. Since the mid height can be ascribed to the phonetics, whether or not it is really underlying in each form is untestable. The point here is that mid height cannot be established on the basis of forms that contain a postvelar.

However, true contrasts exist. A true contrast is one in which the form with the mid vowel lacks a postvelar consonant, that is, contains no phonetic source for the mid height. Those provided by the present corpus are seen in (35). For (35a), the vowels being contrasted are the initial-syllable vowels. Datum (35j.i) is a loan from English. As seen, no pairs for /E/ vs. /O/ and /E/ vs. /U/ were found. This is considered coincidental; it is presumed that further fieldwork would yield minimal pairs for those contrasts also.

2.2.2. Vocalic Inventory

(35) Data Pairs Showing Three-way Height Distinction for the Short Vowels

a. /I/ vs. /E/

i. /sIlk/	{ˈsɪ.lɪk}	'wire'
ii. /sElEk/	{ˈsɛ.lɛk}	'boiled (masc. sg.)' (Adj)

b. /I/ vs. /Æ/

i. /-I/		(1 sg. obj.)
as in, e.g.:		
/Ism-I/	{ˈʔɪs.m-i}	'my name'
ii. /-Æ/		(3 masc. sg. obj.)
as in, e.g.:		
/Ism-Æ/	{ˈʔɪs.m-ə}	'his name'

c. /I/ vs. /O/

i. /lIbIÆ/	{ˈli.bi.ə}	'Lybia'
ii. /lObIÆ/	{ˈlo.bi.ə}	(a type of small pea)

d. /I/ vs. /U/

i. /hI/	{hi}	'she'
ii. /hU/	{hu}	'he'

e. /E/ vs. /Æ/

i. /sElEk/	{ˈsɛ.lɛk}	'boiled (masc. sg.)' (Adj)
ii. /sÆlÆk/	{ˈsa.lɜk}	'he boiled'

f. /E/ vs. /O/

(none found)

g. /E/ vs. /U/

(none found)

h. /Æ/ vs. /O/		
i. /-Æ/		(3 masc. sg. obj.)
as in, e.g.:		
/χÆ:l-t-Æ/	{ˈχal.-t-ə}	'his maternal aunt'
ii. /-O/		(endearment suffix)
as in, e.g.:		
/χÆ:l-t-O/	{ˈχal.-t-o}	'maternal auntie'
i. /Æ/ vs. /U/		
i. /kÆr̘Æ/	{ˈk̘ɑ.r̘ə}	'small boat'
ii. /kUr̘Æ/	{ˈk̘ʊ.r̘ə}	'ball'
j. /O/ vs. /U/		
i. /kOr̘Æn/	{ˈkɔ.rɜn}	'corners'
ii. /kUr̘Æn/	{ˈkʊ.rɜn}	'horns'

There are far fewer forms motivating the contrasts for the mid short vowels than for the high and low short vowels. That is, more pairs could be listed for the high and low vowels than for the mid vowels. However, the existence of (35a,c,e,h,j) is here considered to indicate that there is underlying mid height for the short vowels, too.

2.2.2.5. Reduction of /Æ/

Underlying short /Æ/ surfaces mid and central when not under primary lexical stress. This is illustrated by the data in (36). The alternation of interest is shown by the stem-initial low vowel in (36a) compared to the same vowel in (36b). It is also shown by the stem-final vowel in (36a) compared to the same vowel in (36b). In (36b), the surface length of stem-final /Æ/ is the result of lengthening under shifted stress. The low surface quality of the lengthened vowel shows that it is underlyingly /Æ/. Finally, reduced /Æ/ surfaces as one of three mid central surface vowels: non-rtr {ə}, rtr non-back {ɜ}, rtr back {ɜ˃}. These variants arise through pharyngealisation and uvularisation harmonies. This will be shown in §2.2.2.6 and §2.4.

(36) a.	/χÆllÆ/	{ˈχal.lə}	'he left (something)'
b.	/mÆ-χÆllÆ-ʃ/	{mɜ.-χɜl.ˈlæː-ʃ}	'he didn't leave (something)'

Short /Æ/ reduction is also seen in (37). Specifically, it is shown by the vowel in the 3 fem. sg. obj. suffix, /-hÆ/, in (37a) compared to the same vowel in (37b).

(37) a.	/ʃUːf-t-hÆ/	{ˈsʊf-t.-hə}	'I saw her'
b.	/mÆ-ʃUːf-t-hÆ-ʃ/	{mɜ.-ʃʊf-t.-ˈhæː-ʃ}	'I didn't see her'

External evidence for underlying /Æ/ in /-hÆ/ is stylistic. In an oral narrative told by an 80 year old Abu Shushan woman, I have recorded this suffix as {-hæ}, under phrasal main stress without vowel lengthening. The recorded phrase is: {ʔə.ʤə.-ˈhæ # ʔ̙ɪð̙.-ˈð̙ʌ.b̙ɪʕ̙} 'the hyena came to her'.

The Abu Shusha negative prefix, /mÆ-/, occurs in (36b) and (37b); the prefixal /Æ/ surfaces reduced, as seen. In Abu Shusha, the vowel in this negative prefix is never in a context in which it would receive primary stress. Because of this, the evidence that it is underlyingly /Æ/ is purely crosslinguistic: the Jafa dialect cognates of (36b) and (37b) are ⟨ˈmæ.-ə.ʤə⟩ (with hiatus at the left stem edge) and ⟨ˈma.-ʃʊf-t.-hə⟩, respectively.

Reduced ⟨ə⟩ and ⟨ɜ⟩ are sometimes coloured. This is seen in (38), in which 'ˏ' denotes low front colouring, and 'ˎ' denotes low back colouring. That is, [ˏə] and [ˏɜ] are perceptually similar (but not identical) to [æ]; [ɜ˃ˎ] is perceptually similar (but not identical) to [ɑ].

(38) a. [ˈzæ.lˏə.mə] 'man'
b. [ˈs̙ɑ.l̙ɜ˃ˎ.t̙ə] 'salad'
c. [ˌwˏɜ.ħɜ.ˈd-æː.n-i] 'lone, single (masc. sg.)'
d. [ˌʕ̙ɜ˃ˎ.s̙ɜ˃.ˈb̙-i-j.j-ə] 'temperamental (fem. sg.)'

The colour of the reduced vowel is here assumed to be phonetic. It is assumed that /Æ/ loses the feature [LOW] under lack of primary stress. Colour is then added in the phonetics (in terms of some phonetic property or properties) as a gradient interpolation effect.

A second hypothesis is that there is no feature loss in the phonology, but the robustness of /Æ/'s phonetic implementation depends on stress. However, there is a problem for this second hypothesis, *viz.*: reduction-with-degree-of-colour is not observed for the high and mid vowels. A stress-dependent robustness of phonetic implementation would be expected to affect all vowels to at least some degree. However, only /Æ/ reduces. The high and mid vowels do not reduce. This is evidence that the feature [LOW] is targetted, the effect of some constraint against unstressed low vowels. (See Kenstowicz 1994 and Urbanzcyk 1996b for accounts of low vowel reduction in terms of sonority-driven metrical prominence.) In other words, Palestinian /Æ/ reduction is phonological. This disqualifies the second hypothesis.

The evidence that the colour is gradient, depending on stress, is two-fold. First, the colour decreases gradiently as the distance between the reduced vowel and the most stressed syllable increases. This is seen in [ˈzæ.l↙ə.mə] (38a), in which the second-syllable [↙ə] is gradiently less low and front than the initial syllable [æ], but gradiently more low and front than the final-syllable [ə]. It is also seen in [ˈs̙ɑ.l̙ɜ˃↘.t̙ə] (38b), in which the second-syllable [ɜ˃↘] is gradiently less low and back than the initial syllable [ɑ], but gradiently more low and back than the final-syllable [ə]. This indicates a phonetic Effect 1, 'have less colour with increased distance from primary stress'. Second, the colour surfaces gradiently stronger under secondary stress than under no stress. This is seen in (38c,d). It is assumed that phonetic gradience is not skipping the second-syllable low vowel in such forms, rather, that what is observed is a phonetic Effect 2, 'have more colour if under secondary stress', overlaid on and pre-empting Effect 1.

Complete transcriptions of the data in (38) are presented in (39).

(39) a. /zÆlÆmÆ/	{ˈzæ.lə.mə}	[ˈzæ.l˔ə.mə]	'man'
b. /s̙Æl̙Æt̙Æ/	{ˈs̙ɑ.l̙ɜ˃.t̙ə}	[ˈs̙ɑ.l̙ɜ˃˯.t̙ə]	'salad'
c. /wÆħÆd-Æːn-i/	{ˌwɜ.ħɜ.ˈd-æː.n-i}	[ˌw˔ɜ.ħɜ.ˈd-æː.n-i]	'lone, single (masc. sg.)'
d. /ʕÆs̙Æb-I-jj-Æ/	{ˌʕ̙ɜ˃.s̙ɜ˃.ˈb̙-i-j.j-ə}	[ˌʕ̙ɜ˃˯.s̙ɜ˃.ˈb̙-i-j.j-ə]	'temperamental (fem.sg.)'

Finally, for documentation of the acoustic properties of Palestinian reduced /Æ/, see Shahin and Urbanczyk (in preparation).

2.2.2.6. Pharyngealised Short Vowels

The rtr short vowels {ɪ ɛ a ɜ ɜ˃ ɔ ʊ} occur in forms containing a postvelar consonant. This is illustrated by (40). (In (40d), /Æ/ surfaces short in its open syllable. Palestinian open-syllable vowel shortening will be addressed in §2.3.3 and §2.4.3.)

(40) a. /sUʔÆːl/	{sʊ.ˈʔæːl}	'question'
b. /ʕUlÆ/	{ˈʕʊ.lə}	'Ula' (fem. name)
c. /ð̙Ur̙Æ/	{ˈð̙ʊ.r̙ə}	'corn'
d. /hÆːn-Æ/	{ˈha.n-ə}	'here'
e. /s̙Æl̙Æt̙Æ/	{ˈs̙ɑ.l̙ɜ˃.t̙ə}	'salad'

The rtr short vowels also occur in forms containing a short vowel in a closed, that is (C)VC(C), syllable. This is illustrated by (41). In (41b-d), the initial-syllable vowel surfaces rtr by harmony with the closed-syllable vowel. (In (41c), the epenthetic vowel rounds under harmony with the underlying stem vowel, as discussed by Kenstowicz (1981) and Abu-Salim (1987b). Palestinian rounding harmony will be discussed in §2.3.3.3.)

(41) a. /ʃImm/	{ʃɪmm}	'to smell'
b. /sIlk/	{ˈsɪ.lɪk}	'wire'
c. /kUtb/	{ˈkʊ.tʊb}	'books'
d. /ħÆlÆk/	{ˈħa.lɜk}	'he shaved'
e. /ʃÆmm/	{ʃamm}	'Shem'

When /Æ/ is non-reduced and both closed-syllable-pharyngealised and uvularised, it surfaces as mid back rtr {ʌ}. This is shown by the vowel in the first suffix in (42a), compared to the same vowel in (42b).

(42) a. /t̙ÆjjÆb-Æt-nI/	{ˌt̙aij̙.j̙ɜ˃.ˈb̙-ʌt̙.-n̙i})	(*{ˌt̙aij̙.j̙ɜ˃.ˈb̙-at̙.-n̙i})	'she made me become well'
b. /tÆwwÆb-Æt-nI/	{ˌtauw.wɜ.ˈb-at.-ni}	(*{ˌtauw.wɜ.ˈb-ʌt.-ni})	'she made me repent'

2.2.2.7. Uvularised Low Vowels

The long and short back low vowels, {ɐː ɑ}, occur in forms containing an emphatic. This is seen in the suffixal alternations in (43a-b) and (43c-d).

(43) a. /kÆs-Æːt/	{kə.ˈs-æːt}	(*{kə.ˈs-ɐːt})	‘cups’
b. /mUħr̙-Æːt/	{m̙ʊ.ħ̙ʊ.ˈr̙-ɐːt̙}	(*{m̙ʊ.ħ̙ʊ.ˈr̙-æːt̙})	‘colts’
c. /b-ʔÆχχIr̙-nÆ-ʃ/	{bɪ.-ˌʔɜχ.χɪr.-ˈnæː-ʃ}	(*{bɪ.-ˌʔɜχ.χɪr.-ˈnɐː-ʃ})	‘he does not make us late’
d. /b-ʕÆt̙I-nÆ-ʃ/	{ˌb̙-ʕ̙ɜ˃.t̙i.-ˈn̙ɐː-ʃ}	(*{ˌb̙-ʕ̙ɜ˃.t̙i.-ˈn̙æː-ʃ})	‘he does not give (some-thing) to us’

Short mid central backed {ɜ˃}, a surface variant of reduced /Æ/, also occurs in forms containing an emphatic; it is seen in (43d).

Back low {ɐː ɑ} and mid central backed {ɜ˃} are analysed as the outputs of uvularisation harmony triggered by an emphatic. The basis for analysing the long backed vowel as non-rtr {ɐː} rather than rtr {ɑː} will be explained in §2.4.5.

2.2.2.8. Summary

The foregoing §2.2.2.2 - §2.2.2.7 have presented evidence for the Palestinian vocalic system assumed in this work. It was argued that the underlying and surface inventories are more enriched than has been previously assumed. The full evidence for the tongue-root-retracted short vowels and uvularised low and mid vowels has not yet been presented. It will be presented in §2.3 - §2.5, which detail the sources of pharyngealisation and uvularisation in Palestinian, and the properties of Palestinian's pharyngealisation and uvularisation harmonies.

2.3. Preliminary Issues

2.3.1. Underlying Pharyngealisation, Underlying Uvularisation

Articulatory data, as discussed in §1.4, indicate that Arabic postvelars are produced with retraction of the tongue root. This is assumed here to result from underlying specification for [RTR], where [RTR] is either a primary or secondary specification. The articulatory data also indicate that Arabic uvular gutturals and emphatics are produced with retraction of the tongue back. This is assumed here to result from underlying specification for both [DOR] and [RTR], where [DOR] is either a primary or secondary specification, and [RTR] is a secondary specification. The bases for these assumptions will now be presented.

Assuming the feature system adopted in §1.3, I propose that the representations of the Palestinian gutturals are as seen in (44). Specifications omitted in (44) are: [VOICE] for /ʕ ʁ/ and [STOP] for /ʔ/.

2.3.1. Underlying Pharyngealisation, Underlying Uvularisation

(44) The Representations of Palestinian Gutturals

a. laryngeals	b. pharyngeals	c. uvulars
/ʔ h/	/ʕ ħ/	/ʁ χ/
[CONS]	[CONS]	[CONS]
	[SON]	[SON]
|	|	|
o Place	o Place	o Place
|	|	|
		[DOR]
		|
[TR]	[TR]	[TR]
|	|	|
[RTR]	[RTR]	[RTR]

The representational claims in (44) are as follows: first, the laryngeal and pharyngeal gutturals bear [RTR] as a primary specification. For the laryngeals, this anticipates the harmony data and acoustic findings to be presented later in this chapter. For the pharyngeals, it is based on their articulatory properties (see §1.4.1) and on the acoustic properties reported for Arabic pharyngeals by previous studies (see §1.4.3). It is also based on the harmony data and acoustic findings to be presented later in this chapter. A first set of acoustic findings will be presented shortly. It is here assumed that the laryngeal and pharyngeal gutturals are distinguished by virtue of the [SON] specification of the latter, as seen in (44).

Second, the uvular gutturals bear [DOR] as a primary specification and [RTR] as a secondary specification. This is based on their articulatory properties (see §1.4.1) and on acoustic properties reported previously for Arabic uvular gutturals (see §1.4.3). It is also based on the phonological evidence for these specifications found in Cole (1987), Trigo (1991), Elorietta (1992), and Vaux (1994). Cole, Trigo, and Elorietta provide evidence for distinct [DOR] and [RTR] components of uvular gutturals, based on analyses of Coeur d'Alene Salish, Malay, and Nuu-chah-nulth (Nootka).[9] Vaux (1994:53) presents further evidence from Turkic and Tungusic, and cites Colorusso (1975) for evidence from Dididat (Nitinat), Columbian, Abkhaz, Agaza, and Northwest Semitic. (Cole proposes that the active pharyngeal feature is [TR]; Trigo and Vaux assume it is [-ATR].)[10] The specifications of the uvular gutturals are also based on the harmony data and acoustic findings to be presented in this chapter.

Thirdly, the pharyngeal and uvular gutturals are specified for [SON]. This is based on the conclusions of Catford (1977), McCarthy (1994), and Ladefoged and Maddieson (1996), and on the preliminary phonetic findings described in §2.2.1.3.1. McCarthy (1994:222) proposes that /ʕ ħ ʁ χ/ bear specification for [APPROXIMANT]. In this thesis, the existence of [APPROXIMANT] is not assumed because the necessary distinctions between classes of sonorant segments are considered to be captured without it. This will now be explained.

Clements (1990) argues that the feature [APPROXIMANT] is necessary in order to express the natural class consisting of liquids, semi-vowels (glides), and vowels, to the exlusion of nasals and obstruents. His sonorant classes and the feature specifications he

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[9]See Vaux (1994:52-53) for a review of the evidence from Cole (1987), Trigo (1991), and Elorietta (1992).

[10]Cole (1987:92), defines [TR] as a feature representing the tongue root articulator; she assumes [p.94] "a rule of interpretation that adds the feature [-advanced] to any vowel that bears a tongue root articulation". Trigo (1991:114) defines [-ATR], which she refers to synonymously as '[RTR]', as representing retraction of the tongue root. The same definition of [-ATR] is assumed by Vaux (1994:49).

proposes to distinguish them are seen in (45). (Clements (1990:292-293) assumes [syllabic] to be "defined in language-particular terms", so that glides, liquids, nasals, or obstruents can be [+syllabic] in some languages.)

(45) Clements' (1990:292) Sonorant Classes

Obstruents	Nasals	Liquids	Glides	Vowels	
-	-	-	-	+	[syllabic]
-	-	-	+	+	[vocoid]
-	-	+	+	+	[approximant]
-	+	+	+	+	[sonorant]

This thesis distinguishes two major classes of sonorants: vowels and sonorant consonants. The latter comprises three subclasses: lateral approximants, non-lateral approximants, and nasals. These sonorants are assumed to be specified as seen below:

(46)

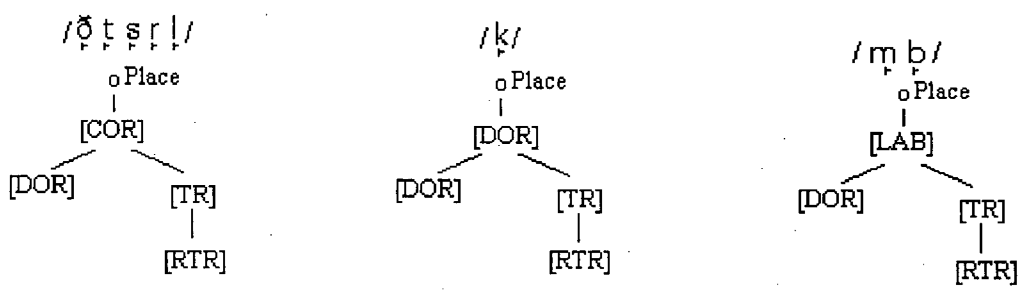
Vowels	Sonorant Consonants: Non-lateral Approximants	Lateral Approximants	Nasals
[SON]	[SON] [CONS]	[SON] [CONS] [LAT]	[SON] [CONS] [NAS]

Because (46) is considered to capture the necessary distinctions among sonorants, the additional feature [APPROXIMANT] is not assumed.

I propose that the Palestinian emphatics have the representations seen in (47). Specifications omitted in (47) are: [VOICE] for /ṛ ð̣/, [STOP] for /ṭ ḳ/, [POST] for /ṛ/, [STRID] for /s̙/, [LAT] for /l̙/, and [NASAL] for /m̙/. (The [POST] and [STRID] specifications distinguish /ð̙/, /s̙/, and /r̙/, yielding least-marked /ð̙/.)

(47) The Representations of Palestinian Emphatics

a. coronal emphatics b. dorsal emphatic c. labial emphatics



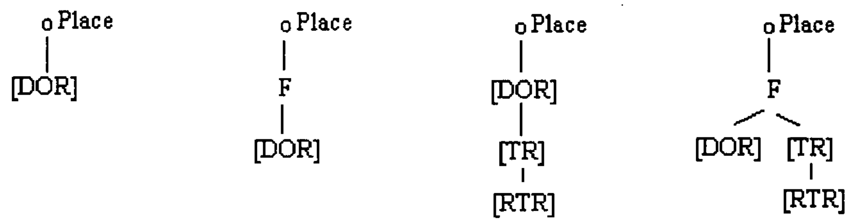
The emphatics are here claimed to bear both [DOR] and [RTR] as secondary specifications. This is based on their articulatory properties (see §1.4.2) and the acoustic findings of previous studies (see §1.4.3). It is also based on the harmony data and acoustic findings to be presented in this chapter. A first set of acoustic findings will be presented shortly.

However, an issue relevant to the feature geometric representations in (44) and (47) will first be discussed, *viz.*, the featural basis for a distinction between primarily velar and primary uvular segments, and between velarised and uvularised segments.

I propose that the representations of primary velar, velarised, primary uvular, and uvularised segments are as seen in (48). In (48b) and (48d), 'F' stands for some articulator feature. (Only those features relevant to the discussion are shown.)

2.3.1. Underlying Pharyngealisation, Underlying Uvularisation

(48) a. primary velar b. velarised c. primary uvular d. uvularised

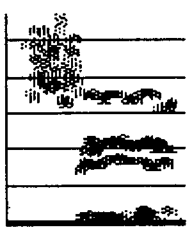


In (48), it is claimed that a segment with primary velar articulation is specified for primary-[DOR] without accompanying specification for [RTR]; a velarised segment is specified for secondary-[DOR] without accompanying specification for [RTR]. A primary uvular segment is specified for primary-[DOR] and secondary-[RTR]; a uvularised segment (i.e., an emphatic) is specified for secondary-[DOR] and secondary-[RTR]. It is the secondary-[RTR] specification of primary uvulars that distinguishes them from primary velars. The same specification of emphatics distinguishes emphatics from velarised segments.

Under this view, primary uvulars and uvularised segments that are not specified for secondary-[RTR] are impossible because (primary or secondary-) [DOR] + secondary-[RTR] is the representation of uvular articulation. Crosslinguistic articulatory data, as discussed in §1.4.1 and §1.4.2, support this complex representation: data on primary uvular and uvularised segments indicate that uvular articulation is invariably accompanied by pharyngealisation. The claim here is that the pharyngealisation of primary uvular and uvularised segments is the automatic result of their specification for secondary-[RTR].

2.3.1. Underlying Pharyngealisation, Underlying Uvularisation

Crosslinguistically, primary uvular segments do not always pattern phonologically with pharyngeals; see Trigo (1991) for discussion. For languages in which they do not, it is assumed that the phenomena showing guttural patterning in such languages are all primary articulation ('AP') phenomena. That is, after the harmony typology proposed in §1.5, they are phenomena involving only primary instances of [RTR]. (It is assumed that a constraint imposing AP harmony specifies the primary status of the harmonic feature. See §2.5.2 and §3.5.2 for proposal of constraints which specify feature status.) But, under the definition of gutturals adopted in §1.4.1, the uvulars in such languages are still gutturals because they are wholly articulated in the postvelar region of the vocal tract.



2.3.1.1. Acoustic Support

This section presents acoustic findings which are relevant to the representational claims in (44) and (47). However, the acoustic study of this thesis will first be described.

Acoustic data from both Palestinian Arabic and St'át'imcets Salish were analysed. This chapter will report on the Palestinian data; chapter 3 will report on the St'át'imcets data. The corpus and speakers for the St'át'imcets data will be described in chapter 3.

2.3.1. Underlying Pharyngealisation, Underlying Uvularisation

corpus and speakers for the Palestinian data

This chapter reports on data from 26 tokens of Palestinian consonants and 481 tokens of Palestinian vowels. The tokens were recorded in 131 carrier forms, which were all real Palestinian words. The carrier forms are listed in Appendix III. Real words were used instead of nonsense words to ensure tokens that resulted from the regular phonology and phonetics of the language. The carrier forms were recorded from two literate, adult male native speakers: KS, a 32-year-old speaker of the Abu Shusha dialect, and KG, a 29-year-old speaker of the Jafa dialect. (See §2.1 for remarks on some differences between these two dialects.) Two tokens of each of the 131 forms were elicited from each speaker.

recording and digitisation

Recordings were made inside a sound-treated room using a TEAC DA-P20 digital audio tape recorder. A few tokens that were not recorded in the soundbooth were recorded in a quiet room using a Marantz P420 analog audio tape recorder. A professional quality microphone of frequency response range 0-13,000 Hz was used. The signals were digitised on a NeXT workstation at 22.05 kHz sampling rate using the digitiser Digital Ears® by Metaresearch, and were stored on the NeXT in soundfiles using the program *Soundworks*.

measurement procedures

The signals were analysed on a NeXT workstation using the in-house-written *Spectrogram* program. Segmentation followed the procedures of Peterson and Lehiste (1967:192-196), which are reproduced in Appendix III.

Vowel formant values reflect the mean of wideband spectrograms and narrowband spectra frequency measurements obtained from the computer by visual placement of the cursor at the estimated formant centre. All frequency measurements are in Hertz (Hz). The measurements were taken on the spectrogram at formant maximum (for a convex formant trajectory) or minimum (for a concave formant trajectory), otherwise at the durational midpoint (for all other types of trajectory), with the exception of vowels immediately following or preceding a pharyngeal (i.e., one of [ʕ ħ]), which were measured at the first quarter of the preceding vowel or at the third quarter of the following vowel. This is because vowels in that environment systematically reached their target at about 1/4 of the vowel duration (for vowels preceding a pharyngeal) or 3/4 of the vowel duration (for vowels following a pharyngeal).

The formants of stop consonants were measured at the VC or CV transition, that is, at the last 1-2 glottal pulses of the preceding vowel (for a consonant in the coda position of its phonological syllable) or the first 1-2 glottal pulses of the following vowel (for a consonant in the onset position of its phonological syllable). For example, in a phonological syllable of the structure {.C_1VC_2.}, measurements for the token of C_1 were taken at the first 1-2 glottal pulses of the token of V; measurements for the token of C_2 were taken at the last 1-2 glottal pulses of the token V. The F_2 values for stops reflect the mean of the VC/CV transition measurement and measurement at the burst/aspiration midpoint. The formants of non-stop consonants were measured at the consonant midpoint.

pooling of vowel data from the two Palestinian speakers

The data on Palestinian consonants were analysed separately for the two Palestinian speakers. However, most of their vowel data were graphed together and enclosed in a single common ellipse because the formants of their vowel tokens were similar. The two speakers are alike in physical stature and size. Because of this, it is hypothesised that their vocal tracts are very similar in length. t-tests showed that differences between the formants, when significant, are highly significant (e.g., $p > 0.001$), suggesting they are due more to differences in dialect. A check of F_4, if measurable, could test the hypothesis that the two vocal tract lengths are nearly identical. (F_4 does not in general vary with articulation. It is therefore expected to be more an indicator of vocal tract length than F_1, F_2, or F_3). However, this check was not done, so the hypothesis remains untested.

The vowel data which are reported separately are a subset of the data on short /E/ and /O/, *viz.*, /E/ and /O/ in stem-final position. These data are treated separately because the quality of stem-final /E/ and /O/ differs across the Abu Shusha and Jafa dialects, as will be discussed in §2.4.5. In that section, data showing the non-similarity between the formants of the Abu Shusha and Jafa tokens of stem-final /E/ and /O/ will also be presented.

reliability measures

An internal blind recheck of 10% of the study's measurements (for both the Palestinian and St'át'imcets data) was conducted by the author. In the internal recheck, formant re-measurements were within an average of 22 Hz of the original measurements. An external blind recheck of 3% of the measurements was conducted by another phonetician, one with several years of experience. In the recheck by this second observer, measurements were within an average of 28 Hz of the original measurements. As these values are less than the 40-Hz accuracy found by Lindblom (1962) in vowel formant measurements of male voices, they are regarded as showing a satisfactory degree of reliability for the measurements reported in this thesis.

Acoustic data which bear on the presumed pharyngeal and uvular articulations of Palestinian gutturals and emphatics, which are the bases of the [RTR] and [DOR] specifications in (44) and (47), will now be presented. A first set is seen in Table 2:1, which reports the F_1 and F_2 of two tokens each of Palestinian pharyngeal /ʕ/ and (geminate) post-alveolar /jj/. The carrier forms for the tokens are identified in the table.

Table 2:1

F_1 and F_2 of tokens of Palestinian /ʕ/ and /jj/

carrier form	token	F_1	F_2
{bɪ.-ˈsa.ʕɪd}	[ʕ]1	728	1482
'he helps'	[ʕ]2	719	1497
{bɪ.-ˈsaij.jɪl}	[jj]1	289	2229
'it leaks'	[jj]2	291	2228

Table 2:1 shows that for /ʕ/, F_1 is high; F_2 is medium, although it is at the low end of the medium range. These formant values contrast with the low F_1 and high F_2 seen for /jj/. (Descriptions of formant frequencies as high, medium, or low will be in reference to Table 1:5.) In §1.4.3, a high F_1 (700 - 950 Hz) and low F_2 (700 - 1300 Hz) were predicted for a segment with primary pharyngeal articulation. The F_1 and F_2 effects observed for /ʕ/ in Table 1:2 almost match the predictions. F_2 of the [ʕ]s might be less lowered than usual due to a coarticulatory effect of the immediately preceding [ɪ] in the carrier form. (Data on Palestinian [ɪ] to be presented in Figure 2:1 indicate that F_2 of [ɪ] is about 1600 Hz.) The data in Table 1:2 are thus considered support for the assumption that the tokens of /ʕ/ reported here were produced with primary pharyngeal articulation. That articulation, in turn, supports the primary-[RTR] specification of Palestinian /ʕ/ in (44). (See §1.7.2 for discussion of this type of use of phonetics in phonology.)

Table 2:2 reports the F_1 and F_2 of four tokens each of Palestinian non-emphatic /t/, emphatic /ṭ/, surface non-emphatic {r} (= de-emphaticised /ṛ/), and surface emphatic {ṛ}, produced by two speakers.

Table 2:2

F_1 and F_2 of tokens of Palestinian /t/, /t̙/, {r}, and {r̙}

		Speaker: KS		Speaker: KG	
carrier form	token	F_1	F_2	F_1	F_2
{tiːn} 'figs'	[t]1	248	2088	248	2085
	[t]2	248	2179	245	2100
	mean F	248	2134	247	2093
{t̙iːn̙} 'mud'	[t̙]1	338	1399	335	1328
	[t̙]2	333	1540	342	1246
	mean F	336	1470	339	1287
	|difference| mean F	88	664	92	806

carrier form	token	F_1	F_2	F_1	F_2
{ħræːm} 'blanket'	[r]1	526	1552	463	1309
	[r]2	542	1472	530	1305
	mean F	534	1512	497	1307
{ħ̙ɜ˃.ˈr̙ɐːm̙} 'shame' (N)	[r̙]1	663	1208	598	1176
	[r̙]2	628	1197	591	1173
	mean F	646	1203	595	1175
	|difference| mean F	112	309	98	132

In Table 2:2, the absolute values of the difference between mean formant values ('|difference| mean F') show that the tokens of emphatic /t̙/ and {r̙} have an F_1 rise which is a small or just barely medium, compared to F_1 of the tokens of their non-emphatic counterparts /t/ and {r}, respectively. The tokens of /t̙/ and {r̙} have a large F_2 drop, compared to F_2 for the tokens of non-emphatic /t/ and non-emphatic {r}. In §1.4.3, the expected F_1 and F_2 effects for emphatics were identified as a medium or large F_1 rise and a large F_2 drop. The data in Table 2:2 show a smaller F_1 effect than expected. The large drop expected for F_2 is observed for /t/ but not for {r}. However, as the expected direction of formant changes is observed, the data above are considered support for an assumption that the tokens of /ṭ/ and {ṛ} were produced with the postvelar articulations of emphatics: uvularisation and pharyngealisation (and that the tokens of their non-emphatic counterparts were not). This, in turn, supports the secondary-[RTR] and secondary-[DOR] specifications of Palestinian /ṭ/ and /ṛ/ in (47).

2.3.2. The Derivation of the Palestinian Underlying Postvelar Inventory

The set of Palestinian segments that can be underlyingly specified for primary-[RTR] is assumed to be those that do not bear primary specification for another articulator feature. This is presumed to follow from the general co-occurrence restriction in (49). For an atheoretical discussion of this restriction, see §1.4.1.

(49) *Prim, Prim
A segment is not specified for two primary articulation features.

The set of consonants that can be underlyingly specified for secondary-[RTR] is assumed to be those that are specified for (primary- or secondary-) [DOR]. This identifies the class of segments that have (primary or secondary) uvular articulation, that is, uvular gutturals and emphatics. This is presumed to follow from the co-occurrence restriction:

2.3.2. The Derivation of the Palestinian Underlying Postvelar Inventory

(50) Sec-RTR/DOR
If secondary-[RTR], then [DOR].

It is sometimes claimed that coronal emphatics are crosslinguistically more frequent than either dorsal or labial emphatics; see, e.g., Bessell and Czaykowska-Higgins (1991). However, to my knowledge, no study has presented data to establish that claim. Hence, no markedness hierarchy for secondary-[DOR] + secondary-[RTR] segments, such as 'COR < DOR < LAB', will be proposed here.

The set of Palestinian segments that can be underlyingly specified for secondary-[DOR] + secondary-[RTR] is assumed to exclude those that are specified for [FRONT]. This is presumed to be the effect of the paradigmatic Grounding condition in (51), which is grounded in the antagonism of simultaneous uvularisation and fronting gestures. See Archangeli & Pulleyblank (1994a) for discussion of this type of grounding.

(51) FRONT/*Sec-DOR ∧ Sec-RTR
A segment specified for [FRONT] is not specified for secondary-[DOR] and secondary-[RTR].

The condition in (51) is motivated by two observations regarding the post-alveolar obstruents /ʃ ʤ ʧ/, which, after McCarthy (1997), are assumed to be specified for [FRONT]: (i) there are no underlying [FRONT] emphatics in the language, that is, no /ʃ̙ ʤ̙ ʧ̙/; (ii) the combination secondary-[DOR] + secondary-[RTR] + [FRONT] is disallowed in the phonology: /ʃ ʤ ʧ/ are opaque to uvularisation harmony, that is, they do not undergo it and they block it. This will be shown in §2.5.3. Gaps in the underlying emphatic inventory that are not handled by FRONT/*Sec-DOR ∧ Sec-RTR, e.g., the lack of coronal /θ̣/, are presumed to be either an accidental gap of Palestinian or due to further restrictions or conditions not investigated here.

2.3.3. Prosodically Conditioned (Closed Syllable) Pharyngealisation

2.3.3.1. Analysis

Besides the underlying pharyngealisation of postvelars, there is another source of pharyngealisation in Palestinian phonology: pharyngealisation is imposed on a short vowel in a closed syllable. Consider first the data in (52), which show that short vowels surface non-rtr in a word containing no closed syllable (and no postvelar). (For (52d-e), the initial-syllable vowel is surface short. It is assumed to be underlyingly long, based on the length of the same vowels in the morphologically related forms /dU:d/ {du:d} 'worms' and /sI:d/ {si:d} 'grandfather'. The forms in (52d-e) will be readdressed in §2.4.3; (52a,c-d) will be readdressed in §2.4.5.)

(52) a. /lObLÆ/	{ˈlo.bi.ə}	(a type of small pea)
b. /sUr-I-Æ/	{ˈsu.r-i.-ə}	'Syria'
c. /tEtÆ/	{ˈte.tə}	'grandma'
d. /dU:d-Æ/	{ˈdu.d-ə}	'worm'
e. /sI:d-O/	{ˈsi.d-o}	'grandpa'

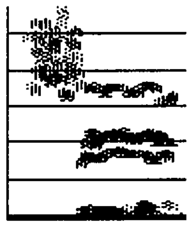
2.3.3. Prosodically Conditioned (Closed Syllable) Pharyngealisation

Closed-syllable pharyngealisation is shown by the data in (53), which are words that contain no postvelar. As seen, each short vowel in (53) surfaces rtr in its closed syllable. (An Optimality tableau for (53b) will be presented in §2.3.3.3.)

(53) a.	/mIʃ/	{mɪʃ}	(*{miʃ})	'not'
b.	/zIft/	{zɪft}	(*{zift})	'ashphalt, bad thing'
c.	/ʃImm/	{ʃɪmm}	(*{ʃimm})	'to smell'
d.	/ʤUll/	{ʤʊll}	(*{ʤull)	'marble' (the toy)
e.	/IktIb/	{'ʔɪk.tɪb}	(*{'ʔik.tib})	'to write'

The forms in (53) show pharyngealisation of non-low short vowels. Discussion of the pharyngealisation of the low short vowel /Æ/ is deferred until §2.4.3.

Prosodically conditioned pharyngealisation occurs in other languages: e.g., Walker (1984) and Dumas (1987) document rtr vowels such as {ɪ} and {ʊ} conditioned by a closed syllable in Québecois (Canadian French); Dudas (1976) and Schlindwein (1988) document the same in Javanese. (Dudas (1976:33) assumes that Javanese {ɪ ʊ}, etc. result from a '[-tense]' specification on the closed-syllable vowel. Schlindwein (1988:196) assumes the active feature is '[-ATR]', which she equates with Dudas' [-tense].) See §2.4.2 for arguments for assuming that vowels such as {ɪ} and {ʊ} in Québecois and Javanese are phonologically rtr.



2.3.3.2. Acoustic Support

Figures 2:1 - 2:4 present F_1 - F_2 plots for the Palestinian non-low surface short vowels. (Acoustic data on the low short vowel will be presented in §2.4.3.2) The tokens plotted in these graphs were produced by two speakers. This is the case for all F_1 - F_2 plots to be presented in this chapter; the reasons for the pooling of the vowel data were discussed in §2.3.1.1. F_1 is plotted along the y-axis and F_2 along the x-axis on a linear (not logarithmic) scale.

At this point, a few remarks about the nature of an F_1, F_2 vowel plot, and of other types of vowel graphs presented in this thesis, are in order. An F_1 - F_2 plot for vowels reports physical (acoustic) data on phonetic vowel tokens, *viz*., the frequency of the first and second formants. It is not the same thing as a vowel diagram. A vowel diagram is an abstract representation in which phonetic or phonemic vowels are classified along abstract dimensions like high-low and front-back. The visual similarity between the two types of graphs is due to the fact that in such an F_1, F_2 plot, F_1 is typically plotted downward, while F_2, is plotted leftward, as in Figure 2:1, "so that the traditional form of representing vowels is preserved" (Ladefoged 1967:92). Furthermore, a vowel diagram is not the same thing as an articulatory diagram, which is a third type of graph. An articulatory diagram, like an F_1 - F_2 plot, reports physical data, *viz*., measurements of a sagittal section of the vocal tract for particular speech tokens, recorded through instrumental means such as x-ray, ultrasound, M.R.I., etc. The high-low and front-back dimensions of a vowel diagram do not necessarily correspond to actual tongue positions reported in an articulatory diagram. See Stevens and House (1955), Jones (1967, 1972), and Ladefoged (1967, 1993) for further discussion.

In the F_1- F_2 plots of this thesis, ellipses enclose 90% of the tokens of a given allophone. IPA symbols identify clusters of tokens that are perceptually non-rtr vs. rtr allophones, per vowel. (No tokens of rtr {ɔ} are plotted in Figure 2:3, due to lack of data.) The IPA symbol associates with the ellipse closest to it. The caption for each figure lists statistics for each allophone: number of tokens plotted, their mean F_1, mean F_2, and the F_1 and F_2 standard deviations ('s.d.'). The standard deviations are also seen implicitly in the length of the ellipse semi-axes, equal in this thesis to 2.15 x s.d., the lengths of the axis of the ellipses being calculated in such a way to include 90% of the data of a bivariate (F_1, F_2) normal distribution.

The tokens in Figures 2:1 - 2:4 are surface short tokens of /I/ or shortened /I:/, /E/ or shortened /E:/, /O/, and /U/. Some tokens in Figures 2:1 and 2:4 are actually the Palestinian epenthetic vowel, which always surfaces short and either high front or high back. The epenthetic vowel will be discussed further in §2.3.3.3. (Tokens that are underlying long or the epenthetic vowel are identified in Appendix III, which lists the carrier forms for all the vowel tokens.) For ease of reference, the tokens in Figures 2:1 - 2:4 will be referred to simply as tokens of /I/, /E/, /O/, and /U/, respectively.

The tokens in Figures 2:1 - 2:4 are all the surface short vowel tokens analysed for this thesis, excluding those of Jafa stem-final /E/ and /O/. The excluded Jafa tokens will be discussed in §2.4.5.2.

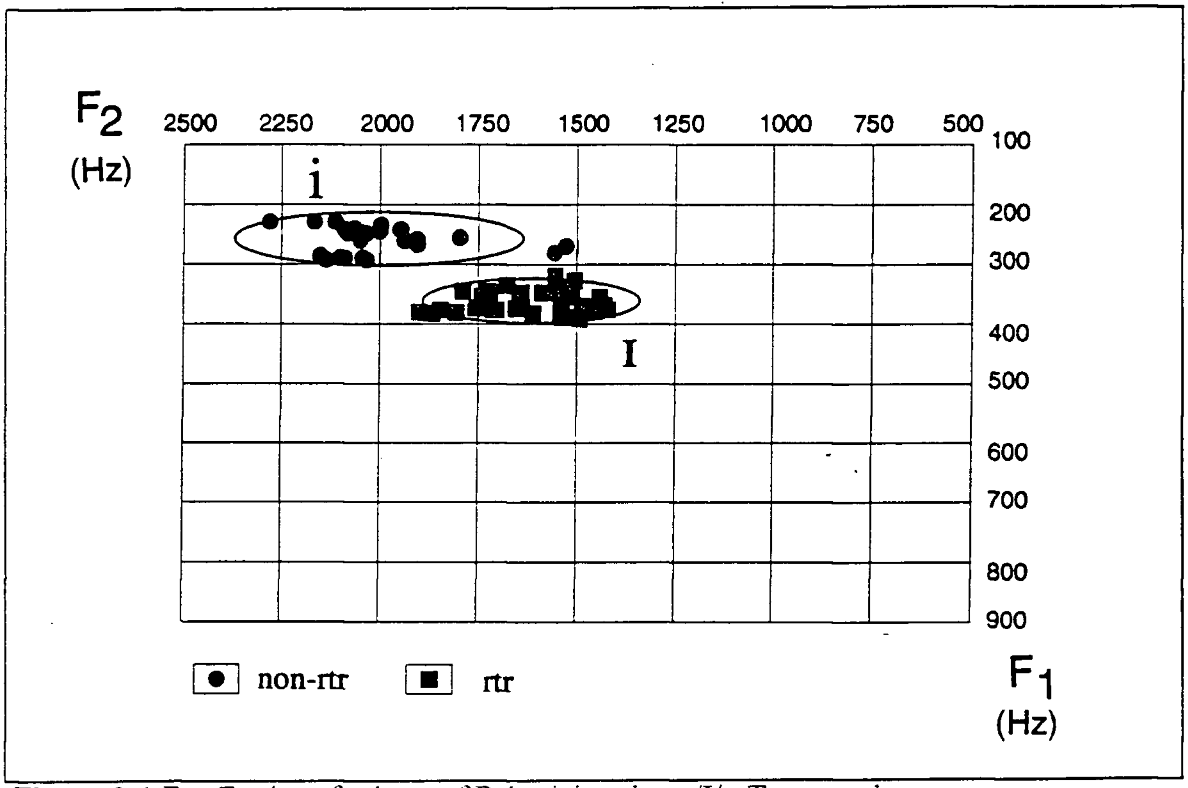


Figure 2:1 F_1 - F_2 plot of tokens of Palestinian short /I/. Two speakers.
[i]: F_1 (mean = 259 Hz; s.d. = 22 Hz); F_2 (mean = 2003 Hz; s.d. = 169 Hz); 24 tokens.
[ɪ]: F_1 (mean = 364 Hz; s.d. = 17 Hz); F_2 (mean = 1620 Hz; s.d. = 129 Hz); 41 tokens.

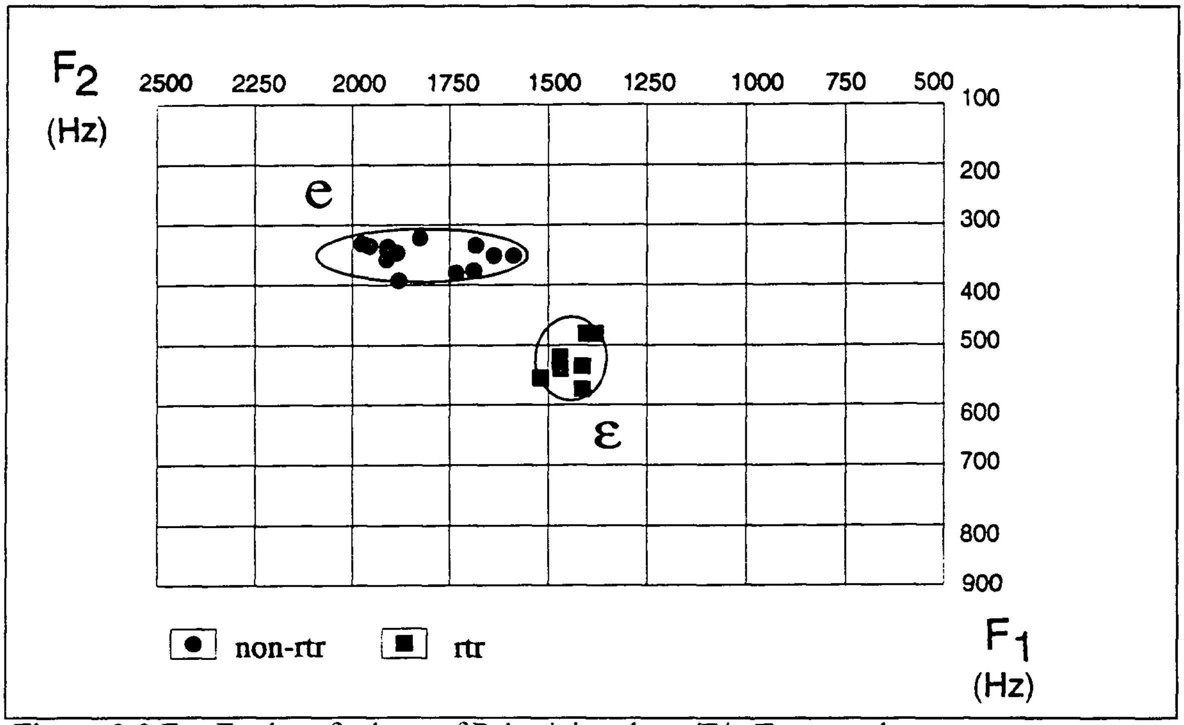


Figure 2:2 F_1 - F_2 plot of tokens of Palestinian short /E/. Two speakers.
[e]: F_1 (mean = 349 Hz; s.d. = 20 Hz); F_2 (mean = 1825 Hz; s.d. = 127 Hz); 14 tokens.
[ɛ]: F_1 (mean = 526 Hz; s.d. = 31 Hz); F_2 (mean = 1443 Hz; s.d. = 43 Hz); 8 tokens.

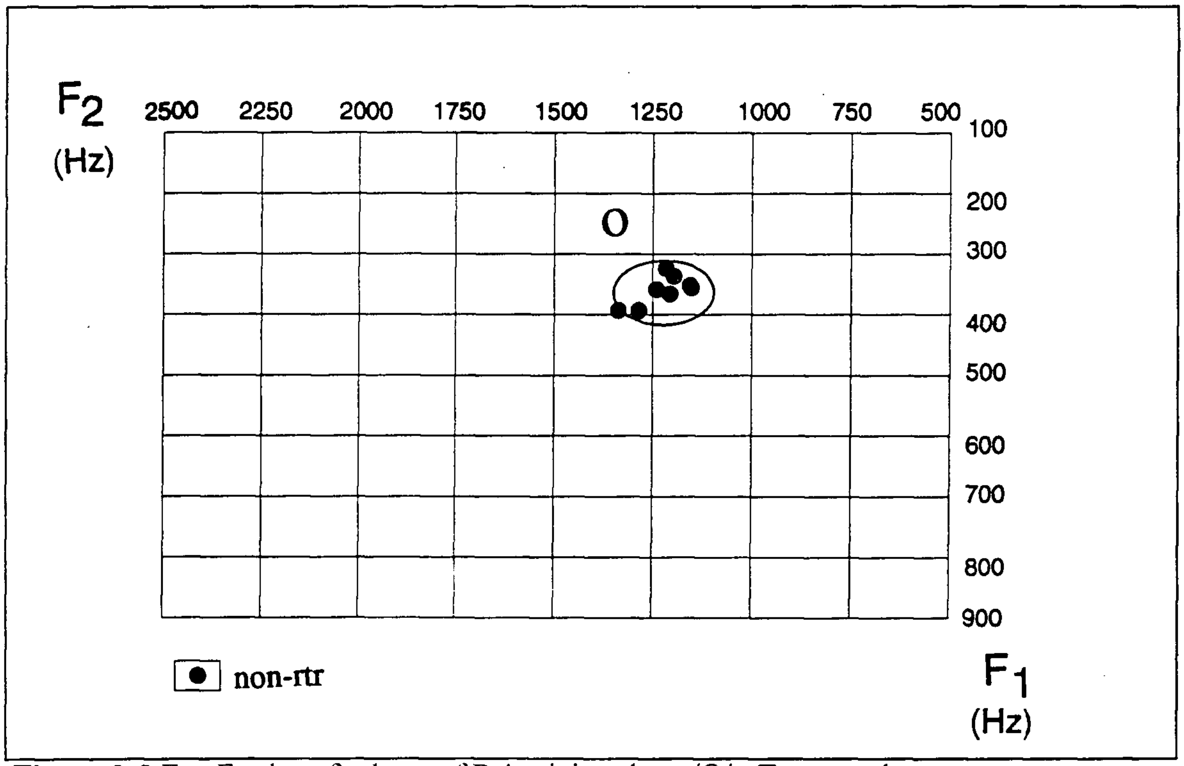


Figure 2:3 F_1 - F_2 plot of tokens of Palestinian short /O/. Two speakers.
[o]: F_1 (mean = 360 Hz; s.d. = 23 Hz); F_2 (mean = 1224 Hz; s.d. = 59 Hz); 8 tokens.
[ɔ]: no tokens.

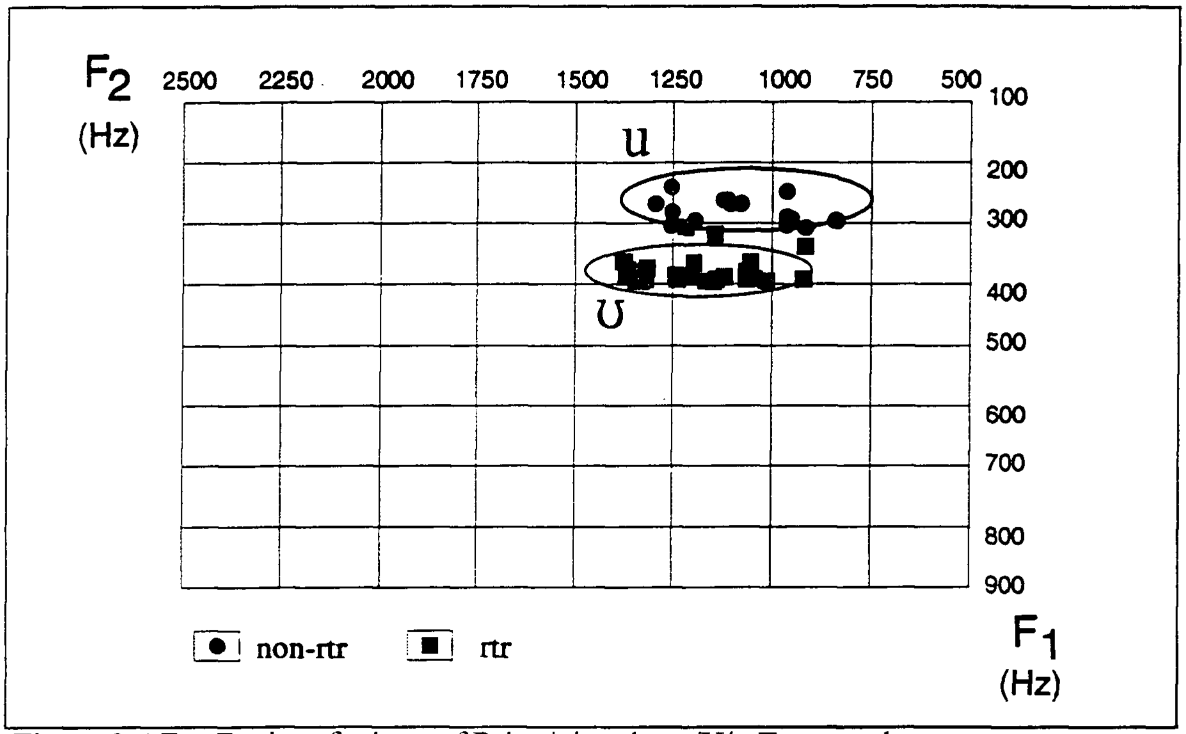


Figure 2:4 F_1 - F_2 plot of tokens of Palestinian short /U/. Two speakers.
[u]: F_1 (mean = 280 Hz; s.d. = 20 Hz); F_2 (mean = 1070 Hz; s.d. = 149 Hz); 16 tokens.
[ʊ]: F_1 (mean = 379 Hz; s.d. = 22 Hz); F_2 (mean = 1192 Hz; s.d. = 134 Hz); 30 tokens.

Figures 2:1 - 2:4 show that, for each vowel, the non-rtr vs. rtr tokens fall within distinct regions of the F_1 - F_2 plane: for each vowel, the rtr tokens fall within a higher F_1 interval and a lower F_2 interval than the non-rtr tokens.

In Figures 2:5 - 2:8, a subset of the tokens in Figures 2:1 - 2:4 are replotted according to the two phonological contexts relevant to closed-syllable pharyngealisation: (i) in an open syllable with no trigger in the word; (ii) in a closed syllable with no trigger in the word. A 'trigger' for pharyngealisation harmony is a postvelar consonant, that is, a guttural or emphatic, or a closed-syllable pharyngealised vowel; this claim will be justified in §2.4. Hence, these two contexts identify a vowel in the phonological contexts {CV.C} and {CVC.}, respectively, in a word containing no postvelar. An example of a vowel in the former context is {i} in {ˈsi.do} 'grandpa'. An example of a vowel in the latter context is the final-syllable {ɪ} in {ˈfɪ.lɪm} 'movie'. (No tokens of /O/ context (ii) are plotted in Figure 2:7, due to lack of data.)

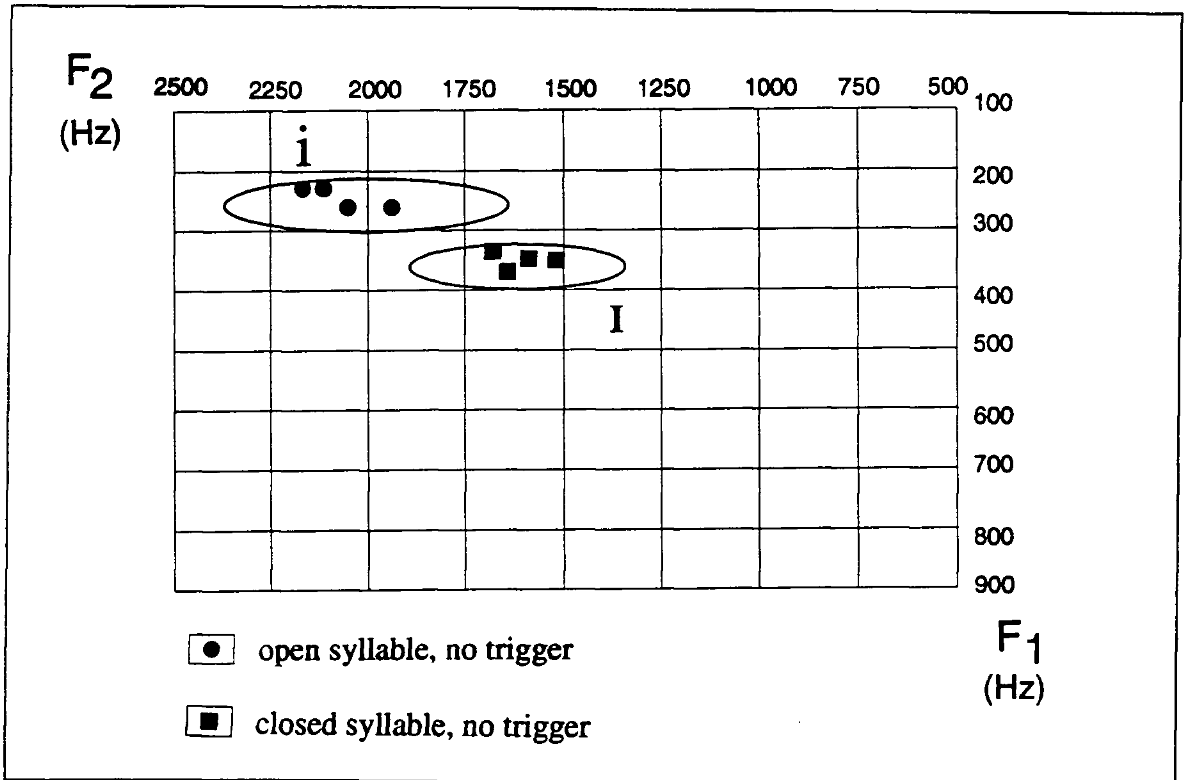


Figure 2:5 F_1 - F_2 plot of tokens of Palestinian short /I/ in the contexts: (i) open syllable, no trigger; (ii) closed syllable, no trigger.

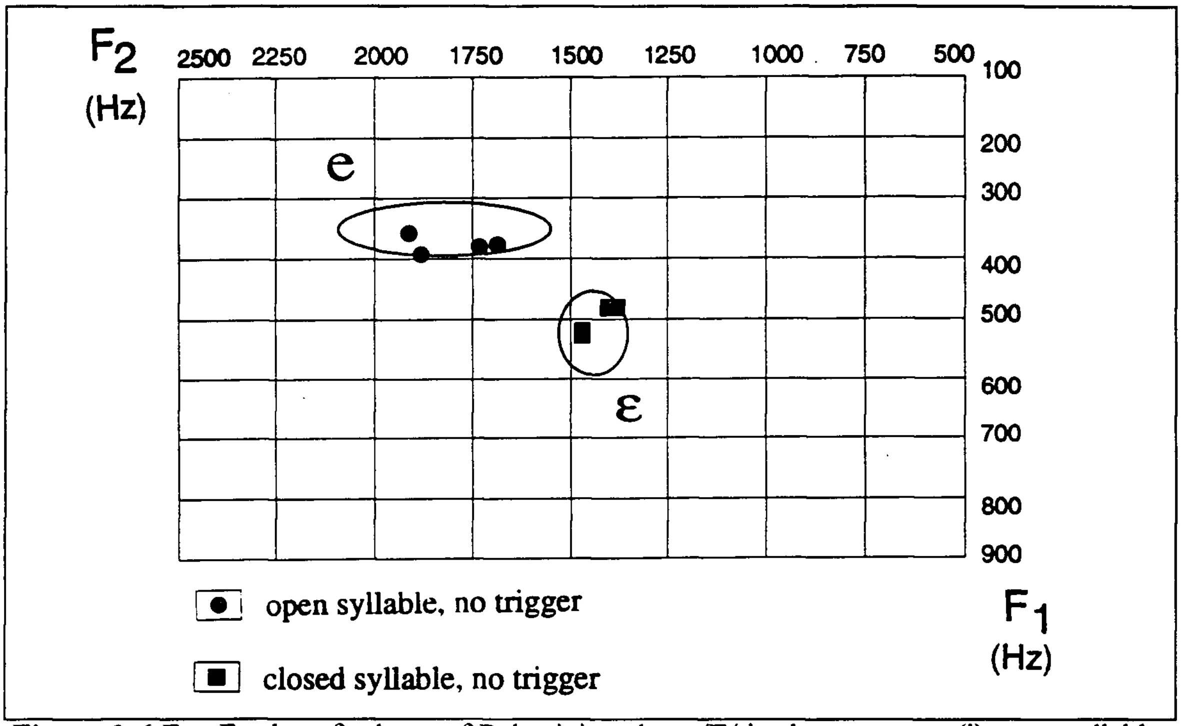


Figure 2:6 F_1 - F_2 plot of tokens of Palestinian short /E/ in the contexts: (i) open syllable, no trigger; (ii) closed syllable, no trigger.

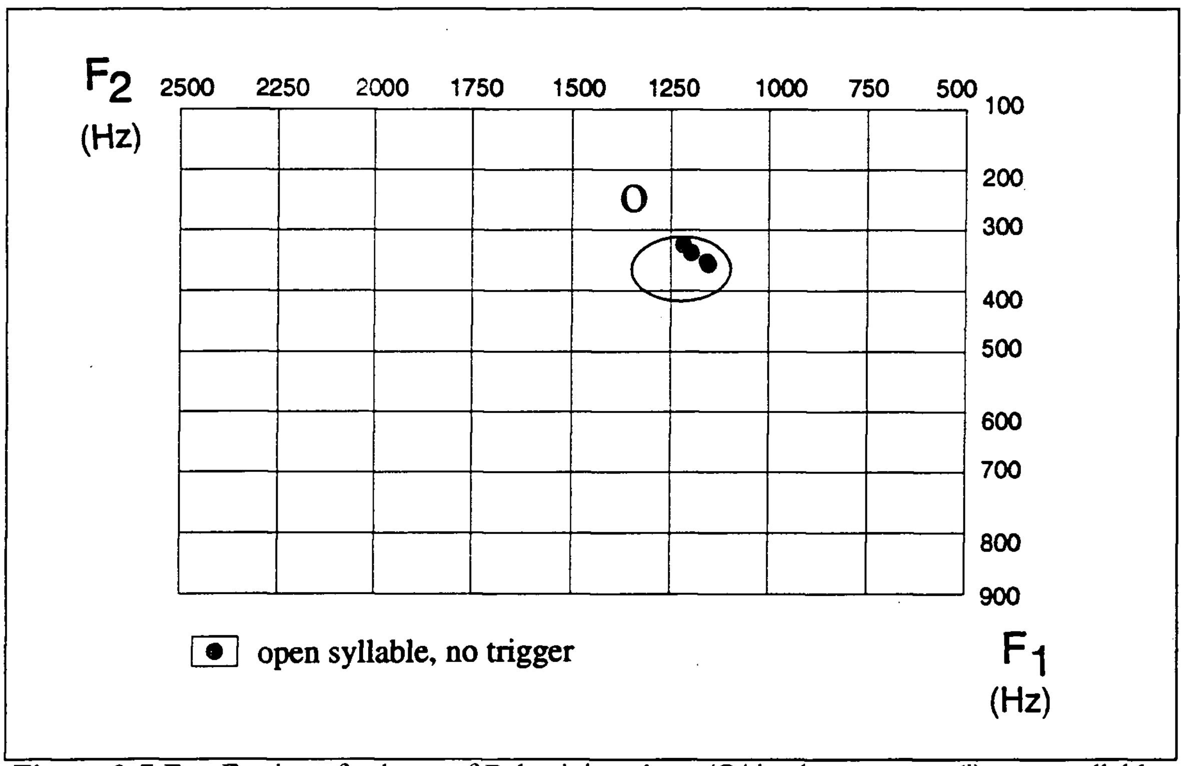


Figure 2:7 F_1 - F_2 plot of tokens of Palestinian short /O/ in the context: (i) open syllable, no trigger

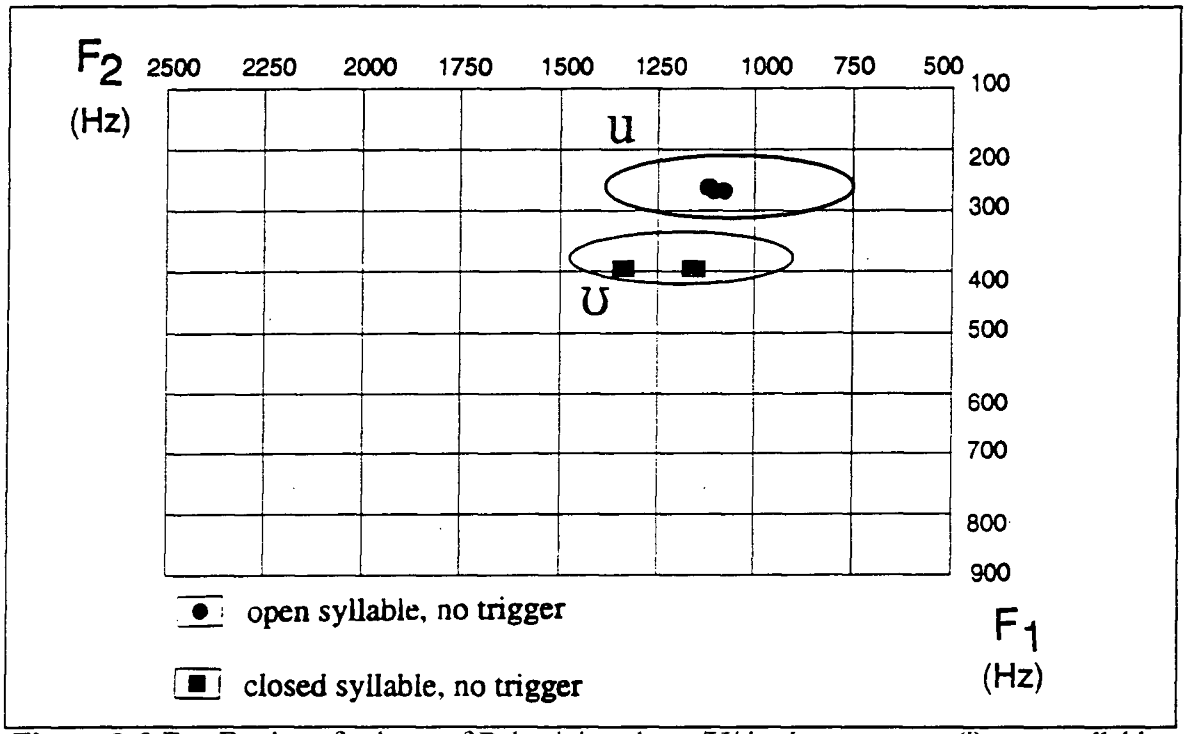


Figure 2:8 F_1 - F_2 plot of tokens of Palestinian short /U/ in the contexts: (i) open syllable, no trigger; (ii) closed syllable, no trigger.

In Figures 2:5 - 2:8, the open syllable, no trigger tokens of /I E O U/ are non-rtr [i e o u], respectively. The closed syllable, no trigger tokens of /I E U/ are rtr [ɪ ɛ ʊ], respectively. The relevant findings from these data are that, for /I E U/, the closed syllable, no trigger tokens have a raised F_1, compared to the open syllable, no trigger tokens per vowel. For /I E/, the closed-syllable, no trigger tokens have a lowered F_2. For /U/ they do not. Based on comparison of the F_1 and F_2 means for the non-rtr vs. rtr allophones per vowel reported in the captions for Figures 2:1 - 2:4, the [ɪ]s have a F_1 rise which is just barely medium (105 Hz), the [ɛ]s have a medium F_1 rise, and [ʊ]s have a small F_1 rise. The [ɪ]s and [ɛ]s have a medium F_2 drop. (Descriptions of formant changes as high, medium, or low, are in reference to Table 1:10.)

2.3.3. Prosodically Conditioned (Closed Syllable) Pharyngealisation

In §1.4.3, the F_1 and F_2 effects predicted for a segment with pharyngealisation articulation were identified as a medium or large rise in F_1 and a large drop in F_2. The data in these figures show a smaller F_1 rise and a smaller F_2 drop than expected. However, the expected direction of formant changes is observed. The [ʊ]s in Figure 2:8 are an exception to this, as they show no F_2 drop. However, this might be due to their having been produced with much less lip rounding than the [u]s. The data Figures 2:5 - 2:8 thus provide some support for the assumption that the closed syllable, no trigger tokens of /I E U/ were produced with a secondary pharyngeal articulation that the open syllable, no trigger tokens lacked. This, in turn, lends support to the phonological claim that Palestinian short vowels pharyngealise in a closed syllable.

2.3.3.3. A Theoretical Account

This section first discusses the featural values of Palestinian vowels. It then proposes the constraints that are responsible for Palestinian closed-syllable pharyngealisation. Their ranking will be identified and their interaction will be illustrated.

It is assumed that [HI], [LOW], and [LAB] are the Place features defining Palestinian underlying vowels. Evidence for active [HI] comes from Palestinian's highly ranked grounded constraint 'HI/*Sec-DOR ∧ Sec-RTR' ('A segment specified for [HI] is not specified for secondary-[DOR] and secondary-[RTR]'), to be proposed in §2.5.6. In

Palestinian, the surface effect of HI/*Sec-DOR ∧ Sec-RTR is that [HI] vowels do not undergo uvularisation harmony.

Evidence for active [LOW] comes from Palestinian vowel reduction. As shown in §2.2.2.5, Palestinian low short /Æ/ reduces to surface mid and central when not under primary lexical stress. Because no other vowels show this reduction, reduction of /Æ/ was argued to be the effect of some constraint against unstressed [LOW]. Further evidence for active [LOW] comes from the constraint, 'LO/*Sec-DOR ∧ Sec-RTR' ('A segment specified for [LOW] is not specified for secondary-[DOR] and secondary-[RTR]'), to be proposed in §2.6. LO/*Sec-DOR ∧ Sec-RTR will be argued to impose the raising of Palestinian /Æ/ > {ʌ}, which will be discussed in §2.4.3.

Evidence for active [LAB] comes from Palestinian rounding harmony. Forms showing this harmony are presented in (54). The harmony is seen from comparison of the final-syllable surface vowels in (54) with the final-syllable surface vowels in (55).

(54) a. /kUtb/	{ˈkʊ.tʊb}	(*{ˈkʊ.tɪb})	'books'
b. /mUħr̙/	{ˈm̙ʊ.ħ̙ʊr̙}	(*{ˈm̙ʊ.ħ̙ɪr̙})	'colt'
c. /fUr̙n/	{ˈfʊ.rʊn}	(*{ˈfʊ.rɪn})	'oven'
(55) a. /sIlk/	{ˈsɪ.lɪk}		'wire'
b. /ʕIʤl/	{ˈʕɪ.ʤɪl}		'calf'
c. /bInt/	{ˈbɪ.nɪt}		'girl'

Each form in (54) and (55) contains an epenthetic vowel. In Palestinian, an epenthetic vowel surfaces to permit syllabification of an underlying word-final CC cluster, as noted earlier with respect to the data in (32). In (54), the epenthetic vowel surfaces as non-rd {ɪ} (and, as expected, rtr in its closed syllable). In (52), it surfaces, instead, as rd {ʊ} (likewise rtr). Because the epenthetic vowel surfaces rd in no other context, the rounding observed forms like those in (54) is here assumed, after Kenstowicz (1981) and Abu-Salim (1987b), to result from rounding harmony with the round stem vowel. See Kenstowicz and Abu-Salim for further discussion of this harmony.

After the Dependency Phonology work work of Kaye, et al. (1985) and the Particle Phonology of Schane (1984), it is assumed that [HI] and [LOW] can co-occur, and that co-occurring [HI] and [LOW] define mid height. However, departing from Kaye et al. and Schane, no dependency relation for these two features is assumed, as a dependency relation is here assumed to hold only between features representing a primary vs. secondary articulation; see §1.3.3.2 for further discussion. (In a Dependency/Particle Phonology approach, if [HI] dominates [LOW], the result is 'high mid' e or o. If [LOW] dominates [HI], the result is 'low mid' ɛ or ɔ. In this thesis, 'low mid' vowels are presumed to result from specification for an additional feature, [RTR], as will be explained shortly.)

Combinatorial specification (Archangeli and Pulleyblank (1994a)) is adopted. Active [HI], [LOW], and [LAB] yield $2^3 = 8$ combinatorial feature sets:

2.3.3. Prosodically Conditioned (Closed Syllable) Pharyngealisation

(56)

	1 (epenth. vowel)	2 /I/	3 /E/	4 /Æ/	5 *	6 *	7 /U/	8 /O/
HI		+	+				+	+
LO			+	+	+			+
LAB					+	+	+	+

In this thesis, 'I', 'E', 'Æ', 'O', and 'U', for Palestinian underlying vowels, denote feature sets 2, 3, 4, 7, and 8 in (54), respectively (plus [SON]). The upper case of the symbols denotes the fact that the ultimate (that is, surface) sets, which are determined through the course of the phonology, potentially differ from those in (56) since, for each vowel, specifications might be added or removed.

Palestinian's epenthetic vowel is feature set 1, the completely unspecified vowel. The epenthetic vowel does not occur as mid, as would be predicted for an unspecified vowel. Instead, it occurs as high, and either non-rd (and front) or rd (and back), as was seen in (54) and (55). Its non-rd~rd alternation was discussed above as a result of rounding harmony with underlying /U/. Its invariable high realisation is assumed to result from specification for [HI] imposed in the input-to-output mapping to prevent it from neutralising with the mid central vowels that arise from /Æ/-reduction. (The constraint interaction responsible for the imposition of [HI] on the epenthetic vowel will not be addressed in this thesis.) Because of its surface [HI] specification, the epenthetic vowel neutralises, instead, with underlying /I/ or /U/.

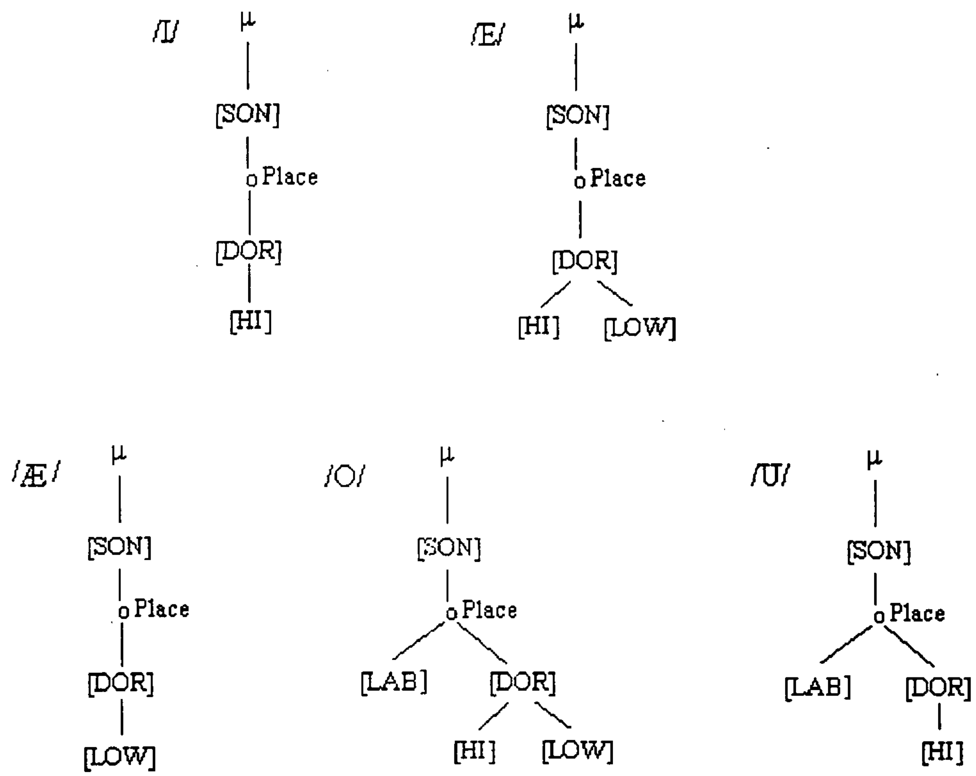
Of the eight possible underlying vowels in (56), Palestinian does not make use of those defined in columns 5 or 6. Combinatorial Specification assumes full instantiation of defined feature sets unless there is a condition ruling out some combination(s), or neutralisation as a result of feature-insertion; see Archangeli and Pulleyblank (1994a) for discussion. For Palestinian, it is here assumed that the former case holds, specifically, that combinations 5 and 6 are ruled out because of a co-occurrence condition 'LAB/HI' ('If [LAB], then [HI]'). This condition is suggested by the finding of Kaun (1995) that low labialised vowels are crosslinguistically disfavoured. For Palestinian it is indicated by the fact that [LAB] and [LOW] do not seem to combine within the phonology. This is suggested by data such as those in (57), in which /Æː/ does not round under harmony with the [LAB] stem vowel. This contrasts with the rounding of the epenthetic vowel illustrated in (54).

(57) a. /mUhr̙-Æːt/	{m̙ʊ.h̙ʊ.ˈr̙-ɐːt̙}	(*{m̙ʊ.h̙ʊ.ˈr̙-ɒːt̙})	'colts'
b. /mUs̙s̙-Æːs-Æ/	{m̙ʊs̙.ˈs̙-ɐː.s̙-ə}	(*{m̙ʊs̙.ˈs̙-ɒː.s̙-ə})	'sucker' (candy)

The representations of underlying short /I E Æ O U/ are seen in (58). After Pulleyblank (1994b), moras ('µ's) are assumed to be underlying.

2.3.3. Prosodically Conditioned (Closed Syllable) Pharyngealisation

(58) The Representations of Palestinian Underlying Short /I E Æ O U/



I propose that a Palestinian short vowel in a closed syllable pharyngealises by receiving specification for [RTR], which is represented with secondary status. The added [RTR] has secondary status because an unconditioned vowel, to use the terminology of Ladefoged and Maddieson (1996), already has 'major' articulatory features. The additional feature of pharyngealisation is seen as introducing a 'minor' articulation to its implementation. 'Minor' articulation features for vowels are assumed here to be represented in the same manner as secondary articulation features for consonants, that is, with secondary status.

2.3.3. Prosodically Conditioned (Closed Syllable) Pharyngealisation

Note that the requirement that a primary articulation feature be implemented with tighter stricture than a secondary articulation feature, which holds for consonants (see §1.4.1), does not hold for vowels. A striking illustration of this are the fricative vowels discussed by Ladefoged and Maddieson (1996:314), e.g., the fricative vowel allophone of "i" in Standard Chinese, and the fricative vowel allophone of "r" in Czech. The reverse stricture requirement for vowels with respect to primary vs. secondary specifications is here considered to follow from the fundamental articulatory difference between consonants and vowels, *viz.*, that (singly-articulated) consonants are produced with obstructive articulation, while (singly articulated) vowels are produced with non-obstructive articulation. In other words, consonant articulation is basically obstructive, while vowel articulation is basically non-obstructive. Given that, it follows that, for a vowel specified for both a primary and secondary articulation feature, the primary feature will be the one with the least tight constriction.

By combinatorial specification, the addition of [RTR] yields the 16 output vowels seen in (59). Mid central ⟨ə ɜ⟩, which are reduced /Æ/, are included in (59). The eight rtr vowels are boxed. Palestinian uses all of them.

(59)

	{ə}	{ɜ}	{i$_1$}	{ɪ$_1$}	{i$_2$}	{ɪ$_2$}	{æ}	{a}
HI			+	+	+	+		
LO							+	+
LAB								
RTR		+		+		+		+

	{u$_1$}	{ʊ$_1$}	{u$_2$}	{ʊ$_2$}	{e}	{ɛ}	{o}	{ɔ}
HI	+	+	+	+	+	+	+	+
LO					+	+	+	+
LAB	+	+	+	+			+	+
RTR		+		+		+		+

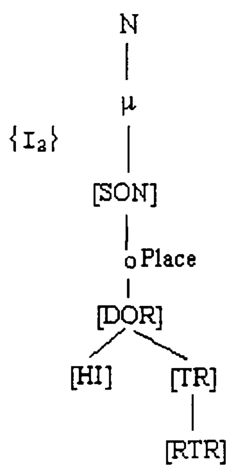
The [HI] and [LAB] specifications imposed on the epenthetic vowel are included in (59). They result in surface variants of the epenthetic vowel which neutralise with the surface variants of /I/ and /U/. The unrounded and rounded variants of the epenthetic vowel are labelled '{i$_1$}' and '{ɪ$_1$}', and '{u$_1$}' and '{ʊ$_1$}', respectively. The surface variants of underlying /I/ and /U/ are labelled '{i$_2$}' and '{ɪ$_2$}', and '{u$_2$}' and '{ʊ$_2$}', respectively. The basis for the claim that Palestinian has non-rtr {æ} vs. rtr {a} and non-rtr {ə} vs. rtr {ɜ} will be presented in §2.4.3.

Note that Palestinian [HI] vowels freely combine with [RTR]. This shows that the paradigmatic Grounding constraint HI/*RTR ('A segment specified for [HI] is not specified for [RTR]'), shown by Archangeli and Pulleyblank (1994b) and Pulleyblank (1994a) to be highly ranked in Niger-Congo, is lowly ranked in Palestinian. (The two studies just referenced phrase the constraint as 'HI/ATR'. The feature '[ATR]' will be addressed in chapter 4.)

2.3.3. Prosodically Conditioned (Closed Syllable) Pharyngealisation

The representational alteration caused by pharyngealisation is illustrated with (/I_2/ >) {I_2} in (60). After Zec (1988) and Shaw (1993), it is assumed that vowels project a nucleus so that, in the surface form, a vowel is dominated by a NUC, as seen in (60). (In prosodic representations, 'N' will abbreviate 'NUC'.)

(60)



I propose that the data in (52) and (53) require the constraints in (61), which are ranked as seen in (62). (The ranking of DEP-RTR with respect to DEP-LINK will be clarified in §2.4.6.)

(61) a. NUC-C]$_\sigma$/RTR
A NUC in a closed syllable is specified for [RTR].

b. DEP-RTR
Every [RTR] in the output corresponds to an [RTR] in the input.

c. DEP-LINK
Every association in the output corresponds to an association in the input.

(62) NUC-C]$_\sigma$/RTR >> DEP-RTR, DEP-LINK

2.3.3. Prosodically Conditioned (Closed Syllable) Pharyngealisation

I propose that NUC-C$]_\sigma$/RTR is a syntagmatic Grounding constraint that is grounded in phonetic undershoot of vowels in a CVC context, shown by Lindblom (1963). Lindblom examined Swedish vowels in CVC syllables. He found that for vowels in that context, F_1 and F_2 did not reach their target values. He summarises this undershoot effect [p.1781] as 'centralisation', a 'contextual assimilation' to schwa. It is here presumed to result from the fact that there is "less time for the articulators to complete their "on-" and "off-glide" movements within the CVC syllable... the speech organs fail, as a result of the physiological limitations, to reach the positions that they assume when the vowel is produced under ideal steady-state conditions" (Lindblom 1963:1770). (In the paragraph from which this quote is taken, Lindblom begins his sentence with: "As a vowel becomes shorter, there is less and less time for the articulators to complete their...". Lindblom's remarks are interpreted here as identifying two factors in undershoot: (i) the closed syllable context, (ii) vowel length. The excerpt quoted above focusses on the remarks that are relevant to the closed syllable context, as distinct from the additional factor of vowel length. For discussion of the influence of vowel length on phonetic undershoot, based on Lindblom's findings, see §2.4.6. With respect to closed-syllable pharyngealisation, the phonetics-phonology link proposed here is that, in a language like Palestinian, the phonetic undershoot of short vowels in a closed syllable is phonologised, that is, imposed in the phonology, by the constraint NUC-C$]_\sigma$/RTR. The result is new short vowel targets in a closed syllable: {ɪ} instead of {i}, {ɛ} instead of {e}, etc.

2.3.3. Prosodically Conditioned (Closed Syllable) Pharyngealisation

The constraint interaction responsible for Palestinian closed-syllable pharyngealisation is illustrated by the tableau in (63).

(63)

input: /zIft/ 'ashphalt,bad thing'; see (53)	NUC-C]$_\sigma$/ RTR	DEP-RTR	DEP-LINK
1. {zift}	*!		
☞ 2. {zɪft} | [RTR]		*	*
3. {zɪ ft} |/ [RTR]		*	**!

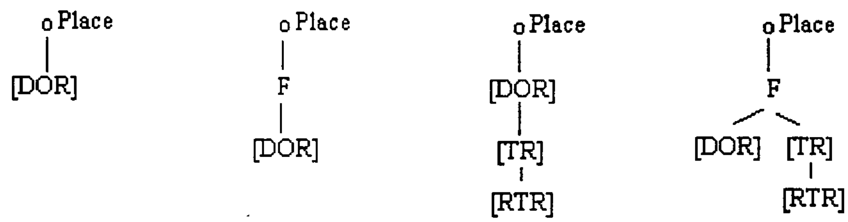
In this tableau, candidate 2 contains a non-underlying [RTR] and a non-underlying link, in violation of DEP-RTR and DEP-LINK but in satisfaction of NUC-C]$_\sigma$/RTR. The fact that candidate 2 is optimal shows that violation of DEP-RTR and DEP-LINK is less serious than violation of NUC-C]$_\sigma$/RTR. This establishes the ranking NUC-C]$_\sigma$/RTR >> DEP-RTR, DEP-LINK.

Candidate 3 contains a link between [RTR] and {f} (yielding a pharyngealised {f}), a link not required by any constraint in the tableau. Because of that link, candidate 3 incurs one more violation of DEP-LINK than candidate 2. This makes candidate 3 less optimal than the winning candidate 2.

2.3.3. Prosodically Conditioned (Closed Syllable) Pharyngealisation

An implicit claim of the account just presented is that Palestinian closed-syllable pharyngealisation does not affect consonants. There is phonological evidence for this, which is explained as follows: consider the representations of primary velar, velarised, primary uvular, and uvularised segments, seen earlier in (48). They are repeated below:

(64) a. primary velar b. velarised c. primary uvular d. uvularised



In (64), it is claimed that the difference between a primary velar and primary uvular segment is the secondary-[RTR] specification of the latter. This claim is based on phonological evidence, which is supported by articulatory and acoustic data, as discussed in §2.3.1. If Palestinian consonants were also affected by closed syllable pharyngealisation, then, like vowels, they would surface specified for [RTR] in a closed syllable. Assuming (64), this predicts that Palestinian /k/ would surface as primary uvular /q/ in a closed syllable. (On the distinction between primary uvular /q/ and uvularised (emphatic velar) /ḳ/, see §1.4.2.) However, data such as those in (65) show it does not.

(65) a. /IktIb/	{ˈʔɪk.tɪb}	(*{ˈʔɪq.tɪb})	'to write'
b. /bInt-Æk/	{ˈbɪn.t-ɜk}	(*{ˈbɪn.t-ɜq})	'your (masc. sg.) daughter'
c. /kUṛsI/	{ˈkʊr.si}	(*{ˈqʊr.si})	'chair'

2.3.3. Prosodically Conditioned (Closed Syllable) Pharyngealisation

Perceptual support for assuming that Palestinian consonants are unaffected by closed-syllable pharyngealisation comes from judgments of Palestinian segments provided by Abu Shusha consultant KS. This speaker is literate and linguistically untrained. He was asked to identify certain sounds in Palestinian words. The sounds for which judgments were elicited were instances of /m/ and /I/ in a non-pharyngealisation vs. closed-syllable pharyngealisation context. The judgments were produced as the oral responses reported in Table 2:3.

As seen, the judgments for /m/ in both a non-pharyngealisation and closed-syllable pharyngealisation context were the same. This is interpreted as indicating that pharyngealisation does not have a categorical perceptual affect on consonants, such that no distinct rtr allophone results for a consonant in a closed syllable. (In §3.4.2, it will be argued that this is true also in St'át'imcets Salish.) However, the judgments for /I/ in the two contexts were not the same: the /I/ in a closed-syllable pharyngealisation context was perceived differently from the /I/ in a non-pharyngealisation context. This is interpreted as demonstrating the categorical effect that pharyngealisation has on vowels. The result is a perceptual distinction between non-rtr and rtr allophones. For the vowel of judgment 5 in Table 2:3, the rtr allophone arises in a closed syllable. The acoustic basis for the perceptual distinction is documented in Figures 2:5, 2:6, and 2:8, which show that an F_1

Table 2:3

Judgments of Palestinian /m/ and /I/ in a non-pharyngealisation vs. closed-syllable pharyngealisation context

Task: Please identify...	Response	Notes
1. the first sound in *Mona* [{ˈmo.nə}‘Mona’ (fem. name)] = /m/ IN A NON-PHARYNGEALISATION CONTEXT	“*mīm*.”	*mīm* = م = m *tā* = ت = t *ħā* = ح = ħ
2. the sound just before *tā* in *kimtha* [{ˈkɪm-t.-hə} ‘I removed it (fem.)’] = /m/ IN A CLOSED-SYLLABLE PHARYNGEALISATION CONTEXT	“*mīm*.”	
3. the sound immediately following *ħā* in *ʔeħmil* [{ˈʔɪħ.mɪl} ‘to carry’] = /m/ IN A CLOSED-SYLLABLE PHARYNGEALISATION CONTEXT	“*mīm*.”	
4. the vowel sound immediately following *sīn* in *sido* [{ˈsi.d-o} ‘grandpa’] = /I/ IN A NON-PHARYNGEALISATION CONTEXT	“It [that vowel in *silik*] is different from the first one in *sido*. You would write it with a *kasra*. For the first vowel vowel in *sido*, there would be a *yā* too.”	*sīn* = س = s *lam* = ل = l *kasra* = ِ = ɪ *yā* = ي = j *kasra* with *yā* = يِ = i(j) or iː(j)
5. the vowel sound immediately following *lam* in *silik* [{ˈsɪ.lɪk} ‘wire’] = /I/ IN A CLOSED-SYLLABLE PHARYNGEALISATION CONTEXT		

difference on the order of 100 Hz distinguishes tokens of the non-rtr vs. rtr allophones of a (non-low) vowel.

A possible counter-argument is: perhaps Palestinian consonants have non-rtr vs. rtr surface variants but the distinction between the two variants is just not perceived by speakers. However, if there were such distinct variants, we would expect to see phonological evidence for them, such as the /k/ > {q} effect shown to be ungrammatical in (65). Based on the lack of that effect and on the perceptual data in Table 2:3, it is concluded that Palestinian closed syllable pharyngealisation does not affect consonants.

The question at this point is: from what formal property of Palestinian does this follow? The answer to be provided below relies on Archangeli and Pulleyblank's (1994a) notion of the 'anchor' for a harmonic feature.

Archangeli and Pulleyblank (1994a:24) describe the anchor for a harmonic feature as "the highest significant level of structure, either organizational or prosodic." The working definition of 'anchor' adopted here is: the representational element onto which a non-underlying link docks. With Archangeli and Pulleyblank [p.23 - 24], it is assumed that where necessary, this docking occurs by interpolation, that is, by automatic generation of hierarchical structure between the harmonic feature and the anchor. Anchors are here assumed to be either root nodes or, assuming the inventory of prosodic constituents recognised within Nuclear/Moraic theory (see §1.3.3.3), moras ('μ's) or NUCs. (Archangeli and Pulleyblank (1994a) assume them to be either organisational (root nodes) or prosodic. For prosodic anchors, they recognise non-head μs, head μs, or all μs (that is, both head and non-head μs).)

The class of NUCs in Palestinian is here considered to identify the class of Palestinian vowels. This is because, although Palestinian consonants can be moraic, as shown on the basis of stress assignment by Hayes (1995), they can be argued to be non-nuclear. Consider (66), in which each form contains an epenthetic vowel. The epenthetic vowel supplies a nucleus for the word-initial syllable. This vowel epenthesis is assumed to be imposed by σNUC ('Syllables must have nuclei') (Shaw 1996b, based on Prince and Smolensky 1993:87).

(66) a.	/kmÆːʃ/	{ʔɪk.ˈmæːʃ}	(*{k̩.ˈmæːʃ})	'cloth'
b.	/ʤfUːn/	{ʔɪʤ.ˈfuːn}	(*{ʤ̩.ˈfuːn})	'eyelids
c.	/ħmÆːr̙/	{ʔ̙ɪħ̙.ˈm̙ɐːr̙}	(*{ħ̩̙.ˈm̙ɐːr̙})	'donkey'

The vowel epenthesis in (64) indicates that Palestinian consonants do not project a nucleus: if they did, the vowel epenthesis would be unexpected, since σNUC could be satisfied without it.

Exceptional forms with syllabic lateral or nasal resonants are observed. However, they are in free variation with (otherwise identical) forms containing an epenthetic vowel; e.g., /lħÆːff/ {l̩.ˈħaff} ~ {ʔɪl.ˈħaff} 'heavy cotton cover'; /m-sÆtʃtʃÆr̙/ {m̩-ˈsatʃ.tʃɜ˃r̙} ~ {ʔɪm.-ˈsatʃ.tʃɜ˃r̙} 'closed (masc. sg.)' (Adj). The variants with the syllabic lateral or nasal are here analysed as violations of σNUC.

Based on the foregoing discussion, the anchor for [RTR] in Palestinian is here identified as the NUC. The exclusion of consonants from the phonological effects of closed-syllable pharyngealisation follows automatically and necessarily from this formal property.

2.4. Palestinian Pharyngealisation Harmony

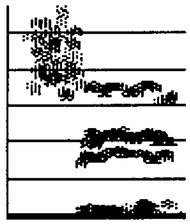
2.4.1. Harmony Under Adjacency to a Postvelar

2.4.1.1. Analysis

In (67), short vowels occur adjacent to an underlying postvelar.

(67) a. /sUʔÆːl/	{sʊ.ˈʔæːl}	(*{su.ˈʔæːl})	‘question’
c. /ʃUhUː/	{ʃʊ.ˈhuː}	(*{ʃu.ˈhuː})	‘what?!’
b. /hIbÆ/	{ˈhɪ.bə}	(*{ˈhi.bə})	‘Hiba’ (fem. name)
d. /ʕUlÆ/	{ˈʕʊ.lə}	(*{ˈʕu.lə})	‘Ula’ (fem. name)
e. /ð̙Ur̙Æ/	{ˈð̙ʊ.r̙ə}	(*{ˈð̙u.r̙ə})	‘corn’
f. /k̙Ur̙Æ/	{ˈk̙ʊ.r̙ə}	(*{ˈk̙u.r̙ə})	‘ball’
g. /sbIt̙Æːr̙/	{s̙b̙ɪ.ˈt̙ɐːr̙}	(*{s̙bi.ˈt̙ɐːr̙})	‘hospital’

These forms show that short vowels surface rtr when adjacent to an underlying postvelar. This is analysed as local pharyngealisation harmony triggered by the postvelar. The postvelar triggers include laryngeal gutturals, as seen in (67a-c). (Issues raised by the non-pharyngealising long {uː} in (67c) and short {ə} in (67c-f) will be addressed in §2.4.5. Optimality tableaux for the forms in (67b) and (67d) will be presented in §2.4.2.)



2.4.1.2. Acoustic Support

This section presents F_1 - F_2 plots for certain subsets of the tokens of /I/ and /U/ that were plotted in Figures 2:1 and 2:4. Each plot contains two ellipses, which are from the two earlier figures just mentioned. Figures 2:9 - 2:10 plot the tokens of /I/ and /U/ in Figures 2:1 and 2:4 which occurred adjacent to an underlying postvelar in a phonological open syllable. (For each vowel, some tokens are adjacent to a guttural, some are adjacent to an underlying emphatic. This is seen from the list of carrier forms in Appendix III.) No graphs are presented for tokens of /E/ and /O/ in this context, due to lack of data.

In Figures 2:9 - 2:10, the tokens of /I/ and /U/ fall within the ellipses for the rtr surface vowels. They are rtr [ɪ] and rtr [ʊ], respectively. That is, as discussed in §2.3.3.2 with respect to the rtr tokens in Figures 2: 1 and 2:4, they show the direction of F_1 and F_2 effects expected for pharyngealisation articulation, though not the expected magnitude. The lack of the expected magnitude is here considered an artifact of the articulation-to-acoustics model used in this thesis, Stevens and House (1955). The observed direction of formant effects is interpreted as support for an assumption that the open syllable, adjacent postvelar tokens of /I/ and /U/, like the closed syllable, no trigger tokens of /I/, /E/, and /U/ in Figures 2:5, 2:6, and 2:8, were produced with pharyngealisation. That articulation,

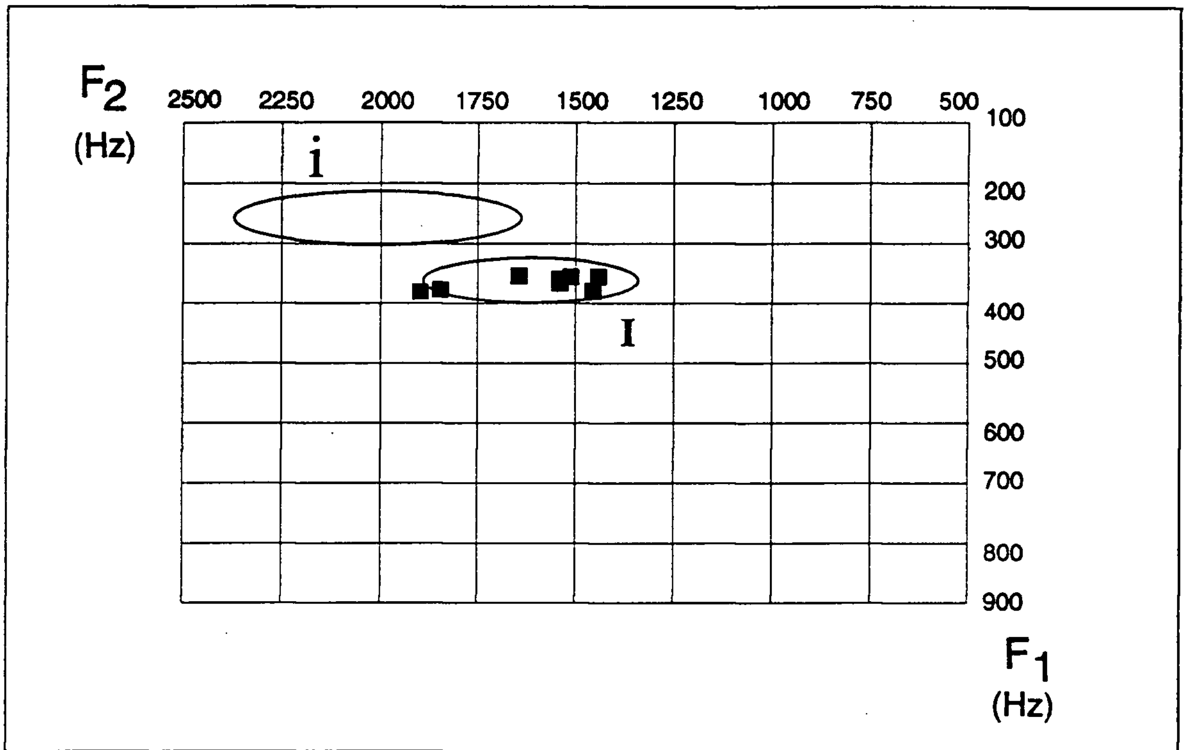


Figure 2:9 F_1 - F_2 plot of open syllable, adjacent postvelar tokens of Palestinian short /I/

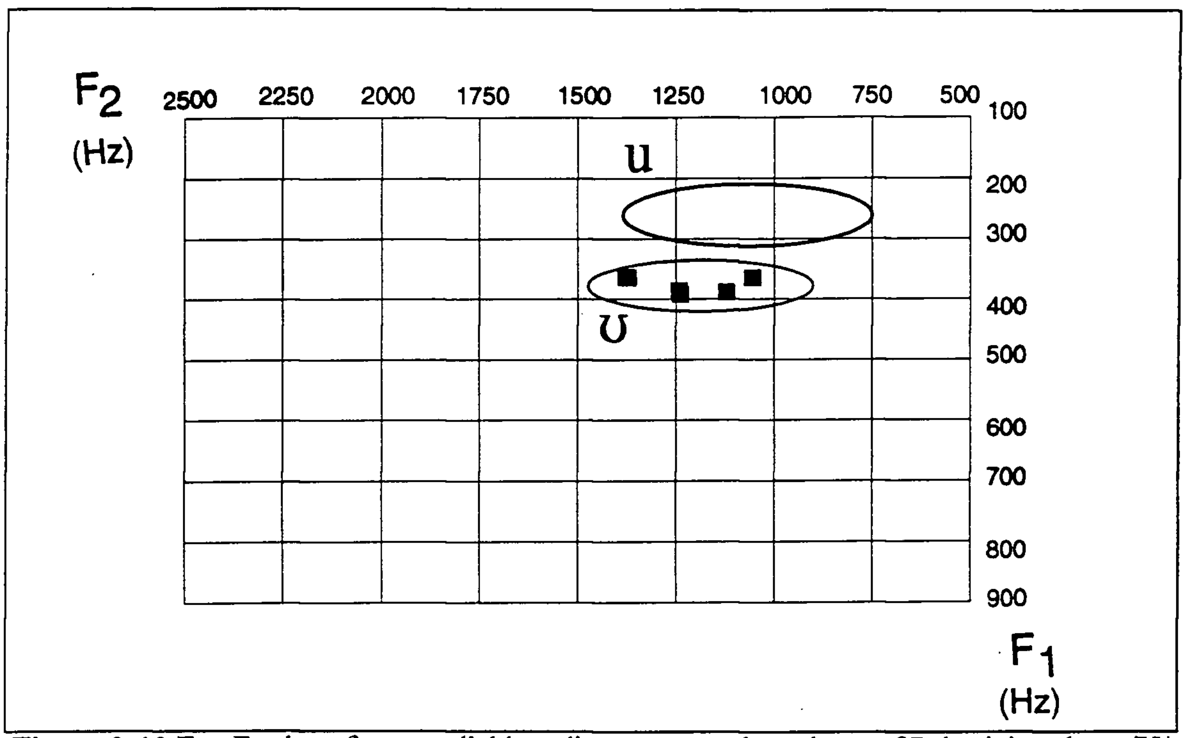


Figure 2:10 F_1 - F_2 plot of open syllable, adjacent postvelar tokens of Palestinian short /U/

in turn, supports the phonological claim that Palestinian short vowels pharyngealise when adjacent to an underlying postvelar.

For some of the tokens in Figure 2:9 and 2:10, the adjacent postvelar is a laryngeal; this is seen from Appendix III. The laryngeal-adjacent tokens also show the expected direction of F_1 and F_2 effects predicted for pharyngealisation. This is the acoustic finding with respect to laryngeal gutturals that was anticipated in §1.3.2.2. It is considered acoustic support for assuming that the adjacent laryngeal were produced with tongue root retraction. This, in turn, is considered support for the claim that Palestinian laryngeals are specified for [RTR].

Figures 2:11 - 2:12 plot the tokens of /I/ and /U/ in Figures 2:1 and 2:4 which occurred adjacent to a postvelar and which are themselves in a closed syllable. Two

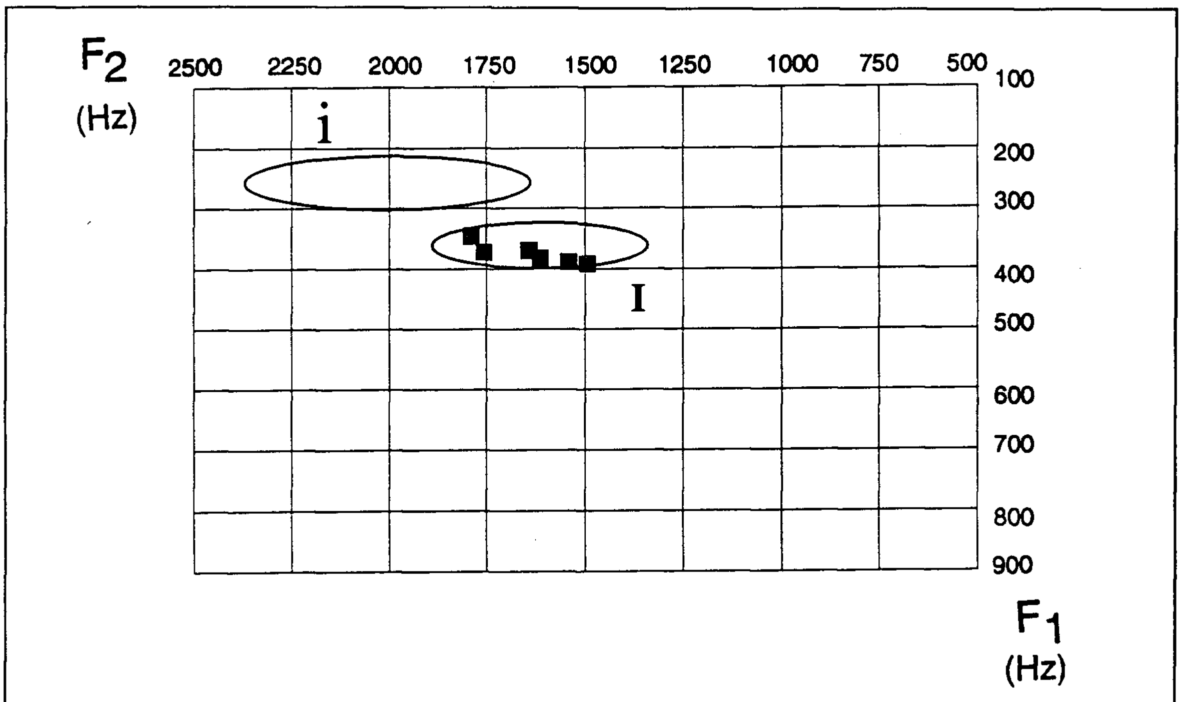


Figure 2:11 F_1 - F_2 plot of closed syllable, adjacent postvelar tokens of Palestinian short /I/

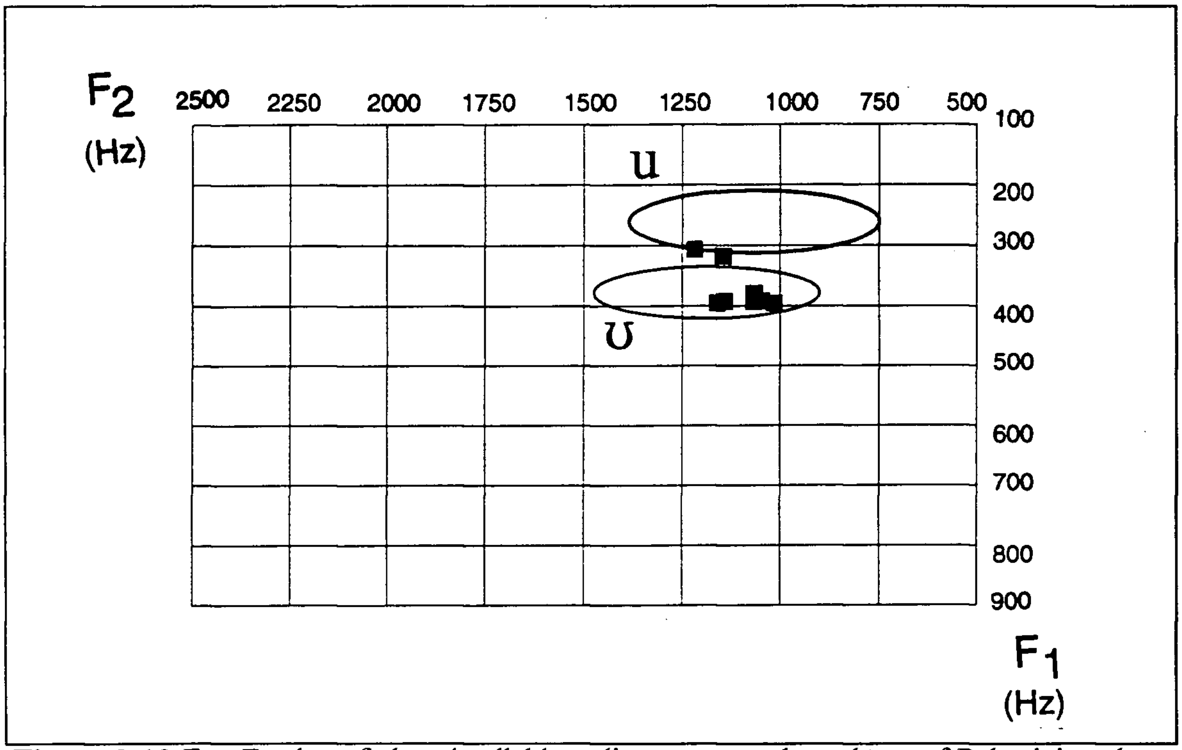


Figure 2:12 F_1 - F_2 plot of closed syllable, adjacent postvelar tokens of Palestinian short /U/

tokens of /U/ in Figure 2:12 fall between non-rtr and rtr ellipses. However, the general observation is that the tokens in Figures 2:11 - 2:12 are, as expected, rtr. (No graphs are presented for /E/ and /O/ in this context, due to lack of data.)

2.4.2. A Theoretical Account: Part I

I propose that the data in (67) require the additional constraints in (68), which are ranked with NUC-C]$_\sigma$/RTR, DEP-RTR, and DEP-LINK as seen in (69). (As noted earlier, the ranking of DEP-RTR with respect to DEP-LINK will be clarified in §2.4.6.

The ranking of NUC-C]$_\sigma$/RTR with respect to ALIGN-L([RTR], NUC) and ALIGN-R([RTR], NUC) will be clarified in §2.6.)

(68) a. ALIGN-L([RTR], NUC)
The left edge of [RTR] is aligned with the left edge of a NUC.
(∀[RTR], ∃NUC with which it is left-aligned.)

b. ALIGN-R([RTR], NUC)
The right edge of [RTR] is aligned with the right edge of a NUC.
(∀[RTR], ∃NUC with which it is right-aligned.)

c. DEP-IO
Every segment (that is, root node) in the output has a correspondent in the input.

d. MAX-RTR
Every [RTR] in the input corresponds to an [RTR] in the output.

e. MAX-LINK
Every association in the input corresponds to an association in the output.

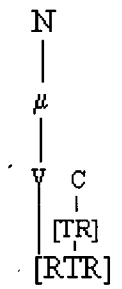
(69) DEP-IO, MAX-RTR, MAX-LINK >>

NUC-C]$_\sigma$/RTR, ALIGN-L([RTR], NUC), ALIGN-R([RTR], NUC) >>

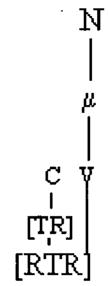
DEP-RTR, DEP-LINK

When unviolated, ALIGN-L([RTR], NUC) and ALIGN-R([RTR], NUC) effect the edge alignments seen below:

(70) a. the effect of unviolated ALIGN-L([RTR], NUC)



b. the effect of unviolated ALIGN-R([RTR], NUC)



As seen from (70), the ALIGN([RTR] NUC) constraints require [RTR] to surface on a vowel. Where they are satisfied, [RTR] gravitates from a postvelar consonant onto a vowel. I propose that these constraints are auditory Grounding constraints that are grounded in the categorical effect that non-underlying pharyngealisation has on vowels but not on consonants; see §2.3.3.3 for discussion. Note that underlying pharyngealisation is categorical for consonants, as it identifies the postvelar class and distinguishes primary velar vs. primary uvular consonants. However, the suggestion here is that distinctiveness of the underlying pharyngealisation of consonants is optimally enhanced in the surface form by concurrent realisation on a vowel. This is imposed by ALIGN-L([RTR], NUC) and ALIGN-R([RTR], NUC) which require [RTR] to be realised on a vowel.

A claim of previous work is in apparent direct contradiction to the suggestion just made, *viz.*, the claim of Goad (1993) that [RTR] is exclusively a consonantal feature. However, under her assumptions, [RTR] is the representation of emphatic articulation. Emphatic articulation was clarified in §1.4.3 as uvularisation (with concomitant pharyngealisation). That articulation is assumed in this thesis to be represented by concurrent specification for secondary-[DOR] and secondary-[RTR]. Given Goad's representational assumptions, her claim with respect to '[RTR]' is thus not directly relevant to the proposal in the preceding paragraph. (As to whether or not the representation of uvularisation is exclusively consonantal, data to be presented in §2.5.1 will show that both consonants and vowels undergo Palestinian uvularisation harmony. This has been shown previously by Card (1983), Davis (1995), Herzallah (1990), and Younes (1982, 1993, 1994). It indicates that, while the representation of uvularisation associates with only consonants underlyingly, in the surface form it can be associated with both consonants and vowels.)

With respect to [RTR], here defined as the representation of pharyngealisation, the present claim that it is optimally realised on vowels makes two predictions: (1) there are languages with [RTR] on vowels but not on consonants; (2) if a language has [RTR] on consonants, it will have [RTR] on vowels; that is, [RTR] vowel harmony will occur in a language with underlying [RTR] consonants.[11] Chapter 4 will argue that Niger-Congo and Nilotic languages bear out prediction 1. Prediction 2 is borne out with Palestinian, as we have seen. Chapter 3 will argue that it is also borne out with St'át'imcets Salish.

Support for Prediction 1 is also found in Maddieson (1984), which lists the consonantal and vocalic inventories of 317 languages from the UCLA Phonological

[11]I thank Pat Shaw for pointing out these predictions.

Segment Inventory Database (UPSID). Of the 317, 139 = 44% have rtr vowels, that is, vowels like {ɪ ɛ ɔ ʊ}, but no postvelar consonants.

Note that the contrast between the vowels {i} and {ɪ}, {e} and {ɛ}, etc., in Germanic languages is argued by Maddieson and Ladefoged (1996:302-306) to be captured by the feature [TENSE], not by a tongue root feature. Their argument is based on the articulatory and statistical findings of Harshman, et al. (1977), Ladefoged and Harshman (1979), Bolla and Valaczkai (1986), and Jackson (1988), which indicate that in Germanic languages there is no common tongue root setting for 'lax' vowels like {ɪ}, {ɛ}, etc., compared to 'tense' vowels like {i}, {e}, etc. Based on this, Ladefoged and Maddieson (1996:p.304) conclude that tongue root position in Germanic languages is "simply one of the concommittants of vowel height" and that Germanic {ɪ}, {ɛ}, etc. are distinguished from {i}, {e}, etc. by the non-tongue-root feature, [TENSE].

However, with Archangeli and Pulleyblank (1994a) and following Halle and Stevens (1969), it is assumed here that all instances of {i} vs. {ɪ}, {e} vs. {ɛ}, etc., contrasts can nevertheless be analysed as manifestations of a tongue root feature. Archangeli and Pulleyblank base their argument on the fact that there is no evidence that a language, like English, that has been argued to use [TENSE] also uses a tongue root feature. Rather, the two types of features are in complementary distribution. Based on this, they conclude [p.450] that "the complementary distribution... should be explained by analyzing the relevant cases as manifestations of a single feature [*viz.*, a tongue root feature];" see Archangeli and Pulleyblank (1994a:449) for further discussion. This position is adopted here. On this basis, Germanic languages are included above with the languages from Maddieson's database that are taken as support for Prediction 1.

As for Prediction 2, Maddieson's data provide only slim support. Of the 317 languages, 64 = 20% have postvelar consonants. Of those, 34 are reported to have rtr vowels, 30 are not.[12] However, it is here hypothesised that a close examination of the phonetics and phonology of the 30 countering languages would show that many of them actually do bear out Prediction 2, that is, that their vocalic inventories contain rtr vowels. This is plausible because, although Maddieson found the UPSID data adequate to test a hypothesis of vowel dispersion (see his discussion, p.136-139), he states:

> Whether or not the vowels of a particular language are represented in sufficient phonetic detail in UPSID depends greatly on the phonetic judgments and transcription methods of the field linguist. Some linguists report the auditory quality of vowels in the narrowest detail, while others simply rely on the commonest vowel symbols, often those available on any typewriter, to make all the necessary distinctions... Unfortunately, while a vowel system reported as /i e a o u/ may be faithfully representing a perfectly balanced system, it may also be concealing a wealth of unreported phonetic detail. (p.138)

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[12]The languages reported in Maddieson (1984) to have postvelar consonants, but no rtr vowels are: Farsi, Pashto, Eastern Armenian, Tigre, Socotri, Neo-Aramatic, Shilha, Tuareg, Awiya, Sui, Mandarin, Tlinglit, Klamath, Wintu, Totonac, K'ekchi, Quileute, Squamish, Hopi, Achumawi, Abipon, Jaqaru, Gununa-Kena, Greenlandic, Aleut, Kurukh, Kabardian, Lak, Burushaski, and !Xũ.

2.4.2. A Theoretical Account: Part I

A close examination of the 30 counterexample languages in Maddieson's database, for a thorough testing of Prediction 2, is left for future work.

Returning now to the constraints in (68), DEP-IO says there must be no segmental epenthesis. In Palestinian, a vowel and a word-initial glottal stop are frequently epenthesised to satisfy syllable structure requirements. This means that the prosodic constraints forcing segmental insertion, here assumed to be ONS-$_{Wd}$[σ and σNUC (see §2.2.1.4, §2.3.3.3), must be more highly ranked than DEP-IO. However, because they are not directly relevant to the issues discussed in this thesis, in that they are always satisfied in the data under consideration, they will not be included in any tableau. For an Optimality account of Arabic vowel epenthesis, see Davis and Zawaydeh (1996).

The constraint interaction responsible for pharyngealisation harmony under adjacency to an underlying postvelar is illustrated in the tableaux in (71) and (72). (In the tableaux, 'ALIGN([RTR], NUC)' abbreviates ALIGN-L([RTR], NUC) and ALIGN-R([RTR], NUC). Discussion of the non-harmonising final vowel in each winning candidate is deferred until §2.4.6. Finally, the constraint interaction producing Palestinian syllabification, stress assignment, and vowel reduction will be ignored in all tableaux in this chapter, as a detailed and motivated treatment of those issues is beyond the scope of this thesis.)

The ranking MAX-RTR, MAX-LINK >> ALIGN-L([RTR], NUC), ALIGN-R([RTR], NUC) is shown by the fact that the in the winning candidates in (71) and (72), the vowel adjacent to the postvelar surfaces bearing [RTR] (ignoring the non-harmonising

(71)

input: /ʃUhUː/ [RTR] 'what?!'; see (67)	DEP-IO	MAX-RTR	MAX-LINK	NUC-C]$_\sigma$/RTR	ALIGN-([RTR], NUC)	DEP-RTR	DEP-LINK
1. {ʃu.ˈhuː}		*!	*				
2. {ʃu.ˈhuː} [RTR]					**!		
☞3. {ʃʊ.ˈhuː} [RTR]					*		*
4. {ʃʊ.ˈhuː} [RTR]					**!		**

(72)

input: /ʕUlÆ/ [RTR] 'Ula' (fem. name); see (67)	DEP-IO	MAX-RTR	MAX-LINK	NUC-C]$_\sigma$/RTR	ALIGN-([RTR], NUC)	DEP-RTR	DEP-LINK
1. {ˈʕu.lə}		*!	*				
2. {ˈʕu.lə} [RTR]					**!		
☞3. {ˈʕʊ.lə} [RTR]					*		*
4. {ˈʕʊ.lə} [RTR]					*		**!
5. {ˈɪ.ʕʊ.lə} [RTR]	*!*						**

final vowels). If MAX-RTR and MAX-LINK were not ranked above the ALIGN([RTR], NUC) constraints, or if the four constraints were equally ranked, then the ALIGN([RTR], NUC) constraints could be vacuously satisfied by deletion of [RTR] and its link with the postvelar. However, forms with such deletion are non-optimal, as seen from candidate 1 in each tableau.

The fact that the winning candidates contain a non-underlying link (between [RTR] and the postvelar-adjacent vowel), in violation of DEP-LINK but in satisfaction of ALIGN-L([RTR], NUC) or ALIGN-R([RTR], NUC), shows that violation of DEP-LINK is less serious than violation of an ALIGN([RTR], NUC) constraint. This establishes the ranking ALIGN-L([RTR], NUC), ALIGN-R([RTR], NUC) >> DEP-LINK.

In candidate 5 in (72), an epenthetic vowel surfaces so [RTR] can left-align with a vowel. This violates DEP-IO, but satisfies the ALIGN([RTR], NUC) constraints. The fact that candidate 5 is non-optimal shows that violation of DEP-IO is more serious than violation of an ALIGN([RTR], NUC) constraint. This shows that DEP-IO, like MAX-RTR and MAX-LINK, dominates the ALIGN([RTR], NUC) constraints.

The candidates 4 contain a non-underlying link between [RTR] and a consonant. Because of this they incur one more violation of DEP-LINK than the winning candidates for their respective forms. For candidate 4 in (71), the link between [RTR] and {ʃ} forces a violation of ALIGN-L([RTR], NUC), as in that candidate [RTR] is not left-aligned with a NUC. Candidate 4 in (71) is thus ruled out by its ALIGN-L([RTR], NUC) violation. Candidate 4 in (72) is ruled out by the DEP-LINK violation caused by the link between

[RTR] and ⦃l⦄. These observations show that a non-underlying link between [RTR] and a peripheral, that is, word-initial or word-final, consonant is ruled out by an ALIGN([RTR], NUC) constraint; a non-underlying link with an intervocalic consonant is ruled out by DEP-LINK.

The data examined so far provide no evidence that NUC-C]$_\sigma$/RTR is as highly ranked as DEP-IO, MAX-RTR, and MAX-LINK. For this reason, it is assigned non-crucial equal ranking with the ALIGN([RTR], NUC) constraints. In §2.6, it will be argued that the ALIGN([RTR], NUC) constraints crucially dominate NUC-C]$_\sigma$/RTR.

Finally, the data examined provide no evidence that DEP-IO is crucially ranked with respect to MAX-RTR and MAX-LINK. Because of this, these three constraints are assumed to be non-crucially equally ranked.

2.4.3. Non-local Harmony

2.4.3.1. Analysis

This section examines non-local pharyngealisation harmony in Palestinian. Data showing non-local harmony are presented in (73). (Tableaux for (73a-b) will be presented in §2.4.4.)

(73) a. /lIbUʔÆ/	⦃ˈlɪ.bʊ.ʔə⦄	(*⦃ˈli.bʊ.ʔə⦄)	‘lioness’
b. /ʁInIm-Æ/	⦃ˈʁɪ.nɪ.m-ə⦄	(*⦃ˈʁɪ.ni.m-ə⦄)	‘goat’
c. /ʁIlIbÆ/	⦃ˈʁɪ.lɪ.bə⦄	(*⦃ˈʁɪ.li.bə⦄)	‘bother’ (N)

2.4.3. Non-local Harmony

In each form in (73), an initial-syllable (73a) or medial-syllable (73b-c) vowel surfaces rtr, even though it is not adjacent to a postvelar. This is analysed as nonlocal leftward (73a) and rightward (73b,c) harmony with the postvelar consonant in each form.

Non-local harmony is also shown by the data in (74). (A tableau for (74c) will be presented in §2.4.4.)

(74)	a. /fIlm/	{ˈfɪ.lɪm}	(*{ˈfi.lɪm})	'movie'
	b. /kUtb/	{ˈkʊ.tʊb}	(*{ˈku.tʊb})	'books'
	c. /tIbn/	{ˈtɪ.bɪn}	(*{ˈti.bɪn})	'straw'
	d. /sElEk/	{ˈsɛ.lɛk}	(*{ˈse.lɛk})	'boiled (masc. sg.)' (Adj)
	e. /kIʃr̩/	{ˈkɪ.ʃɪr}	(*{ˈki.ʃɪr})	'peel' (N)

In each form in (74), the initial-syllable vowel surfaces rtr, even though it is not adjacent to a postvelar or in a closed syllable. This is analysed as non-local pharyngealisation harmony with the closed-syllable-pharyngealised vowel in the final syllable of each form.

The data in (67) and (73) - (74) show that the triggers for Palestinian pharyngealisation harmony are postvelar consonants and closed-syllable-pharyngealised vowels. For certain of these triggers (laryngeal and pharyngeal gutturals), [RTR] is a primary specification. For others (uvular gutturals, emphatics, and closed-syllable-pharyngealised vowels), it is a secondary specification. (The bases for these claims were discussed in §2.3.1 and §2.3.3.3.) Because of this, after the harmony typology proposed in §1.5, Palestinian pharyngealisation harmony is analysed here as [RTR] 'A' harmony.

That is, it is harmony of [RTR] triggered by the class of segments specified for either primary- or secondary-[RTR].

The data in (75) show that pharyngealisation harmony does not extend beyond the word. This confirms the word as the harmony domain.

(75) a. /ħIlm # sIːd-O/	{ˈħɪ.lɪm # ˈsi.d-o}	(*{ˈħɪ.lɪm # ˈsɪ.d-o})	'grandpa's dream'
b. /tEtÆ # r̙Æːħ-Æt/	{ˈte.tə # ˈr̙eː.ħ̙-ɜ˃t̙}	(*{ˈtɛ.tə # ˈr̙eː.ħ̙-ɜ˃t̙})	'grandma went'

The pharyngealisation of the low short vowel /Æ/ will now be addressed. Data such as those in (76) show that /Æ/ also pharyngealises: in each form, the initial-syllable vowel is rtr, even though it occurs in an open syllable and is not adjacent to any postvelar. The initial-syllable rtr vowels in such forms are here analysed as arising through pharyngealisation harmony with a closed-syllable–pharyngealised {ɜ} (shown in §2.2.2.5 to be reduced /Æ/), and are considered evidence that /Æ/ also pharyngealises.

(76) a. /bElÆd/	{ˈbɛ.lɜd}	(*{ˈbe.lɜd})	'land, country'
b. /lEbÆn/	{ˈlɛ.bɜn}	(*{ˈle.bɜn})	'yoghurt'

The pharyngealised (/Æ/ >) {ɜ} in (76) contrasts with the non-pharyngealised (/Æ/ >) {ə} in (77).

2.4.3. Non-local Harmony

(77) a. /lObLÆ/ {ˈlo.bi.ə} (*{ˈlo.bɪ.ɜ}, *{ˈlɔ.bɪ.ɜ}) (a type of small pea)

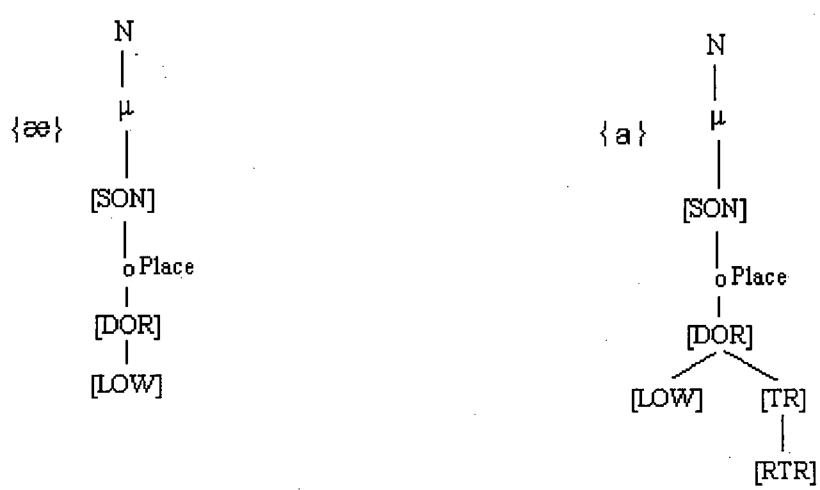
b. /sUṛ-I-Æ/ {ˈsu.r-i.-ə} (*{ˈsu.r-ɪ.-ɜ}, *{ˈsʊ.r-ɪ.-ɜ}) ‘Syria’

The fact that /O I U/ surface respectively as non-rtr {o i u} in (77) is considered evidence that the word-final reduced vowels in these forms are not pharyngealised, that is, that they are non-rtr {ə}, not rtr {ɜ}: if they were {ɜ}, we would expect rtr {ɔ ɪ ʊ} instead of non-rtr {o i u}, as /O I U/ would be expected to harmonise with pharyngealised {ɜ}.

Based on data such as those discussed above, it is here claimed that Palestinian /Æ/ pharyngealises, that is, that it has non-rtr vs. rtr surface variants: non-rtr {æ} and non-rtr {ə} (the reduced counterpart of {æ}) vs. rtr {a} and rtr {ɜ} (the reduced counterpart of {a}). The representations of non-reduced {æ} and {a} are seen in (78).

(78) The Representations of Palestinian Non-rtr {æ} and Rtr {a}

a. non-rtr {æ} b. rtr {a}



2.4.3. Non-local Harmony

As discussed in §2.2.2.5, Palestinian /Æ/ reduction is here assumed to result from /Æ/'s loss of specification for [LOW]. This yields the representations of {ə} and {ɜ} seen in (79).

(79) The Representations of Palestinian Non-rtr (/Æ/ >) {ə} and Rtr (/Æ/ >) {ɜ}

a. non-rtr {ə}

```
        N
        |
        μ
{ə}     |
      [SON]
        |
        o Place
        |
      [DOR]
```

b. rtr {ɜ}

```
        N
        |
        μ
{ɜ}     |
      [SON]
        |
        o Place
        |
      [DOR]
        |
       [TR]
        |
      [RTR]
```

Goad (1991, 1993) argues that [LOW] and '[-ATR]' are mutually exclusive features, occupying the same place in the feature geometry. However, the foregoing data and discussion have demonstrated that non-pharyngealised and pharyngealised low vowels can be contrasted in Palestinian. Assuming that [RTR] = [-ATR], as will be argued in chapter 4, the result is that in Palestinian, a segment can be [LOW] but not [-ATR], or both [LOW] and [-ATR]. This means that [LOW] and [-ATR] are not mutually exclusive in Palestinian and is considered strong counter-evidence against Goad's proposal. For further counter-evidence, see Leitch (1996) on Niger-Congo tongue root harmony.

2.4.3. Non-local Harmony

In (80), /Æ/ occurs under primary lexical stress. The phonetic forms show that Palestinian rtr {a} is phonetically [æ]. (In (80), the source of {a}'s pharyngealisation is the closed syllable (80a), the adjacent /ħ/ (80b) and the closed-syllable-pharyngealised {ɜ} (80b-c).) Acoustic data which support the phonetic non-distinctness of Palestinian {æ a} will be presented in §2.4.3.2.

(80) a. /tʃÆlb/	{tʃalb}	[tʃælb]	'dog'
b. /ħÆlÆk/	{ˈħa.lɜk}	[ˈħæ.lɜk]	'he shaved'
c. /sÆlÆk/	{ˈsa.lɜk}	[ˈsæ.lɜk]	'he boiled (something)'

Dudas (1976:36-37) remarks on a gap in the vowel inventory of Javanese, a language shown by Dudas and Schlindwein (1988) to have phonological tongue root retraction (here analysed as active [RTR]). Dudas states: "Javanese nonlow vowels each have 'tense/lax' surface variants (yielding [i~ɪ, e~ɛ, o~ɔ, u~ʊ]); the two low underlying vowels have invariant 'lax' forms, [a] and [ə]." Based on the evidence for non-rtr {æ} vs. phonetically non-distinct rtr {a} in Palestinian, discussed above, it is plausible that Javanese low vowels might have non-rtr vs. phonetically non-distinct rtr variants, too. This issue will be pursued no further here.

When Palestinian non-reduced /Æ/ is both pharyngealised and uvularised, it surfaces as non-low {ʌ}. However, this is only observed where the pharyngealisation is from a closed syllable. This is illustrated by the forms in (81), in which /Æ/ is in a closed syllable. (A tableau for (81a) will be presented in §2.6.)

(81) a. /mÆṣṛ/ {ṃʌṣṛ} 'Egypt'
b. /bÆṭṭ-Æ/ {ˈḅʌṭ.ṭ-ə} 'duck'
c. /ʕÆṭ-Æt-nI/ {ʕ̣ɜ˃.ˈṭ-ʌṭ.-ṇi} 'she gave (something) to me'

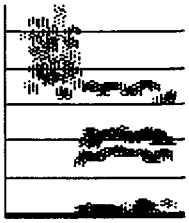
It also illustrated by the forms in (82), in which /Æ/ is uvularised and also pharyngealised under harmony with a closed-syllable-pharyngealised vowel.

(82) a. /ṭÆmṛ/ {ˈṭʌ.ṃɪṛ} 'datefruit''
b. /ḳÆmÆṛ/ {ˈḳʌ.ṃɜ˃ṛ} 'moon'

Otherwise — that is, when /Æ/ it occurs under primary stress in a word containing an emphatic, but no closed-syllable-pharyngealised vowel — /Æ/ surfaces as low, uvularised {ɑ}. This is seen below:

(83) a. /ṣÆlÆṭÆ / {ˈṣɑ.ḷɜ˃.ṭə} (*{ˈṣʌ.ḷɜ˃.ṭə}) 'salad'
b./mÆṛÆ/ {ˈṃɑ.ṛə} (*{ˈṃʌ.ṛə}) 'woman, wife'
c./ṭÆṛ-I/ {ˈṭɑ.ṛ-i} (*{ˈṭʌ.ṛ-i}) 'soft (masc. sg.)'

2.4.3. Non-local Harmony



2.4.3.2. Acoustic Support

Figures 2:13 - 2:15 present a subset of the tokens of Palestinian /I/, /E/, and /U/ shown in Figures 2:1 - 2:2, and 2:4, specifically those tokens which occurred in an open syllable, and either non-adjacent to a postvelar elsewhere in the word or in a word that contains a closed-syllable-pharyngealised vowel (but no postvelar). (No graph for /O/ in either non-local harmony context is presented, due to lack of data.)

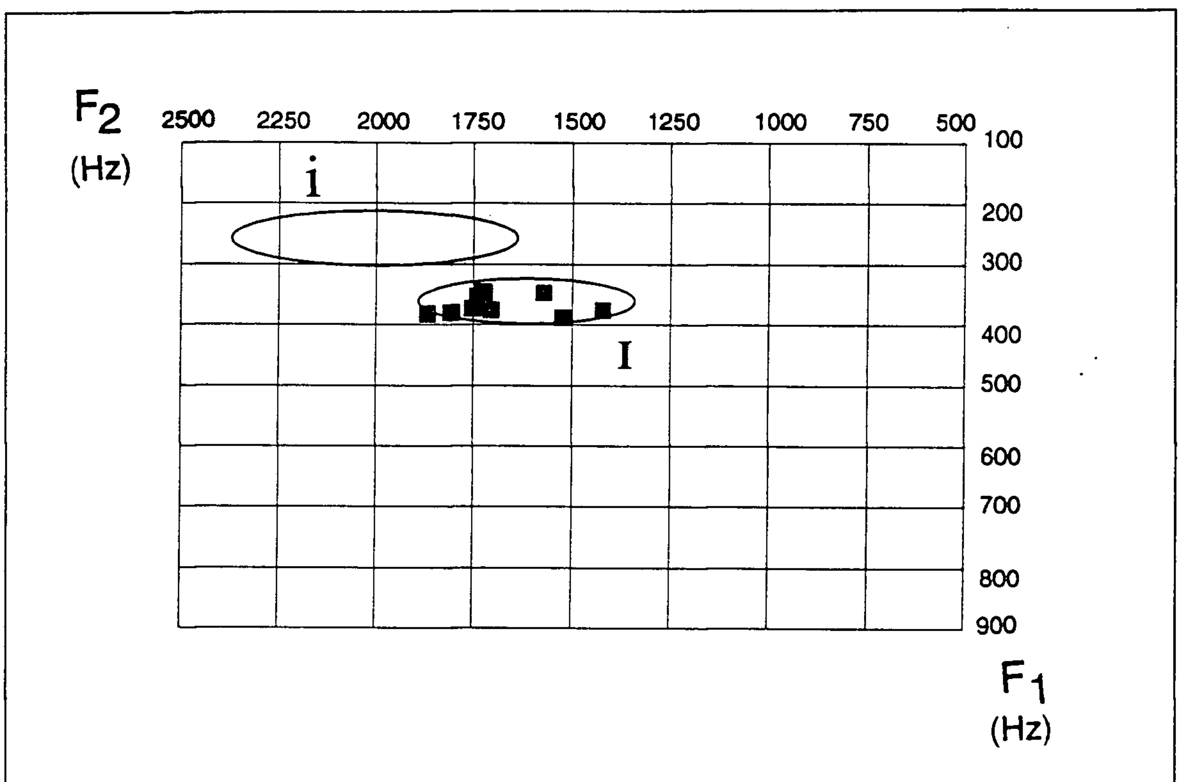


Figure 2:13 F_1 - F_2 plot of open syllable, non-local harmony tokens of Palestinian short /I/

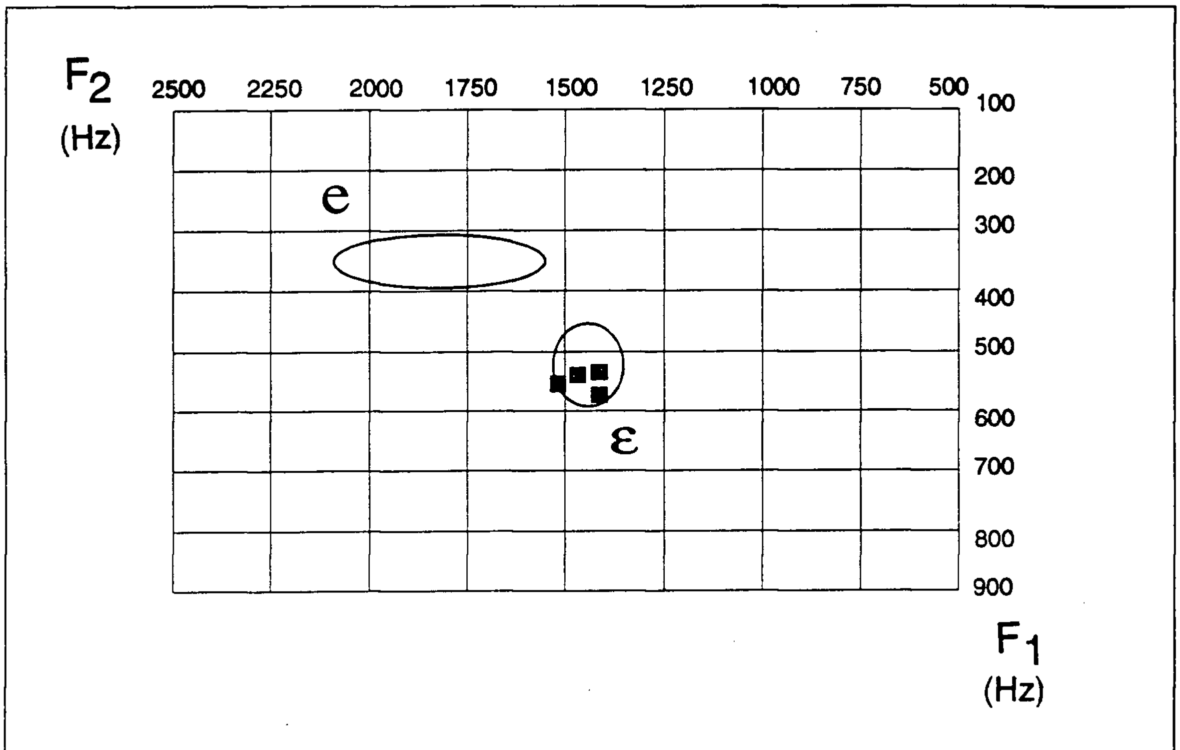


Figure 2:14 F_1 - F_2 plot of open syllable, non-local harmony tokens of Palestinian short /E/

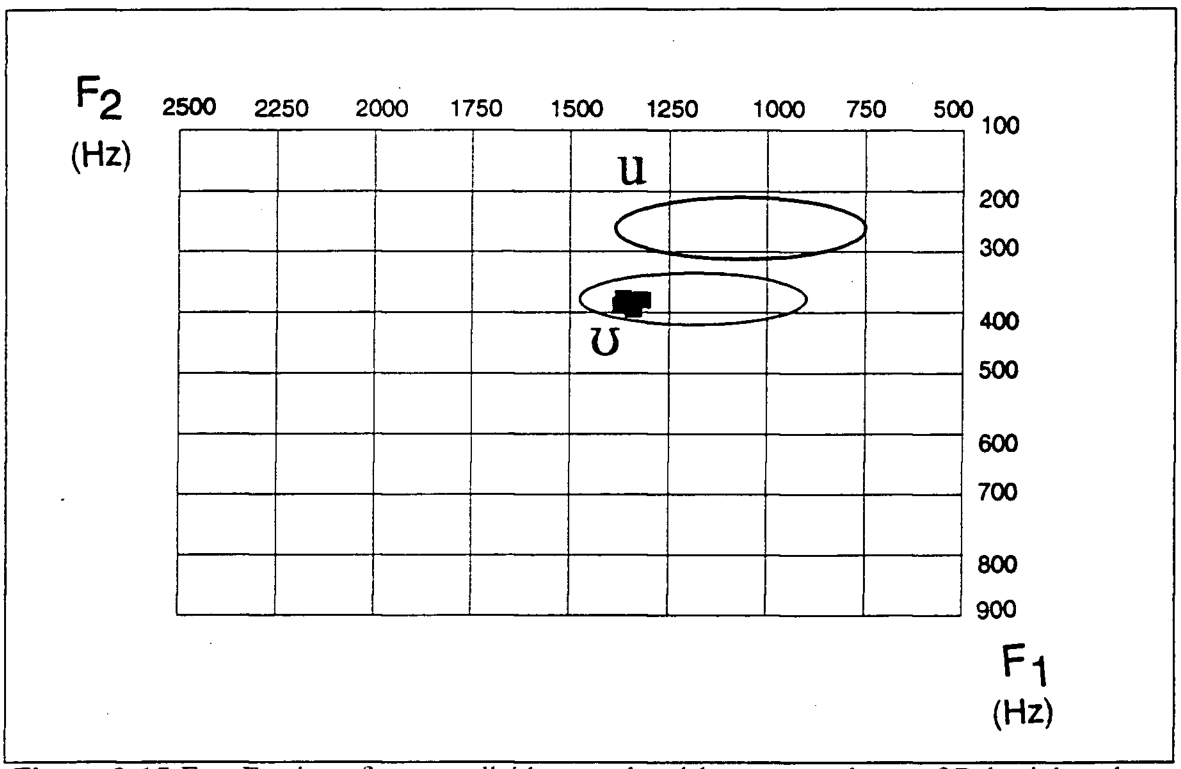


Figure 2:15 F_1 - F_2 plot of open syllable, non-local harmony tokens of Palestinian short /U/

The tokens in Figures 2:13 - 2:15 are rtr. That is, as discussed in §2.3.3.2, they match the direction, though not the magnitude, of the F_1 and F_2 effects predicted for pharyngealisation articulation. The match in direction provides some support for the assumption that the open-syllable, non-local harmony tokens of /I E U/ were produced with pharyngealisation. This, in turn, supports the phonological claim that Palestinian short vowels undergo non-local pharyngealisation harmony with a postvelar or a closed-syllable-pharyngealised vowel.

Figures 2:16 and 2:17 show the tokens of /I/ and /U/, from Figures 2:1 and 2:4, which occurred in a non-local harmony context and which are themselves in a closed syllable. (The present database contains no tokens of /E/ and /O/ in this context.) As expected, they are rtr.

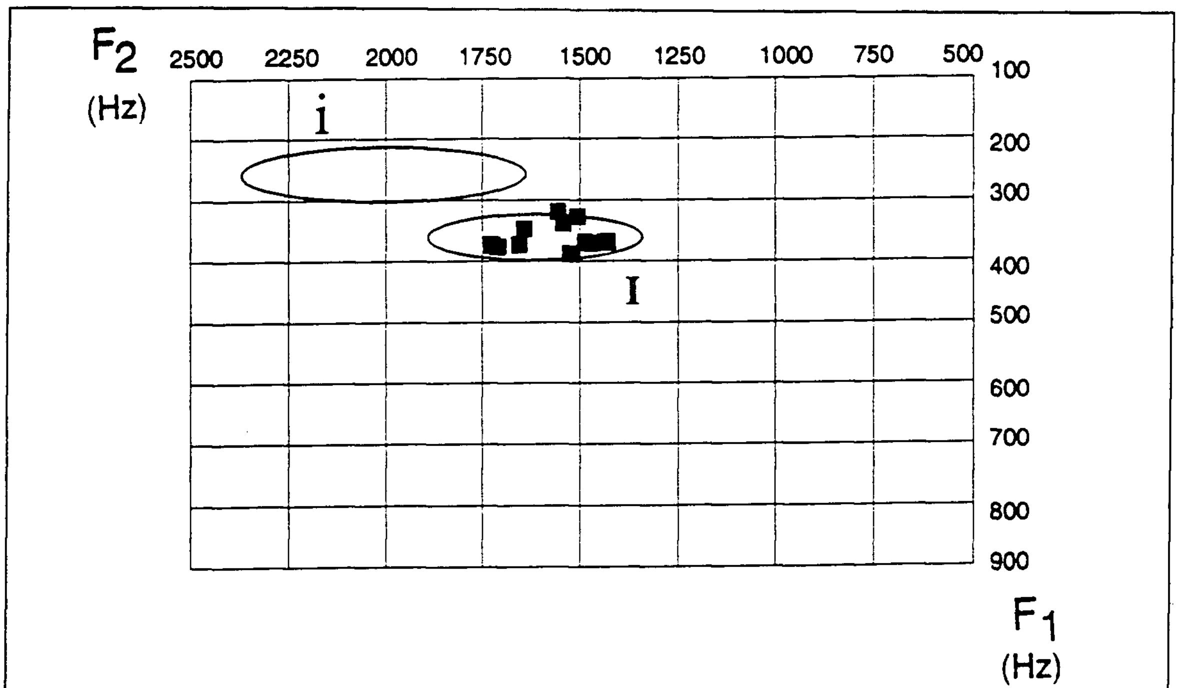


Figure 2:16 F_1 - F_2 plot of closed syllable, non-local harmony tokens of Palestinian short /I/

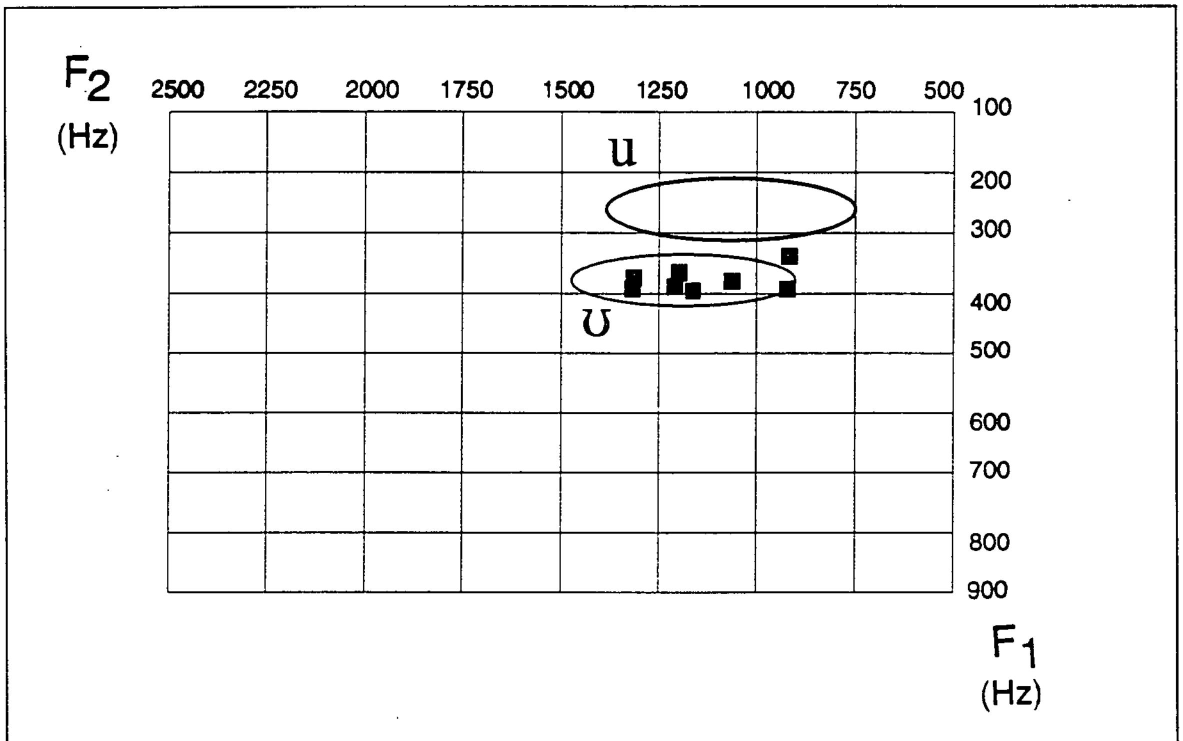


Figure 2:17 F_1 - F_2 plot of closed syllable, non-local harmony tokens of Palestinian short /U/

We now turn our attention to short /Æ/. Tokens of Palestinian /Æ/ are plotted in Figures 2:18. All are tokens of stressed /Æ/. Tokens of non-stressed, that is, reduced, /Æ/ were not analysed for this thesis. For acoustic data on the surface variants of reduced /Æ/, see Shahin & Urbanczyk (in preparation).

In Figure 2:18, IPA symbols identify clusters of tokens that are perceptually [æ] vs. [ʌ] vs. [ɑ]. As before, ellipses enclose 90% of the tokens of a given allophone. As seen, the tokens of /Æ/ cluster in distinct regions of the F_1 - F_2 plane. F_1 of the [æ]s and [ɑ]s is higher than it is for the [ʌ]s. F_2 is highest for the [æ]s, lowest for the [ɑ]s. The [æ]s and [ʌ]s will be discussed in this section. The [ɑ]s, which occurred in words containing an emphatic, will be discussed in §2.5.1.

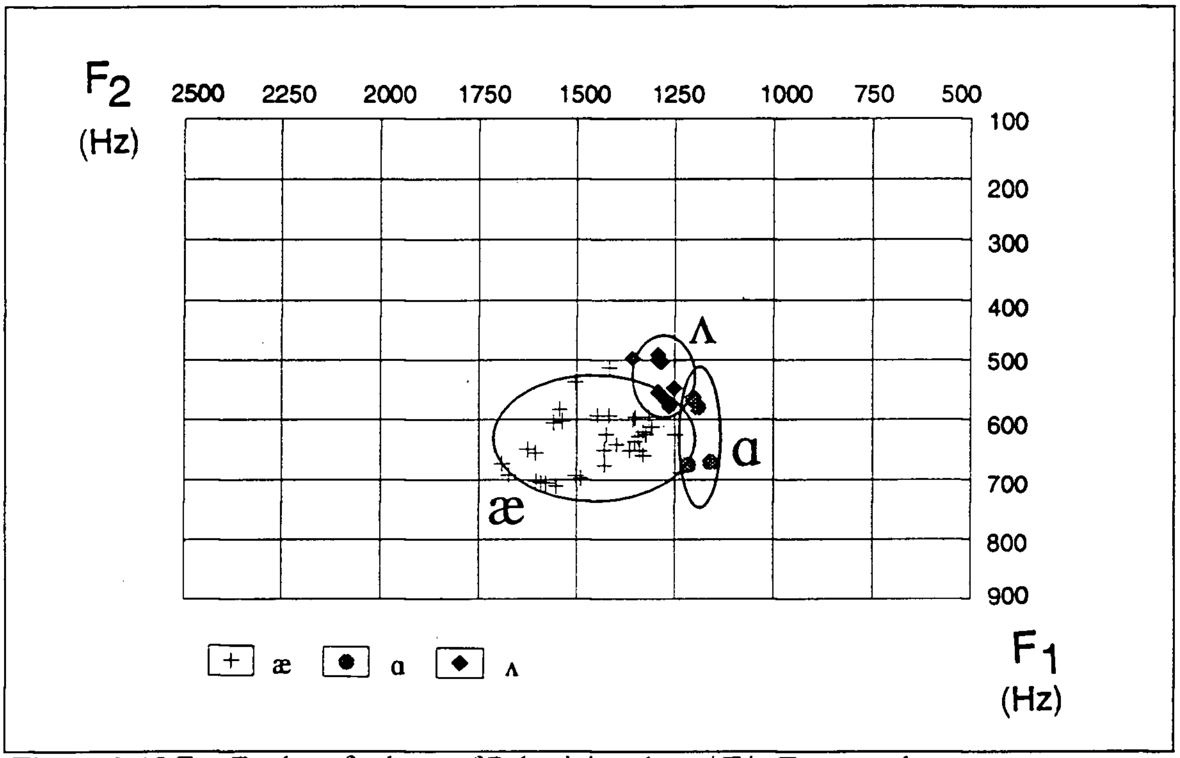


Figure 2:18 F_1 - F_2 plot of tokens of Palestinian short /Æ/. Two speakers.
[æ]: F_1 (mean = 638 Hz; s.d. = 48 Hz); F_2 (mean = 1449 Hz; s.d. = 122 Hz); 34 tokens.
[ɑ]: F_1 (mean = 622 Hz; s.d. = 51 Hz); F_2 (mean = 1192 Hz; s.d. = 22 Hz); 4 tokens.
[ʌ]: F_1 (mean = 530 Hz; s.d. = 33 Hz); F_2 (mean = 1288 Hz; s.d. = 30 Hz); 8 tokens.

Figure 2:19 plots a subset of the tokens in Figure 2:18, *viz.*, the tokens of /Æ/ that occurred in the phonological contexts: (i) open syllable, no trigger, e.g., /Æ/ in /sÆmI/ {'sæ.mi} 'Sami' (masc. name); (ii) closed syllable, no trigger, e.g., /Æ/ in /ʃÆmm/ {ʃamm} 'Shem'; (iii) open syllable, adjacent guttural, e.g., the initial-syllable /Æ/ in /hÆnÆ/ {'ha.nə} 'here'; (iv) closed syllable, adjacent emphatic, e.g., the initial-syllable /Æ/ in /bÆṭṭ-Æ/ {'ḅʌṭ.ṭ-ə} 'duck'. As shown in §2.3.3 and §2.4.1, (i) is not a context for phonological pharyngealisation, but (ii) and (iii) are. Context (iv) is a context for both closed-syllable-pharyngealisation and uvularisation from the adjacent emphatic.

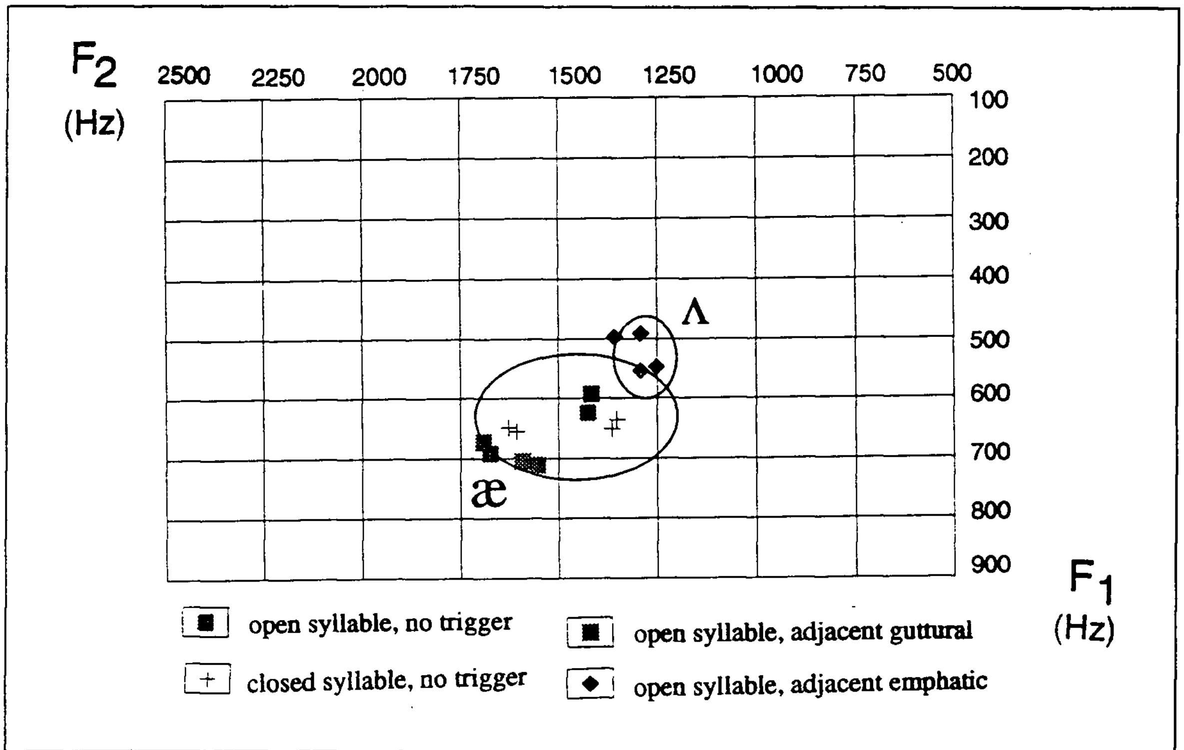


Figure 2:19 F_1 - F_2 plot of tokens of Palestinian short /Æ/ in the contexts: (i) open syllable, no trigger; (ii) closed syllable, no trigger,; (iii) open syllable, adajcent guttural; (iv) closed syllable, adjacent emphatic

In Figure 2:19, the tokens of /Æ/ in contexts (i) - (iii) overlap with respect to both F_1 and F_2, and fall within the ellipse for [æ]. That is, the tokens of /Æ/ in contexts (i) - (iii) are acoustically non-distinct and are all perceptually [æ]. This documents an acoustic basis for the lack of phonetic distinction between tokens of non-rtr {æ} vs. rtr (non-uvularised) {a}, discussed in §2.4.3.1.

By contrast, the tokens of /Æ/ in context (iv) have both a lower F_1 and a lower F_2 than the tokens in contexts (i) - (iii), and fall within the ellipse for [ʌ], a non-low vowel. This supports the phonological claim that /Æ/ surfaces without specification for [LOW] when it is both closed-syllable pharyngealised and uvularised.

2.4.3. Non-local Harmony

Further documentation of the lack of acoustic distinction between tokens of non-rtr {æ} vs. rtr {a} is provided by Figure 2:20. Figure 2:20 plots all the tokens of /Æ/ in Figure 2:18 that are not in a phonological pharyngealisation context (that is, the tokens of non-rtr {æ}) vs. all the tokens that are (the tokens of rtr {a}). (Besides tokens that occurred in a closed-syllable, no trigger or open-syllable, adjacent guttural context, Figure 2:20 includes tokens that occurred in a non-local pharyngealisation harmony context.)

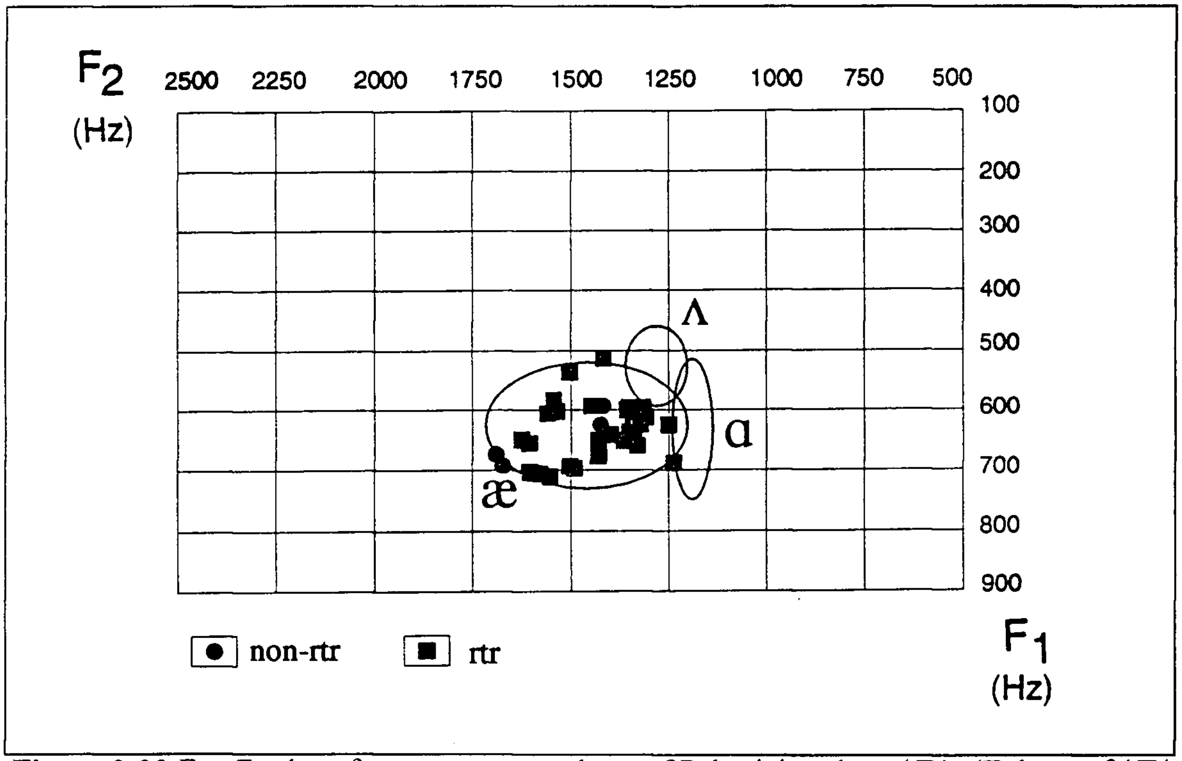


Figure 2:20 F_1 - F_2 plot of non-rtr vs. rtr tokens of Palestinian short /Æ/. (Tokens of /Æ/ > {ɑ} excluded.)

In Figure 2:20, the non-rtr and rtr tokens overlap with respect to F_1 and F_2: no distinct F_1 or F_2 interval can be assigned to either set. The tokens of rtr /Æ/ thus do not show the F_1 and F_2 effects expected for pharyngealisation. Figures 2:5 - 2:6 and 2:8 - 2:17 showed that tokens of phonologically rtr /I E U/ do. The question now is: why is there a difference for the tokens of /Æ/?

A partial answer, which addresses only the lack of F_1 effects, is sketched as follows: articulatory data indicate that Arabic /Æ/ is produced with a large mouth opening; see, e.g., Al-Ani's (1970:27) x-ray tracing of Arabic [æ] in an isolation context. It could be that in Palestinian, phonetic tokens of this vowel have an F_1 ceiling, so to speak, so that when they are pharyngealised, the raised F_1 predicted for a large mouth opening + the raised F_1 predicted and documented for tongue root retraction cannot combine to yield a super-raised F_1. (For the former prediction, see the graphs in Fig. 3 of Stevens & House 1955:487. Those graphs predict a raised F_1 for all vocal tract configurations with a large A/ℓ, which corresponds to a large mouth opening.) This hypothesis predicts, e.g., that the mouth opening is smaller for tokens of Palestinian rtr {a} than for tokens of non-rtr {æ}. The predicted acoustic effect would be less F_1 raising due to degree of mouth opening for tokens of {a} so the net F_1 of tokens of {a} would be about the same as that of tokens of non-rtr {æ}. This hypothesis awaits testing elsewhere.

2.4.4. A Theoretical Account: Part II

I propose that the further properties of pharyngealisation harmony identified in §2.4.3 require the additional constraints in (84), which are ranked with the constraints discussed in §2.3.3.3 and §2.4.2 as shown in (85). The constraints below do not include those responsible for /Æ/ > {ʌ}; an Optimality account of raised {ʌ} will be presented in §2.6. (The ranking in (85) will be modified in §2.4.6 and §2.5.6, on the basis of further data to be examined later in this chapter.)

(84) a. ALIGN([RTR], L; Wd, L)
$\forall$word, $\exists$[RTR], the left edge of [RTR] and the left edge of the word coincide.
(The left edge of the word is aligned with the left edge of any [RTR].)

b. ALIGN([RTR], R; Wd, R)
$\forall$word, $\exists$[RTR], the right edge of [RTR] and the right edge of the word coincide.
(The right edge of the word is aligned with the right edge of any [RTR].)

(85) DEP-IO, MAX-RTR, MAX-LINK >>

NUC-C]$_\sigma$/RTR, ALIGN-L([RTR], NUC), ALIGN-R([RTR], NUC),
ALIGN([RTR], L; Wd, L), ALIGN([RTR], R; Wd, R) >>

DEP-RTR, DEP-LINK

ALIGN([RTR], L; Wd, L) requires that, if [RTR] is present in a word, then the left edge of some [RTR] should be aligned with the left edge of the word. ALIGN([RTR], R; Wd, R) requires the same with respect to the right edge of the word. I propose that these constraints are syntagmatic Grounding constraints that are grounded in the slow movement of the tongue root, which is due to its relative large mass. The phonological consequence of this sluggishness is that [RTR] tends to span more than one segment in the word. ALIGN([RTR], L; Wd, L) and ALIGN([RTR], R; Wd, R) are equally ranked in Palestinian. This means that together they require [RTR] to span the word.

In §2.3.3.3, the NUC was identified as the anchor for pharyngealisation harmony. In that section, phonological evidence was presented in support of this, *viz.*, that Palestinian /k/ does not surface as primarily uvularised /q/ in a closed syllable. It does not surface as /q/ in forms with non-local pharyngealisation harmony either, as seen from forms like /kUtb/ {ˈkʊ.tʊb} (*{ˈqʊ.tʊb}) 'books' and /kÆtÆb/ {ˈkæ.tɜb} (*{ˈqæ.tɜb}) 'he wrote'). The data just presented are further evidence that the Palestinian anchor for [RTR] is the NUC. Because the anchor is the NUC, only the presence or absence of [RTR] on vowels is considered when satisfaction of ALIGN([RTR], L; Wd, L) and ALIGN([RTR], R; Wd, R) is evaluated.

In the tableaux of this chapter, representations are abbreviated in a manner illustrated in (86) for /tIbn/ {ˈtɪ.bɪn} 'straw'. This type of abbreviation omits prosodic structure (and several elements of the segmental structure).

(86) {ˈtɪ.bɪn}
\ /
[RTR]

E.g., (86) abbreviates the representation in (87).[13]

(87)
```
   N N
   | |
   μ μ
   | |
{'tɪ.bɪn}
    \ /
   [RTR]
```

The abbreviated representations are clarified here in order to point out that a representation such as that in (86) is not a gapped configuration. A gapped configuration obtains when a multiply-linked feature is linked to segments that are not formally adjacent, where formal Adjacency for linked features is defined by Archangeli and Pulleyblank (1994a:35) as:

(88) <u>Adjacency for Linked Features, from Archangeli and Pulleyblank (1994a:35)</u>
α is structurally adjacent to β iff both α and β are associated to the same anchor tier and no anchor intervenes on that tier between the anchors to which α and β are associated.

The configuration in (86) is not gapped because the harmonising vowels are adjacent on the NUC tier, as clarified by (87).

Archangeli and Pulleyblank (1994a) argue that gapped configurations are universally ill-formed. Pulleyblank (1994a:16-18) argues they are not produced by *GEN*. These

[13]The representation in (87) is also an abbreviation, as seen from the prosodic representations in §1.3.3.3; (87) shows the prosodic elements relevant to the discussion at hand.

positions are not adopted here. Rather, it is assumed that gapped configurations are highly disfavoured but not absolutely ruled out. That is, a candidate output can be gapped and in some instances the gapped candidate is the optimal form. Data and arguments in support of this claim will be presented in §2.5.6, which discusses the transparency of Palestinian non-low vowels to uvularisation harmony. The no gapping that is usually observed in Palestinian is assumed to be the effect of a constraint against gapped configurations which is highly ranked in the language, as also claimed by McCarthy (1997). That constraint will not be explicitly addressed or included in any tableau until §2.5.6, when its necessity is demonstrated.

Tableaux illustrating the non-local harmony resulting from the ranking in (85) are presented in (89) - (91). (In the tableaux, 'I-O Faith' abbreviates DEP-IO, MAX-RTR, and MAX-LINK; 'ALIGN-RTR-Wd' abbreviates ALIGN([RTR], L; Wd, L) and ALIGN([RTR], R; Wd, R). All candidates in (91) violate I-O FAITH. The violation is of DEP-IO, forced very highly ranked σNUC; see §2.3.3 for discussion. Finally, for the winners in (89) and (90), ALIGN([RTR], R; Wd, R) is satisfied as fully as possible. Full satisfaction would entail a link between [RTR] and the stem-final vowel in each form. However, such a link is prohibited by a more highly-ranked constraint, to be discussed in §2.4.5.)

(89)

<table>
<tr><th>input:
/lIbUʔÆ/
|
[RTR]
'lioness'; see (73)</th><th>I-O FAITH</th><th>NUC-$C]_\sigma$/ RTR</th><th>ALIGN ([RTR], NUC)</th><th>ALIGN-RTR-Wd</th><th>DEP-RTR</th><th>DEP-LINK</th></tr>
<tr><td>1. {ˈli.bu.ʔə}</td><td>*!*</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2. {ˈli.bu.ʔə}
|
[RTR]</td><td></td><td></td><td>**!</td><td>***</td><td></td><td></td></tr>
<tr><td>3. {ˈli.bʊ.ʔə}
\ |
[RTR]</td><td></td><td></td><td>*</td><td>**!</td><td></td><td>*</td></tr>
<tr><td>☞4. {ˈlɪ.bʊ.ʔə
\ \ |
[RTR]</td><td></td><td></td><td>*</td><td>*</td><td></td><td>**</td></tr>
<tr><td>5.{ˈlɪ.bʊ.ʔə}
| \|
[RTR] [RTR]</td><td></td><td></td><td>*</td><td>*</td><td>*!</td><td>**</td></tr>
<tr><td>6. {ˈlɪ.bʊ.ʔə}
\\ | /
[RTR]</td><td></td><td></td><td>*</td><td>*</td><td></td><td>***!</td></tr>
<tr><td>7. {ˈlɪ.bʊ.ʔə}
\\ | | /
[RTR]</td><td></td><td></td><td>**!</td><td>*</td><td></td><td>****</td></tr>
</table>

(90)

input: /ʁInIm-Æ/ | [RTR] 'goat'; see (73)	I-O FAITH	NUC-C]$_\sigma$/ RTR	ALIGN ([RTR], NUC)	ALIGN-RTR-Wd	DEP-RTR	DEP-LINK
1. {'ɣi.ni.m-ə}	*!*					
2. {'ʁi.ni.m-ə} | [RTR]			**!	***		
3. {ɪ'.ʁi.ni.m-ə} \ | [RTR]	*!		*	***		*
4. {ɪ'.ʁɪ.ni.m-ə} \ |/ [RTR]	*!			**		**
5. {'ʁɪ.ni.m-ə} |/ [RTR]			*	**!		*
☞6.{'ʁɪ.nɪ.m-ə} \\ | [RTR]			*	*		**
7. {'ʁɪ.nɪ.m-ə} | | [RTR] [RTR]			*	*	*!	**

(91)

<table>
<tr><th>input: /tIbn/

'straw'; see (74)</th><th>I-O FAITH</th><th>NUC-C]$_\sigma$/ RTR</th><th>ALIGN ([RTR], NUC)</th><th>ALIGN-RTR-Wd</th><th>DEP-RTR</th><th>DEP-LINK</th></tr>
<tr><td>1. {ˈti.bin}</td><td>*</td><td>*!</td><td></td><td></td><td></td><td></td></tr>
<tr><td>2. {ˈtɪ.bin}
|
[RTR]</td><td>*</td><td>*!</td><td></td><td>*</td><td>*</td><td>*</td></tr>
<tr><td>3. {ˈti.bɪn}
|
[RTR]</td><td>*</td><td></td><td></td><td>*!</td><td>*</td><td>*</td></tr>
<tr><td>☞4. {ˈtɪ.bɪn}
\ /
[RTR]</td><td>*</td><td></td><td></td><td></td><td>*</td><td>**</td></tr>
<tr><td>5. {ˈtɪ.bɪn}
| |
[RTR] [RTR]</td><td>*</td><td></td><td></td><td></td><td>**!</td><td>**</td></tr>
<tr><td>6. {ˈtɪ.bɪn}
\ |/
[RTR]</td><td>*</td><td></td><td></td><td></td><td>*</td><td>***!</td></tr>
<tr><td>7. {ˈtɪ.bɪn}
\\|//
[RTR]</td><td>*</td><td></td><td>*!*</td><td></td><td>*</td><td>****
*</td></tr>
</table>

The ranking MAX-RTR, MAX-LINK >> ALIGN([RTR], L; Wd, L), ALIGN([RTR], R; Wd, R) is established by the winning candidates in (89) and (90). In each of those winners, the postvelar is linked to [RTR]. If the ranking were reversed, or if these constraints were equally ranked, then ALIGN([RTR], L; Wd, L) and ALIGN([RTR], R; Wd, R) could be vacuously satisfied by deletion of [RTR] and its link with the postvelar. However, the losing candidates 1 in the tableaux show that such deletion is non-optimal.

Each winner in (89) - (91) contains a non-underlying link between [RTR] and a vowel that is not in a closed syllable or adjacent to a postvelar, *viz.*, the initial-syllable {ɪ} of the winner in (90), and the second-syllable {ɪ} in (89) and (91). The context of each of those {ɪ}s shows that its link with [RTR] is imposed solely by ALIGN([RTR], L; Wd, L) (for (89) and (91)) or ALIGN([RTR], R; Wd, R) (for (90)). Because of that link, each winner satisfies ALIGN([RTR], L; Wd, L) and ALIGN([RTR], R; Wd, R) but incurs an additional violation of DEP-LINK. (For the winners in (89) and (90) ALIGN([RTR], R, Wd, R) is satisfied as fully as possible. As noted earlier, full satisfaction would entail violation of a more highly ranked constraint, to be discussed in §2.4.5.) This shows that it is more optimal to violate DEP-LINK than ALIGN([RTR], L; Wd, L) or ALIGN([RTR], R; Wd, R). Hence, ALIGN([RTR], L; Wd, L), ALIGN([RTR], R; Wd, R) >> DEP-LINK.

An important question at this point is: what is the evidence for distinct ALIGN([RTR], NUC) and ALIGN([RTR]); Wd) constraints? Notice that a link between [RTR] and a postvelar-adjacent vowel is required by both types of constraints (though for the latter, the adjacency to a postvelar is irrelevant). If there is no evidence for both types, then the ALIGN([RTR]); Wd) constraints alone can account for the new [RTR] specifications resulting from the harmony.

By claiming the existence of ALIGN([RTR], NUC) and ALIGN([RTR]); Wd) constraints, the present account claims there are two distinct contexts for pharyngealisation harmony: (i) adjacency to an underlying postvelar; (ii) the presence of a postvelar consonant or pharyngealised vowel in the word. Evidence for these distinct contexts, based on the properties of Palestinian /Æ/ > {ʌ} raising, will be presented in

§2.6. On the basis of that evidence, it will be concluded that both types of constraints exist.

Finally, the data so far examined do not indicate that ALIGN([RTR], L; Wd, L) and ALIGN([RTR], R; Wd, R) are crucially ranked with respect to NUC-C]$_\sigma$/RTR or the ALIGN([RTR], NUC) constraints. For this reason, they are assumed in this section to be non-crucially equally ranked.

2.4.5. Opaque Stem-final Vowels and Long Vowels

2.4.5.1. Analysis

This section examines the role of stem-final vowels and long vowels in Palestinian pharyngealisation harmony. It will be shown that they are opaque to the harmony. That is, they do not pharyngealise and they also block the progression of the harmony in the word. Data showing that they do not undergo the harmony will first be examined first, then data showing that they also block it.

Stem-final vowels will be addressed first. The initial data to be considered are presented in (92). Each form in (92) contains a word-final short vowel in a pharyngealisation context: each occurs either adjacent to an underlying postvelar (92c-d), non-adjacent to an underlying postvelar (92a-b,e), or in a word containing a closed-syllable-pharyngealised vowel (92a-b,f). (A tableau for (92a) will be presented in §2.4.6.)

2.4.5. Opaque Stem-final Vowels and Long Vowels

(92)	a. /IʁlI/	{ˈʔɪʁ.li}	(*{ˈʔɪʁ.lɪ})	‘to boil’
	b. /t̙ÆʕmI/	{ˈt̙ʌʕ̙.m̙i}	(*{ˈt̙ʌʕ̙.m̙ɪ})	‘to feed (someone, something)’
	c. /hU/	{ˈhu}	(*{ˈhʊ})	‘he’
	d. /ÆχU/	{ˈʔa.χu}	(*{ˈʔa.χʊ})	‘brother’
	e. /ħIlU/	{ˈħɪ.lu}	(*{ˈħɪ.lʊ})	‘pretty (masc.sg.)’
	f. /sÆmm-U/	{ˈsam.m-u}	(*{ˈsam.m-ʊ})	‘they (masc.) named (someone, something)’; ‘they (masc.) said the words: *bi-sm-illāh ir-rahmān ir-rahīm* ‘in the name of God, the Gracious, the Merciful’ ’

The generalisation from (92) is that word-final vowels do not pharyngealise.

The data in (93) show that it is the right stem edge that blocks pharyngealisation: they show that vowels at an internal right stem edge do not pharyngealise either. This is so whether the vowel is in a closed syllable (93a-b), or whether the word contains an underlying postvelar (93b-e) or a closed-syllable-pharyngealised vowel (93a,d). (Right stem edges in the surface forms below are marked by an immediately following ‘|’. In (93a), /kk/ degeminates and stem-internal /I/ elides. In (93b), infixal long /Eː/ shortens before another long vowel in the word; on this type of shortening, see Abdo (1969) and Abu-Salim (1986). In the same form, prefixal /Æ/ elides before stem-initial /ʕ/. A tableau for (93a) will be presented in §2.4.6.)

(93) a. /b-sÆkkIf-U-l-nÆ-ʃ/ {bɪ.-ˌsɜk.f|-u|-l.|-ˈnæː|-ʃ} (*{bɪ.-ˌsɜk.f|-ʊ|-l.|-ˈnæː|-ʃ})

'they (masc.) don't clap for us'

b. /mÆ-ʕÆt̙-Eː-t-tʃU-ʃ/ {ˌm̙-ʕ̙ɜ˃.t̙|-e-t̙.|-ˈtʃuː|-ʃ} (*{ˌm̙-ʕ̙ɜ˃.t̙|-ɛ-t̙.|-ˈtʃuː|-ʃ})

'I didn't give (something) to you (masc. pl.)'

c. /wIt̙I-Æt/ {ˈw̙ɪ.t̙i.|-ɜ˃t̙} (*{ˈw̙ɪ.t̙ɪ.|-ɜ˃t̙})

'lowered (fem. sg.)' (Adj)

d. /t-t̙ÆʕmI-nÆ-ʃ / {ʔ̙ɪ̙t.-ˌt̙ɜ˃ʕ̙.m̙i.|-ˈn̙ɐː|-ʃ} (*{ʔ̙ɪ̙t.-ˌt̙ɜ˃ʕ̙.m̙ɪ.|-ˈn̙ɐː|-ʃ})

'(2 masc. sg.) don't feed us!'

e. /fÆr̙U-I/ {ˈf̙ɑ.r̙u.|-i} (*{ˈf̙ɑ.r̙ʊ.|-i})

'my fur'

By the criteria for phonological vs. phonetic status discussed in §1.7.1, the sensitivity to word-internal morphological structure shown in (93) confirms the phonological status of Palestinian pharyngealisation harmony, since phonological properties can refer to word-internal structure, but phonetic properties cannot; see §1.7.1 for further discussion.

The role of the right stem edge is further indicated by the data in (94). In (94a) the short vowel in the closed syllable pharyngealises as expected. In (94b) the same vowel in an identical, closed syllable does not pharyngealise because it sits at a right stem edge. Several examples given previously, such as those in (74), have shown that both underlying and epenthetic vowels pharyngealise. The non-harmony of {i} in (94b), therefore, cannot be due to its underlying status.[14]

(94) a. /r̙Æml-nÆ/	{ˈr̙ʌ.m̙ɪ̙l. |-n̙ə}	‘our dirt’
b. /b-IrmI-l-nÆ-ʃ/	{ˌb-ɪr.mi|-l.|-ˈnæː|-ʃ}	(*{ˌb-ɪr.mɪ|-l.|-ˈnæː|-ʃ}) ‘he’s not throwing (something) for us’

The findings of other studies indicate that an incompatability between the right stem edge and rtr vowels is not unique to Palestinian: Halle and Mohanan (1985:59-62) show that English disallows ‘lax’ vowels in a stem-final position, as seen from {ˈsɪ.ti|} (*{ˈsɪ.tɪ|}) ‘city’, {ˈsɪ.ti|-z} (*{ˈsɪ.tɪ|-z}]) ‘cities’, {sɪ.ti.|-ˈhɑl} (*{sɪ.tɪ.|-ˈhɑl}) ‘city hall’ (compound word), and {ˈhæ.pi.|-nɛs} (*{ˈhæ.pɪ.|-nɛs}) ‘happiness’; Dudas’ (1976:36) summary of the Javanese vowel distribution shows that ‘lax’ {ɪ ɛ ʊ} cannot appear at the right edge of the word in Javanese. (As discussed in §2.4.2, the ‘tense/lax’ distinction is here assumed to be captured by a tongue root feature.)

Long vowels will be addressed next. Data with long vowels in pharyngealisation contexts are presented in (95): the long vowels in (95) occur in a closed-syllable (95a-e), adjacent to an underlying postvelar (95d-f), or non-adjacent to an underlying postvelar (95d-e). (A tableau for (95a) will be given in §2.4.6.)

[14] I thank Bert Vaux for suggesting this point.

2.4.5. Opaque Stem-final Vowels and Long Vowels

(95) a. /tI:n/ {ti:n} (*{tɪ:n}) 'figs'
b. /kU:m/ {ku:m} (*{kʊ:m}) 'get up'
c. /θO:m/ {θo:m} (*{θɔ:m}) 'garlic'
d. /χO:f/ {χo:f} (*{χɔ:f}) 'fear' (N)
e. /ṣE:f-E:n/ {ṣɛ.ˈf̣-e:n} (*{ṣɛ.ˈf̣-ɛ:n}) 'two summers'
f. /nð̣I:f-Æ/ {ṇ.ˈð̣i:.f̣-ə} (*{ṇ.ˈð̣ɪ:.f̣-ə}) 'clean (fem. sg.)' (Adj)

The generalisation from (95) is that Palestinian long vowels do not pharyngealise.

In (52), the forms /dU:d-Æ/ {ˈdu.d-ə} 'worm' and /sI:d-O/ {ˈsi.d-o} 'grandpa' were presented to illustrate that short vowels surface non-rtr in an open syllable in a word containing no postvelar. These forms merit reconsideration now, since they contain underlyingly long vowels. The underlying length is shown by the morphologically related forms /dU:d/ {du:d} 'worms' and /sI:d/ {si:d} 'grandfather'. It could be argued that the lack of tongue root retraction for the initial-syllable vowels in {ˈdu.d-ə} 'worm' and {ˈsi.d-o} is due (somehow) to the underlying length. However, the data below show that shortened vowels do pharyngealise if they are in a pharyngealisation context:

(96) a. /t-ṣI:b-I-ʃ/ {ʔɪ̣ṭ.-ṣɪ.ˈḅ-i:-ʃ} (*{ʔɪ̣ṭ.-ṣi.ˈḅ-i:-ʃ}) '(2 fem. sg.) don't touch (it)!'
(compare: {ṇ.-ˈṣi:ḅ} 'should we touch (it)?')

b. /ħE:ṭ-E:n/ {ħ̣ɛ.ˈṭ-e:ṇ} (*{ħ̣e.ˈṭ-e:ṇ}]) 'two walls'
(compare: {ħ̣e:ṭ} 'wall')

c. /ṣE:f-E:n/ {ṣɛ.ˈf̣-e:ṇ} (*{ṣe.ˈf̣-e:ṇ}) 'two summers'
(compare: {ṣe:f} 'summer')

2.4.5. Opaque Stem-final Vowels and Long Vowels

The data in (97) show that, consistent with the generalisation (based on the observations for /I: E: O: U:/) that long vowels do not pharyngealise, long /Æ:/ also does not pharyngealise. (Tableaux for (97a) and (97c) will be given in §2.4.6.)

(97) a. /slImÆːn/	{sli.ˈmæːn}	(*{slɪ.ˈmaːn})	'Sliman' (masc. name)
b. /rIjÆl-Æːt/	{ri.jə.ˈl-æːt}	(*{rɪ.jə.ˈl-aːt})	'droolings'
c. /dInÆːr̙/	{d̙i.ˈn̙ɐːr̙}	(*{d̙ɪ.ˈn̙ɑːr̙})	'dinar'
d. /kInÆːr̙/	{k̙i.ˈn̙ɐːr̙}	(*{k̙ɪ.ˈn̙ɑːr̙})	'canary'

The non-rtr initial-syllable {i} in each form in (97) is evidence that the long vowel in each form is not pharyngealised, that is, that the long vowels in (97a-b) are non-rtr {æː}, not rtr {aː}, that the long vowels in (97c-d) are non-rtr {ɐː}, not rtr {ɑː}. If they were rtr, we would expect rtr {ɪ} instead of non-rtr {i} in each form, as /I/ would be expected to harmonise with a pharyngealised long vowel. On the basis of data such as those in (97), it is here claimed that the Palestinian long low back vowel is non-rtr. For this reason, it is transcribed in this thesis as {ɐː} instead of {ɑː}.

This analysis is supported by comparison of the data in (97) with those seen earlier in (76), which is repeated as (98), below:

(98) a. /bElÆd/	{ˈbɛ.lɜd}	(*{ˈbe.lɜd})	'land, country'
b. /lEbÆn/	{ˈlɛ.bɜn}	(*{ˈle.bɜn})	'yoghurt'

2.4.5. Opaque Stem-final Vowels and Long Vowels

The data in (98) were analysed earlier as showing that the initial-syllable /E/ surfaces as rtr {ε} under pharyngealisation harmony with the closed-syllable pharyngealised short {ɜ}, which is reduced /Æ/. The important observation here is that the only relevant difference between the data in (97) and those in (98) is the length of the low vowel. The lack of pharyngealisation harmony in (97) is thus analysed as an effect due to the length of the low vowel.

Based on the foregoing discussion, it is concluded that Palestinian has no long pharyngealised vowels.

A relevant discussion at this point concerns the possible guttural status of Palestinian low vowels. Herzallah (1990) claims that the they are gutturals. However, it will be argued below that they are not.

Herzallah (1990:63-66) bases her claim on the sagittal sections of Delattre (1971), which she describes as showing that low "a" in several languages is produced with pharyngeal constriction. She further bases her claim on the fact that Perkell's (1971) articulatory study reports pharyngeal constriction for low vowels, and the fact that Sibawayh, a medieval Arab Grammarian, classified the Arabic long low vowel with the guttural consonants. (Sibawayh (1966, vol.4: 433) describes both the guttural consonants and the long low vowel as 'throat' sounds.)[15]

With respect to the first grounds for Herzallah's argument, Delattre's data from non-Arabic low vowel tokens are here considered not to settle the issue at hand, as are findings

[15]Sibawayh died in 793 or 796 AD, according to to Mattsson (1911:9)).

of Perkell, which are based on non-Arabic data. This is because it is assumed that only articulatory data from tokens of Arabic low vowels can reveal the articulatory nature of Arabic low vowels. As for Delattre's data from Arabic low vowel tokens, the data he provides are of the Arabic short low vowel immediately following a guttural or an emphatic: his sagittal sections [p.130] are of the vowel immediately following each of /ʕ/, /ħ/, /ʁ/, /χ/, and /k̙/. (He denotes the emphatic velar as 'q'.) However, the findings of this chapter indicate that the contexts 'immediately following a guttural' and 'immediately following an emphatic' are not neutral contexts for the Arabic short low vowel. In Palestinian, they are contexts for phonological pharyngealisation. In order to obtain data which could reveal whether or not an unconditioned low vowel is produced with pharyngeal constriction, it is assumed that tracings of tokens in a neutral context (e.g., in an open syllable in a word containing no postvelar and no pharyngealised vowel) would be necessary.

Regarding the second grounds for Herzallah's argument, an impressionistic articulatory classification (that is, an articulatory classification not based on articulatory data), such as Sibawayh's, is here not considered evidence for actual articulation.

There is evidence that Palestinian /Æ Æː/ are phonologically not gutturals, which comes from forms such as those seen earlier in (97) and those to be presented shortly. It is explained as follows: based on the findings of §2.4.1, Palestinian gutturals are underlyingly pharyngealised, that is, underlyingly specified for [RTR], and trigger pharyngealisation harmony. If Palestinian /Æ Æː/ were gutturals, they would be underlyingly pharyngealised and would also trigger the harmony. However, in (97), long /Æː/ does not trigger pharyngealisation harmony on the initial-syllable short vowels, as discussed above. Data presented earlier in (52a,c-d) indicate that short /Æ/ does not either. Those forms are presented again in (99). (The present corpus contains no relevant forms involving /Æ/ under primary stress.)

(99)	a. /lObIÆ/	{ˈlo.bi.ə}	(a type of small pea)
	b. /tEtÆ/	{ˈte.tə}	'grandma'
	c. /dUːd-Æ/	{ˈdu.d-ə}	'worm'

It could be counterargued that perhaps Palestinian /Æ/ is underlyingly specified for [RTR] but in forms such as those in (99) it does not surface specified for [RTR] because it is in stem-final position. This would predict non-rtr vowels in the initial syllables. However, data considered earlier, such as those in the tableaux of (71) - (72) and (89) - (90), indicate that underlying [RTR] specifications persist into the surface form: underlying postvelars surface bearing their underlying [RTR] specification. Based on that, deletion of a hypothesised underlying link between [RTR] and /Æ/ would be unexpected.

Furthermore, in (100), /Æ/ is not stem-final. As seen, the initial syllable vowel in this form surfaces non-rtr, not rtr as would be expected if /Æ/ were a guttural.

(100)	/bOmÆlI/	{ˈbo.mə.li}	(*{ˈbɔ.mə.li})	'pomelo'

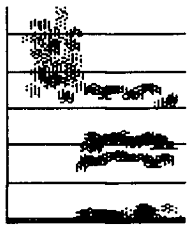
2.4.5. Opaque Stem-final Vowels and Long Vowels

On the basis of the foregoing arguments, it is here concluded that the Palestinian low vowels are not gutturals.

The full role of stem-final and long vowels in Palestinian pharyngealisation harmony is shown by data such as those in (101), of which (101b-c) were seen earlier in (97): in each of these forms, a stem-final (101a) or long vowel (101b-c) intervenes between the initial-syllable vowel and a trigger for non-local pharyngealisation harmony. The trigger in (101a) is the closed-syllable-pharyngealised {ɪ}; in (101b-c) it is the word-final {r̙}. As seen, the initial-syllable vowels surface non-rtr. This is analysed here as showing that stem-final and long vowels block pharyngealisation harmony. (In the grammatical surface form in (101a), an arrow points out the blocking stem-final vowel. The feminine noun stem of that form (/sUr-I-Æ(t)/ 'Syria') surfaces with a final {t}, to mark it as a feminine noun. Its underlying correspondent is here denoted as '(t)'. Theoretical analysis of this {t} will not be pursued here. As seen, stem /Æ/ raises immediately preceding it. Tableaux for (101a-b) will be presented in §2.4.6.)

(101) a. /sUr̙-I-Æ(t)-nÆ/	{su.r͵-i.͵-ˈɪt.͵-nə})	(*{sʊ.r͵-i.͵-ˈɪt.͵-nə})	'our Syria'
b. /dInÆːr̙/	{d̙i.ˈn̙ɐːr̙}	(*{d̙ɪ.ˈn̙ɐːr̙})	'dinar'
c. /kInÆːr̙/	{k̙i.ˈn̙ɐːr̙}	(*{k̙ɪ.ˈn̙ɐːr̙})	'canary'

On the basis of the data presented in this section, it is concluded that Palestinian stem-final and long vowels are opaque to pharyngealisation harmony.



2.4.5.2. Acoustic Support

The graphs in Figures 2:21 - 2:24 plot a further subset of the tokens of Palestinian short /I E O U/ in Figures 2:1 - 2:4, *viz.*, those in stem-final position. (The present database contains no tokens of /Æ/ in this context.) The ellipses in these graphs are those shown in Figures 2:1 - 2:4.

Most of the tokens that are plotted in Figures 2:21-2:24 occurred in a pharyngealisation harmony context, that is, adjacent to an underlying postvelar, in a closed syllable, non-adjacent to an underlying postvelar, or in a word containing a closed-syllable pharyngealised vowel. (This is seen from the list of carrier forms in Appendix III.) The tokens in Figures 2:22-2:23 exclude the Jafa tokens of stem-final mid /E/ and /O/, which were also excluded from Figures 2:1 - 2:4. They are excluded because they phonetically differ from the Abu Shusha tokens seen in Figures 2:22 and 2:23. Data showing this will be presented shortly.

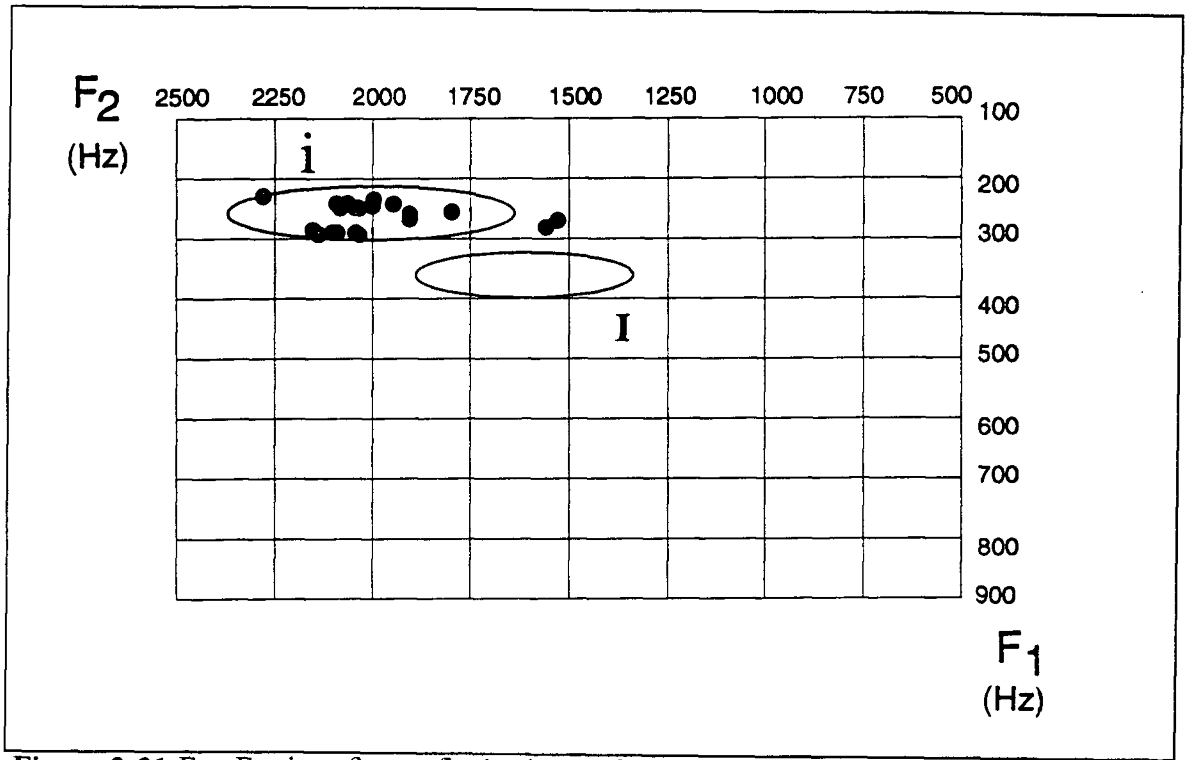


Figure 2:21 F_1 - F_2 plot of stem-final tokens of Palestinian short /I/ (Abu Shusha and Jafa data)

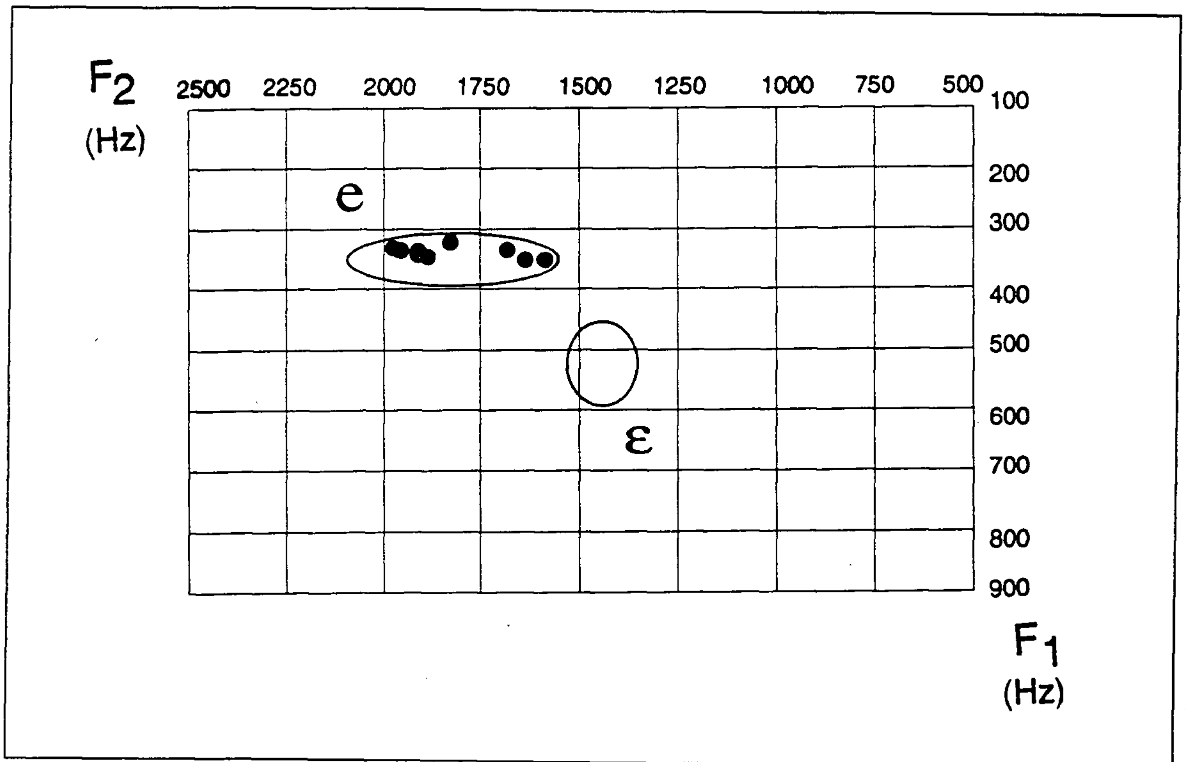


Figure 2:22 F_1 - F_2 plot of stem-final tokens of Palestinian short /E/ (Abu Shusha data)

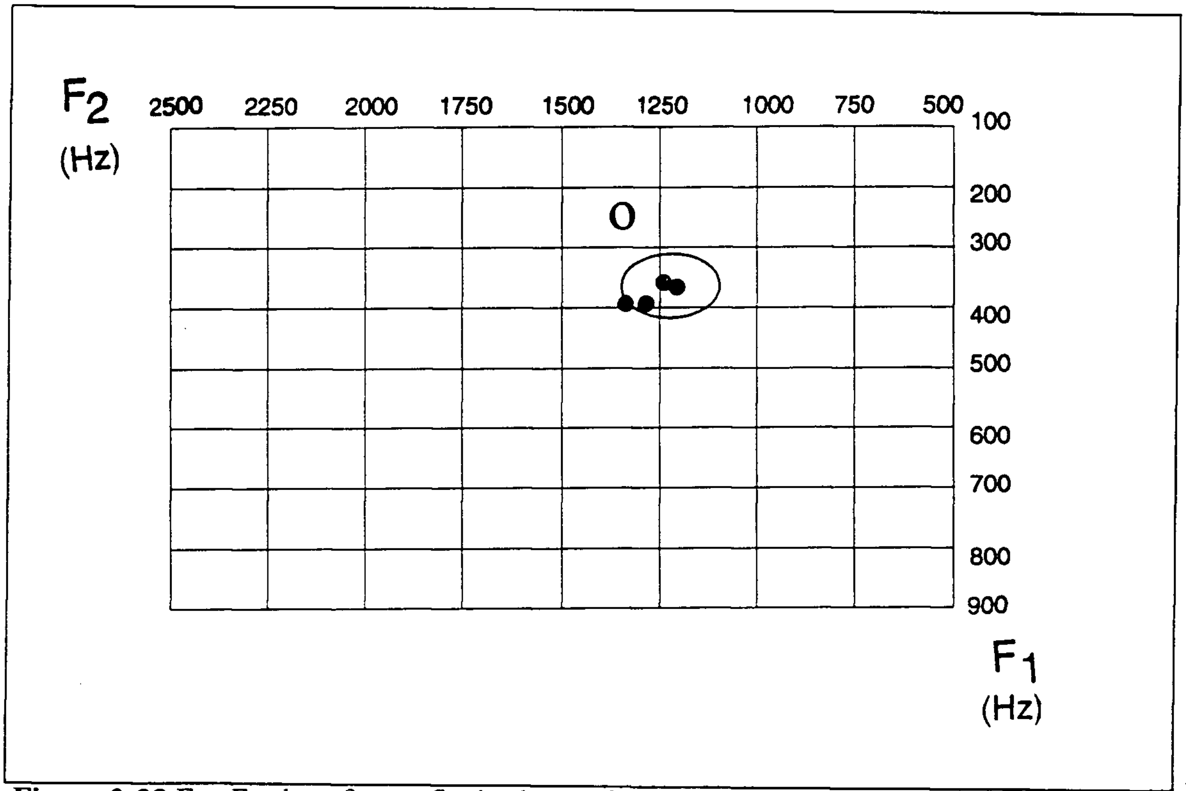


Figure 2:23 F_1 - F_2 plot of stem-final tokens of Palestinian short /O/ (Abu Shusha data)

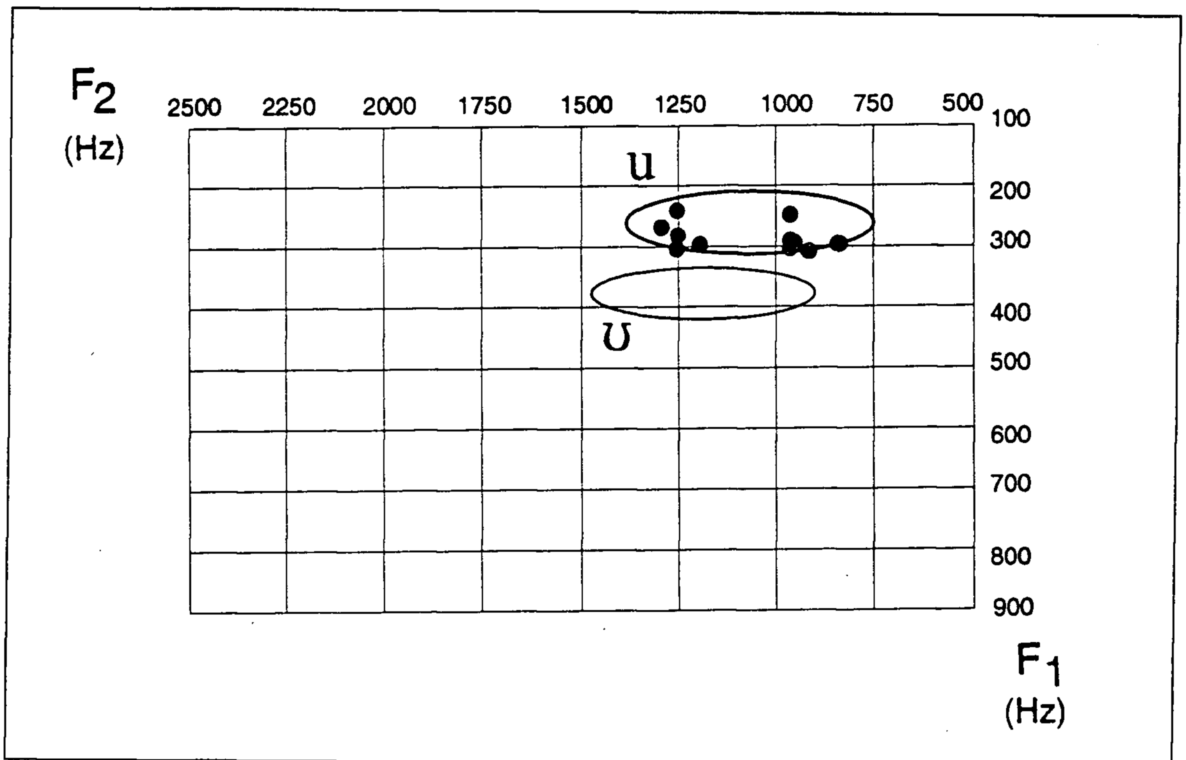


Figure 2:24 F_1 - F_2 plot of stem-final tokens of Palestinian short /U/ (Abu Shusha and Jafa data)

2.4.5. Opaque Stem-final Vowels and Long Vowels

In Figures 2:21-2:24, the stem-final tokens of /I E O U/ are non-rtr. That is, they do not show the F_1 and F_2 effects predicted for pharyngealisation articulation. This supports the assumption that they were not pharyngealised. With respect to those several tokens in Figures 2:21 - 2:24 that occurred in a pharyngealisation harmony context, this supports the phonological claim that Palestinian stem-final vowels do not undergo pharyngealisation harmony.

In Figure 2:21, two tokens of /I/ lie outside the non-rtr region for the entire [i] sample. They are tokens of stem-final /I/ in /t-k̙Us̙s̙-I-nÆ-ʃ/ {ʔ̙ɪ̙t.-ˌk̙ʊs̙.s̙ˌ-i.ˌ-ˈn̙ɐːˌ-ʃ} '(2 fem. sg.) don't cut us!'. However, these outliers are within the F_1 region for [i], as seen from the [i] ellipse. Based on the mean F_2 for [i] reported in the caption of Figure 2:1, F_2 of the outlying [i]s is lowered by about 200 Hz. As will be discussed in §2.5.5, there is acoustic support for assuming that the F_2 drop for these tokens results from the fact that for the first part of their duration they were produced with uvularisation coarticulation with the adjacent emphatic /s̙/. However, F_2 of the outliers was measured at durational midpoint and does not reflect the higher F_2 attained by offset. The significance of this will be discussed in §2.5.5.

The acoustic support for an assumed lack of pharyngealisation articulation for tokens of stem-final /E O/ does not extend to the Jafa data. Graphs showing tokens of Jafa stem-final /E/ and /O/ are presented in Figures 2:25 - 2:26. The ellipses in Figures 2:25 are the ellipses for the Abu Shusha non-rtr vs. rtr tokens of /E/ shown in Figure 2:2. The ellipse in Figure 2:26 is the ellipse for the Abu Shusha non-rtr tokens of /O/ shown in Figure 2:3.

The non-rtr ellipses mark the F_1 - F_2 regions expected for non-rtr tokens of these vowels, based on the current sample.

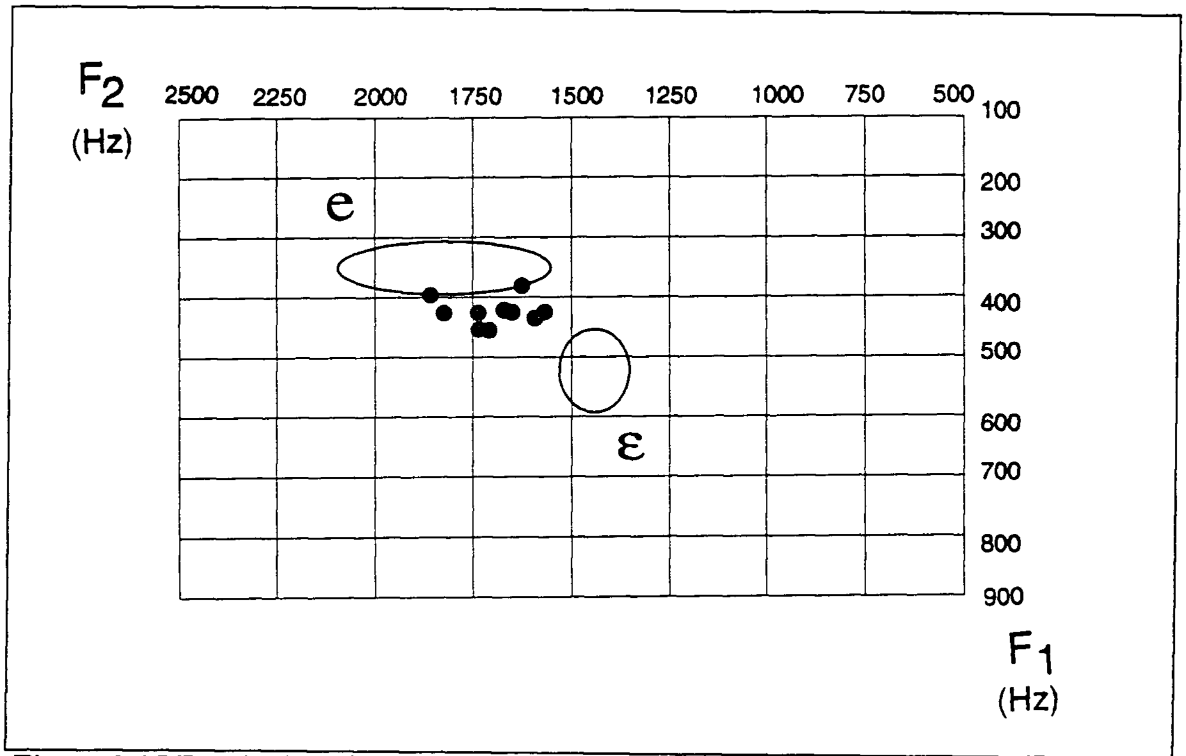


Figure 2:25 F_1 - F_2 plot of stem-final tokens of Jafa Palestinian short /E/. One speaker. F_1 (mean = 424 Hz; s.d. = 21 Hz); F_2 (mean = 1697 Hz; s.d. = 90 Hz); 10 tokens.

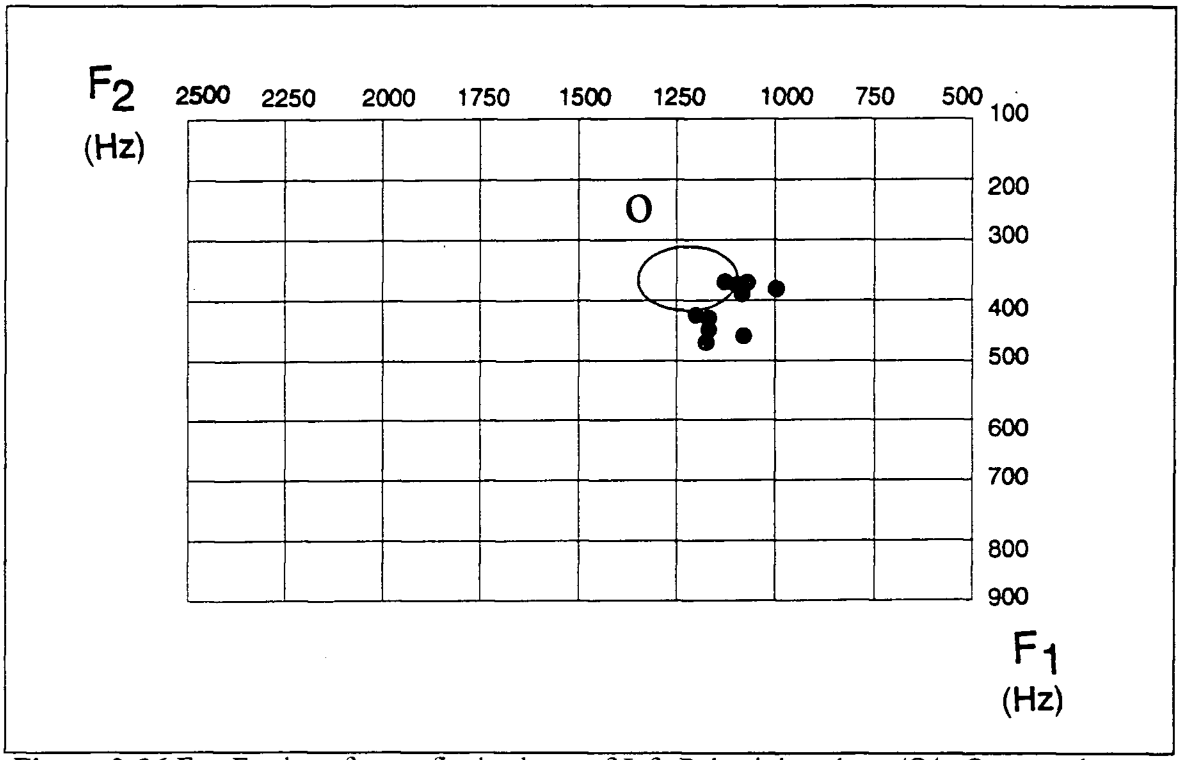


Figure 2:26 F_1 - F_2 plot of stem-final tokens of Jafa Palestinian short /O/. One speaker. F_1 (mean = 411 Hz; s.d. = 37 Hz); F_2 (mean = 1117 Hz; s.d. = 60 Hz); 10 tokens.

As seen, several tokens of Jafa stem-final /E/ and /O/ lie outside the region of Palestinian non-rtr [e] and [o], respectively: they have a higher F_1 and a lower F_2 than the non-rtr allophones per vowel. The Jafa stem-final tokens of /E/ and /O/ are perceptually similar to [ɛ] and [ɔ], respectively. They contrast with the Abu Shusha right stem edge tokens of /E/ and /O/: Figures 2:22 - 2:23 show that the Abu Shusha stem-final tokens lie within the region of the non-rtr allophones and are [e] and [o], respectively.

The Jafa data in Figures 2:25 - 2:26 document an acoustic phonetic basis for the dialectal difference between Jafa and Abu Shusha with respect to the quality of stem-final mid vowels. Potential phonological bases of this difference will not be pursued here.

2.4.5. Opaque Stem-final Vowels and Long Vowels

Acoustic data on the Palestinian long vowels will now be discussed. Tokens of long /Iː Eː Æː Oː Uː/ are plotted in Figures 2:27 - 2:31. For /Æː/, only the tokens which are [æː] are presented. Several other tokens of /Æː/ in the current sample are back [ɐː]. The [ɐː]s occurred in words containing an emphatic; they will be discussed in §2.5.1.

Figures 2:27 - 2:31 plot, for each long vowel, those tokens which did not occur in a phonological pharyngealisation context vs. those which did. As indicated by the single IPA symbol and single ellipse in each graph, for each vowel, the tokens in non-pharyngealisation and pharyngealisation contexts are perceptually the same. Statistics for each surface vowel, that is, for {iː}, {eː}, {oː}, and {uː}, the single surface realisations of /Iː/, /Eː/, /Oː/, /Uː/, respectively, and for {æː} the front surface variant of /Æː/, are presented in the figure captions.

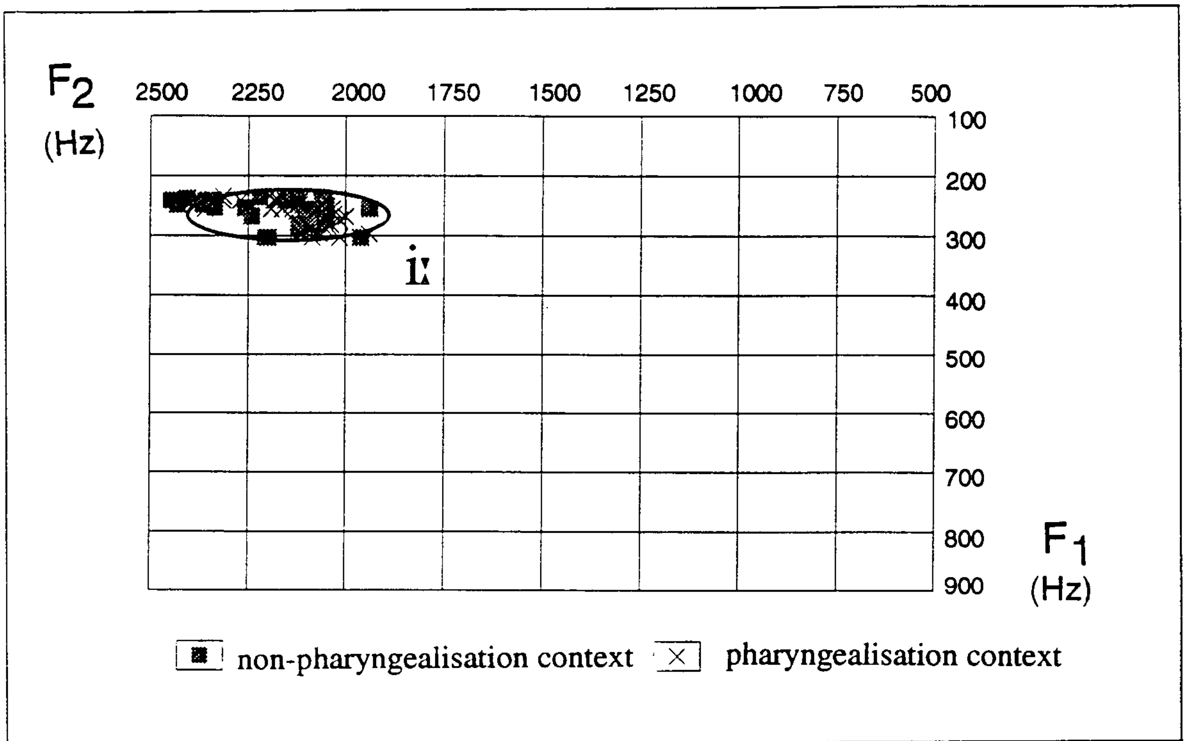


Figure 2:27 F_1 - F_2 plot of non-pharyngealisation context vs. pharyngealisation context tokens of Palestinian /Iː/. Two speakers.
[iː]: F_1 (mean = 263 Hz; s.d. = 21 Hz); F_2 (mean = 2148 Hz; s.d. = 119 Hz); 71 tokens.

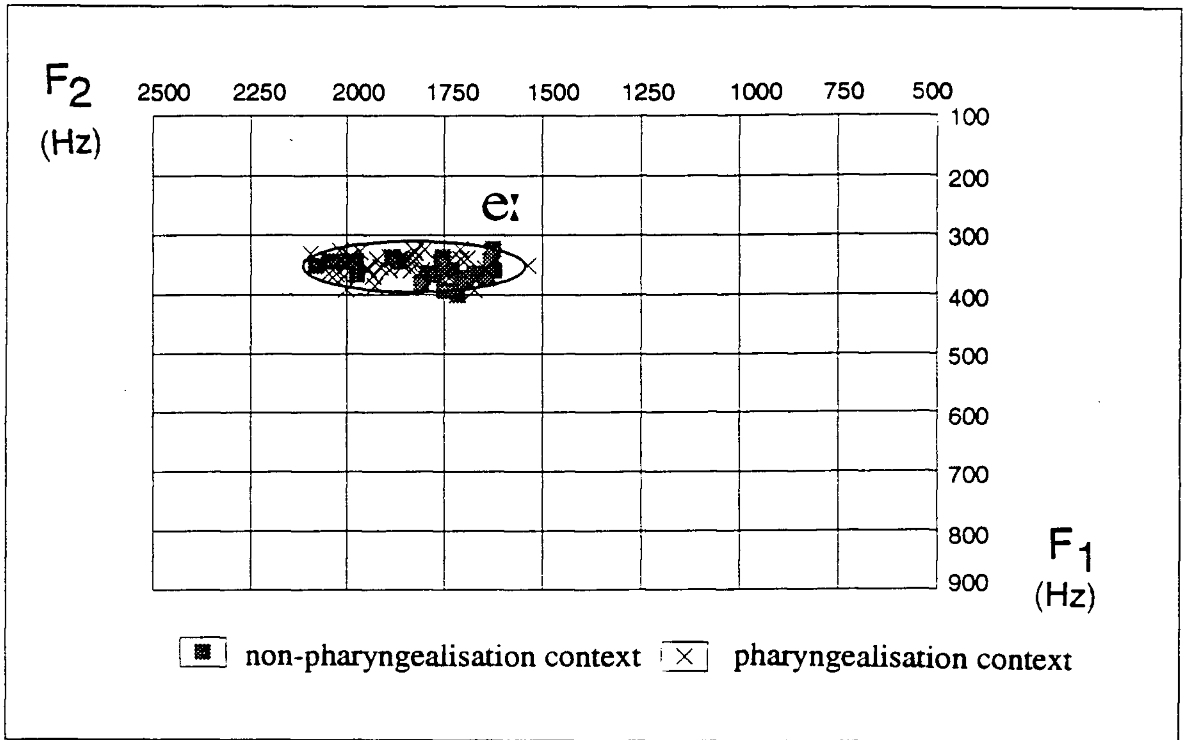


Figure 2:28 F_1 - F_2 plot of non-pharyngealisation context vs. pharyngealisation context tokens of Palestinian /E:/. Two speakers.
[e:]: F_1 (mean = 353 Hz; s.d. = 18 Hz); F_2 (mean = 1838 Hz; s.d. = 135 Hz); 67 tokens.

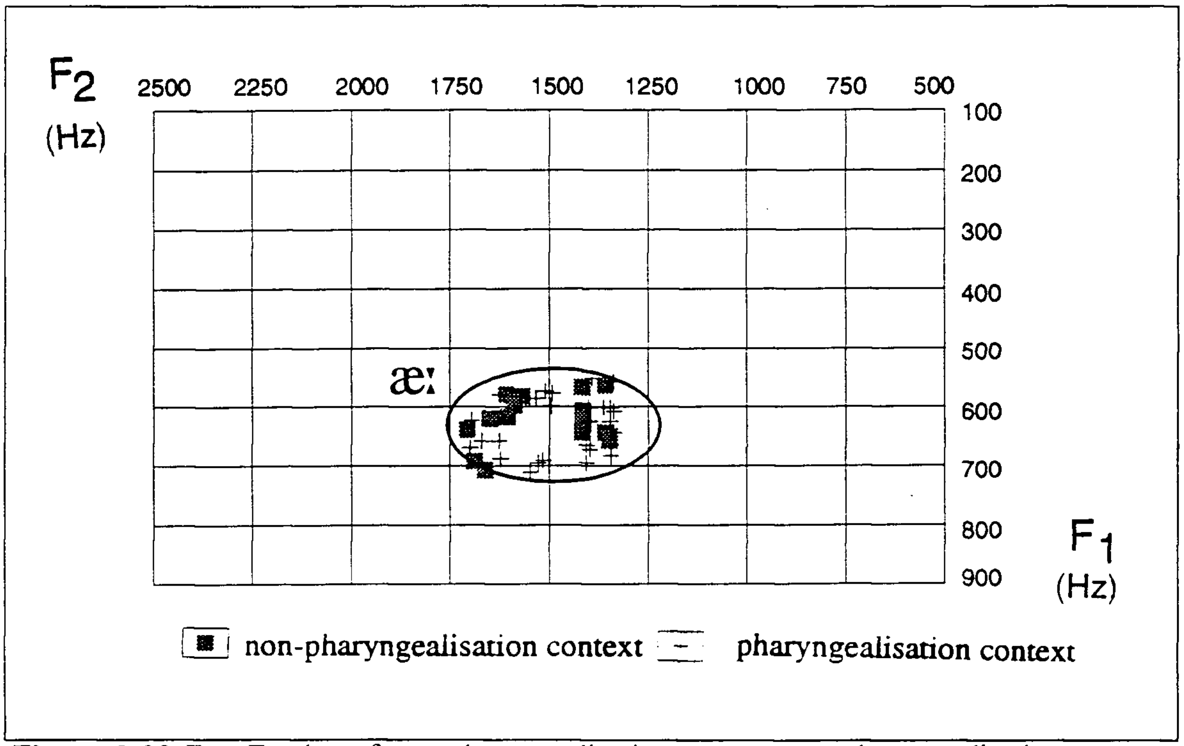


Figure 2:29 F_1 - F_2 plot of non-pharyngealisation context vs. pharyngealisation context tokens of Palestinian /Æː/ > {æː}. Two speakers.
[æː]: F_1 (mean = 629 Hz; s.d. = 44 Hz); F_2 (mean = 1487 Hz; s.d. = 125 Hz); 44 tokens.

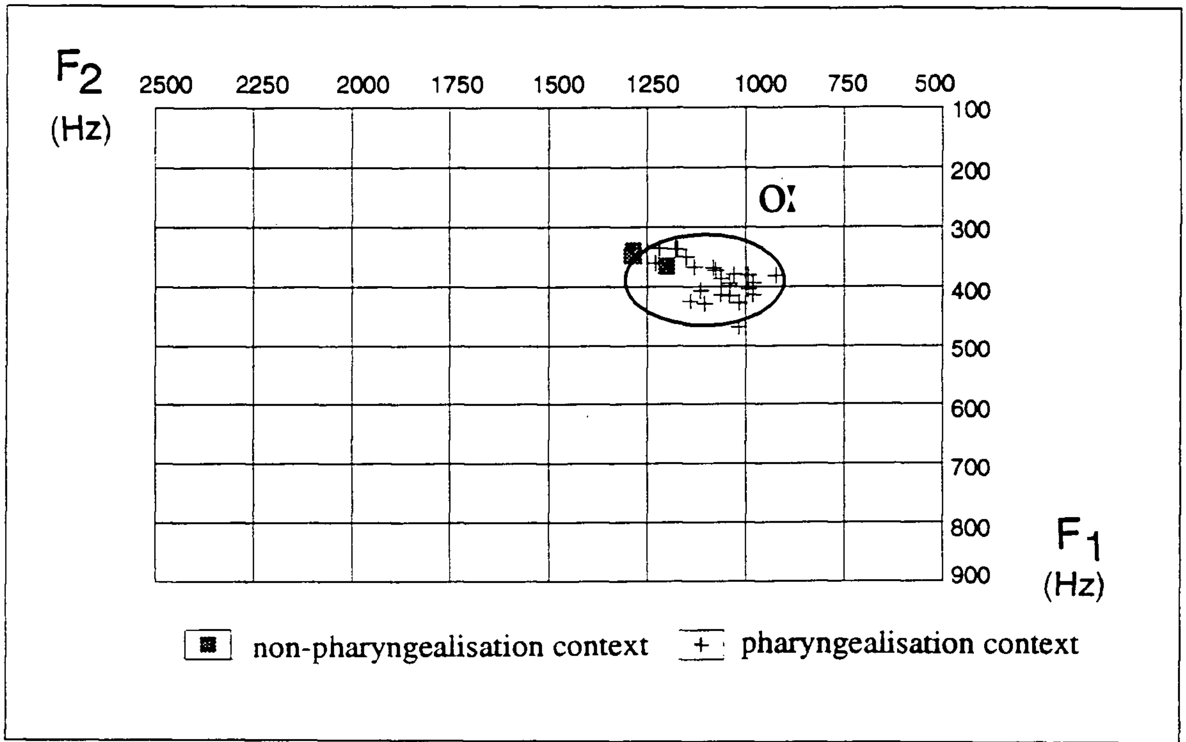


Figure 2:30 F_1 - F_2 plot of non-pharyngealisation context vs. pharyngealisation context tokens of Palestinian /O:/. Two speakers.
[o:]: F_1 (mean = 386 Hz; s.d. = 33 Hz); F_2 (mean = 1100 Hz; s.d. = 97 Hz); 30 tokens.

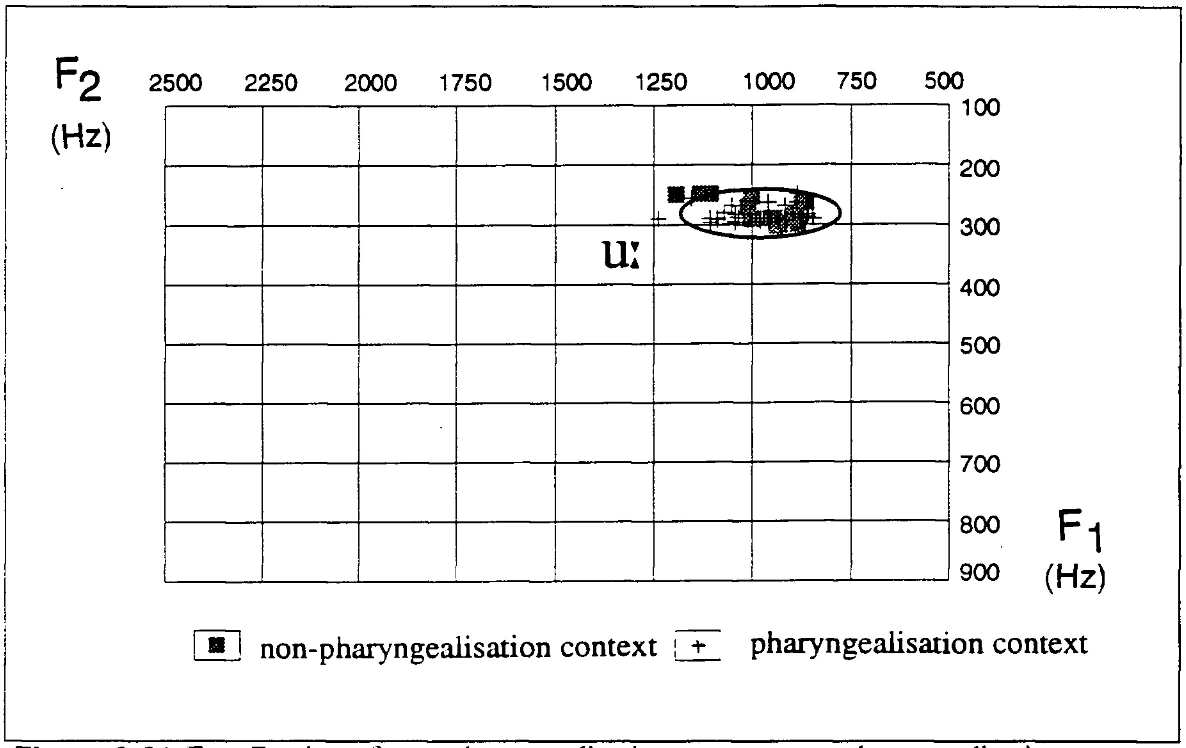


Figure 2:31 F_1 - F_2 plot of non-pharyngealisation context vs. pharyngealisation context tokens of Palestinian /U:/. Two speakers.
[u:]: F_1 (mean = 280 Hz; s.d. = 16 Hz); F_2 (mean = 978 Hz; s.d. = 97 Hz); 50 tokens.

In Figures 2:27 - 2:31, for each vowel, the non-pharyngealisation context and pharyngealisation context tokens overlap with respect to both F_1 and F_2. That is, for each vowel, no distinct lower or higher F_1 or F_2 region can be assigned to the tokens in either type of context.

Several pharyngealisation context tokens of /O:/ in Figure 2:30 have an F_1 rise and an F_2 drop, compared to F_1 and F_2 of the non-pharyngealisation context tokens of /O:/. However, some of the former tokens fall within the same F_1 or F_2 region as the latter. Given this, no distinct observation for /O:/ (*viz.*, that the non-pharyngealisation context vs. pharyngealisation context tokens can be assigned distinct lower vs. higher F_1 or F_2 regions, respectively) will be made here.

The finding of F_1 and F_2 overlap from Figures 2:27 - 2:31 indicates no F_1 and F_2 effects for the long vowel tokens in a pharyngealisation context. This supports the assumption that those tokens, like the non-pharyngealisation context tokens, were not produced with pharyngealisation. This, in turn, supports the phonological claim that Palestinian long vowels do not pharyngealise.

2.4.6. A Theoretical Account: Part III

I propose that the properties of pharyngealisation harmony identified in §2.4.5 require the additional constraints in (102). These constraints will be motivated shortly.

(102) a. NUC]$_{Stm}$/*RTR
A NUC at a right stem edge is not specified for [RTR].

b. NUCμμ /*RTR
A bimoraic NUC is not specified for [RTR].

This section will argue for the constraint ranking in (103). It will present evidence that DEP-RTR crucially dominates the ALIGN([RTR]; Wd) constraints. The result is the reranking of DEP-RTR in (103), from its previous ranking in (85). It will be argued that the higher ranking of DEP-RTR over the ALIGN([RTR]; Wd) constraints derives the opacity effects of stem-final and long vowels, in an account similar to that proposed by Pulleyblank (1994a) for Yoruba.

2.4.6. A Theoretical Account: Part III

(103) DEP-IO, MAX-RTR, MAX-LINK, NUC]$_{Stm}$/*RTR, NUC$\mu\mu$ /*RTR >>

NUC-C]$_\sigma$/RTR, ALIGN-L([RTR], NUC), ALIGN-R([RTR], NUC),

DEP-RTR >>

ALIGN([RTR], L; Wd, L), ALIGN([RTR], R; Wd, R) >>

DEP-LINK

NUC]$_{Stm}$/*RTR is proposed here as a morphophonological constraint requiring that [RTR] not be linked to a stem-final vowel. It is here considered part of a NON-FINALITY family of constraints, which require that a specified phonological element not occur at a right ('final') edge of some morphological category. NON-FINALITY constraints referencing the right edge of the word are proposed by Prince and Smolensky (1993); see their account [p.40, 43] of Hindi and Latin stress assignment.

I propose that NUC$\mu\mu$/*RTR is a syntagmatic Grounding constraint which, like NUC-C]$_\sigma$/RTR, is grounded in the properties of phonetic undershoot. This is based on the finding of Lindblom (1963:1779) that degree of vowel undershoot in a closed syllable is inversely correlated with vowel length. (The longer the vowel, the less the undershoot; the shorter the vowel, the more the undershoot.) See §2.3.3.3 for related discussion. The closed syllable context and vowel length are separate factors influencing the degree of undershoot. NUC-C]$_\sigma$/RTR phonologises the factor of the closed syllable context. NUC$\mu\mu$/*RTR phonologises the factor of vowel length. The present proposal is that, given Lindblom's finding of less undershoot for longer vowels, the lack of pharyngealisation observed for long vowels in a language like Palestinian is syntagmatically grounded in a *lack* of phonetic undershoot over the longer duration of a bimoraic vowel.

A correlation between length and non-rtr (or atr) vowels is shown for Menomini by Archangeli and Suzuki (1995) and for English by Halle and Mohanan (1985). In Menomini, only long vowels can surface atr. For this, under the assumption of binary features, Archangeli and Suzuki assume the constraint ATR/μμ ('If [+ATR], then bimoraic'). For English, Halle and Mohanan identify a correlation between length and 'tenseness'. (As discussed in §2.4.2, the 'tense/lax' distinction is assumed here to be captured by a tongue root feature.)

The constraint interaction resulting from the ranking in (103) is illustrated by the tableaux in (104) - (109). (In (105) and (108), '☞' marks the winning candidate. Each candidate in (104) violates IO-FAITH (DEP-IO) because it contains an epenthetic consonant; each candidate in (105) violates IO-FAITH (DEP-IO) because it contains an epenthetic vowel. Each candidate in (108) violates IO-FAITH (MAX-RTR and MAX-LINK) because of the deletion of the underlying [RTR] and its link to /ṛ/. That deletion results in Palestinian /ṛ/ de-emphasis, discussed in §2.2.1.3.2. The constraint forcing the deletion will not be formulated here. Finally, the constraint interaction producing the stem-final {t} and raised low vowel in (108) will be ignored, as treatment of those issues is beyond the scope of this study.)

(104)

input: /IʁlI/ | [RTR] 'boil'; see (92)	I-O FAITH	NUC]$_{Stm}$/ *RTR	NUCμμ / *RTR	NUC-C]$_\sigma$/ RTR	ALIGN ([RTR], NUC)	DEP-RTR	ALIGN-RTR-Wd	DEP-LINK
1. {'ʔiɣ.li}	**!*			*				
2. {'ʔiʁ.li} | [RTR]	*			*!	**		**	
☞ 3. {'ʔɪʁ.li} \\| [RTR]	*				*		*	*
4. {'ʔɪ.ʁɪ.li} \\|/ [RTR]	**!						*	**
5. {'ʔɪʁ.l ɪ} \\| / [RTR]	*	*!						**
6. {'ʔiʁ.l ɪ} | / [RTR]	*	*!		*	*		*	*

(105)

input: /b-sÆkkIf-U-l-nÆ-ʃ/ 'they (masc.) don't clap for us'; see (93)	I-O FAITH	NUC]$_{Stm}$/ *RTR	NUCμμ / *RTR	NUC -C]$_{σ}$/ RTR	ALIGN ([RTR], NUC)	DEP-RTR	ALIGN -RTR- Wd	DEP-LINK
1. {bi.-ˌsək.f-u-l.-ˈnæː-ʃ}	*			**!*				
2. {bi.-ˌsɜk.f-u-l.-ˈnæː-ʃ} | [RTR]	*			**		*	***!	*
☞ 3. {bɪ.-ˌsɜk.f-u-l.-ˈnæː-ʃ} \ | [RTR]	*			**		*	**	**
4. {bɪ.-ˌsɜk.f-ʊ-l.-ˈnæː-ʃ} \ | / [RTR]	*	*!		*		*	*	***
5. {bɪ.-ˌsɜk.f-ʊ-l.-ˈnaː-ʃ} \ | / / [R T R]	*	*!*	*			*		****
6. {bɪ.-ˌsɜk.f-u-l.-ˈnaː-ʃ} \ | | [RTR] [RTR]	*	*!	*	*		**	*	***

(106)

input: /tI:n/ 'figs'; see (95)	I-O FAITH	NUC]$_{Stm}$/ *RTR	NUCμμ / *RTR	NUC- C]$_{σ}$/ RTR	ALIGN ([RTR], NUC)	DEP-RTR	ALIGN- RTR- Wd	DEP-LINK
☞ 1. {tiːn}				*				
2. {tɪːn} | [RTR]			*!			*		*
3. {tɪːn} \ | / [RTR]			*!		**	*		***

(107)

input: /slImÆ:n/ 'Sliman' (masc. name); see (97)	I-O FAITH	NUC]$_{Stm}$/ *RTR	NUCμμ / *RTR	NUC-C]$_{\sigma}$/ RTR	ALIGN ([RTR], NUC)	DEP-RTR	ALIGN -RTR- Wd	DEP-LINK
☞1.{sli.ˈmæ:n}				*				
2. {sli.ˈma:n} [RTR]			*!			*	*	*
3.{slɪ.ˈma:n} [RTR]			*!			*		**
4. {slɪ.ˈmæ:n} [RTR]				*		*!	*	*

(108)

input: /sUr̩-I-Æ(t)-nÆ/ [RTR] 'our Syria'; see (101)	I-O FAITH	NUC]$_{Stm}$/ *RTR	NUCμμ / *RTR	NUC-C]$_{\sigma}$/ RTR	ALIGN ([RTR], NUC)	DEP-RTR	ALIGN-RTR-Wd	DEP-LINK
1. {su.r-i.-ˈit.-nə}	**			*!				
☞ 2. {su.r-i.-ˈɪt.-nə} [RTR]	**					*	***	*
3. {su.r-i.-ˈɪt.-nɜ} [RTR]	**	*!				*	**	**
4. {su.r-ɪ.-ˈɪt.-nə} [RTR]	**	*!				*	**	**
5. {sʊ.r-i.-ˈɪt.-nə} [RTR] [RTR]	**					**!	**	**
6. {sʊ.r-ɪ.-ˈɪt.-nə} [RTR]	**	*!				*	*	***

(109)

input: /dInÆ:ṛ/ [RTR] 'dinar'; see (97), (101)	I-O FAITH	NUC]$_{Stm}$/ *RTR	NUCμμ / *RTR	NUC-C]$_{\sigma}$/ RTR	ALIGN ([RTR], NUC)	DEP-RTR	ALIGN-RTR-Wd	DEP-LINK
☞ 1.{ḍi.'ṇɐːṛ} [RTR]				*	**		**	
2. {ḍi.'ṇɑːṛ} [RTR]			*!		*		*	*
3. {ḍɪ.'ṇɑːṛ} [RTR]			*!		*			**
4. {ḍɪ.'ṇɑː.ṛɪ} [RTR]	*!	*	*					***
5. {ḍɪ.'ṇɐːṛ} [RTR] [RTR]				*	**	*!	*	*

In (105) - (107) and (109), the winning candidate contains a stem-final or long vowel that is does not pharyngealise even though it is in a closed syllable or adjacent to an underlying postvelar. (Issues surrounding the lack of triggering by de-emphaticised /ṛ/ > {r}, as observed in (108), will not be pursued in this study.) This shows that violation of NUC-C]$_{\sigma}$/RTR or an ALIGN([RTR], NUC) constraint is less serious than violation of NUC]$_{Stm}$/*RTR or NUCμμ /*RTR, and establishes the ranking NUC]$_{Stm}$/*RTR, NUCμμ /*RTR >> NUC-C]$_{\sigma}$/RTR, ALIGN-L([RTR], NUC), ALIGN-R([RTR],NUC).

The winners in (104) - (105) and (108) - (109) each contain a long or stem-final vowel that is does not harmonise even though it is in a context for non-local harmony, *viz*., either non-adjacent to an underlying postvelar or in a word containing a closed-syllable-pharyngealised vowel. This shows that violation of an ALIGN([RTR]; Wd) constraint is also less serious than violation of $\mathrm{NUC]_{Stm}}$/*RTR or NUCμμ /*RTR, and establishes the ranking $\mathrm{NUC]_{Stm}}$/*RTR, NUCμμ /*RTR >> ALIGN([RTR], L; Wd, L), ALIGN([RTR], R; Wd, R).

The blocking effect of Palestinian stem-final and long vowels is seen in the winning candidates in (108) - (109). In those tableaux, the losing candidates 5 contain an additional [RTR] so the initial-syllable vowel can link to [RTR] in satisfaction of ALIGN([RTR], L; Wd, L). (The data that have been examined happen not to involve rightward blocking. For this reason, no tableau is presented here to illustrate a candidate with insertion of [RTR] for satisfaction of ALIGN([RTR], R; Wd, R).) For candidate 5 in (109), the additional [RTR] avoids the gapped configuration:

(110)

```
  N   N
  |   /\
  μ   μ μ
  |   \/
{d̙ɪ.ˈn̙ɐːr̙}
   \     /
   [RTR]
```

The configuration in (110) is here considered gapped because [RTR] is linked to {r̙} and {ɪ}, but not to the NUC anchor, {ɐː}, that intervenes between them; that is, an anchor is skipped. It disobeys Locality (Archangeli and Pulleyblank 1994a:26), Precedence in particular.

The Precedence Principle is defined by Archangeli and Pulleyblank (1994a:38) as:

(111) <u>Precedence Principle</u> (Archangeli and Pulleyblank (1994a:38)
Precedence relations cannot be contradictory.

The representation in (112) clarifies the manner in which (110) disobeys Precedence. The problem is with $NUC_b/root_\delta$, {ɐː}: as seen, it precedes [RTR], since it precedes $root_\varepsilon$ which is specified for [RTR]. However, $NUC_b/root_\delta$ also follows [RTR], since it follows $NUC_a/root_\beta$ which is specified for [RTR]. That is, the precedence relations of $NUC_b/root_\delta$ are contradictory. The representation is thus illformed.

(112)
```
          Na          Nb
          |           / \
          μ           μ  μ
          |           \ /
    {d̙α   ɪβ . ˈn̙γ    ɐːδ    r̙ε }
          \                  /
           [  R  T  R  ]
```

In the tableaux in (108) and (109), the additional [RTR] of the losing candidates 5 incurs an additional violation of DEP-RTR. The winners in those tableaux lack that additional DEP-RTR violation, but incur more violations of ALIGN([RTR], L; Wd, L) than the losing candidates 5. This shows that violation of DEP-RTR is more serious than violation of ALIGN([RTR], L; Wd, L) and establishes DEP-RTR >> ALIGN([RTR], L; Wd, L). The data that have been examined include no forms showing rightward blocking. However, it is assumed that a larger data set would provide such forms, to also establish DEP-RTR >> ALIGN([RTR], R; Wd, R). For this reason, ALIGN([RTR], R; Wd, R) is assumed to be equally ranked with ALIGN([RTR], L; Wd, L).

In §2.3.3.3, it was shown that NUC-C$]_\sigma$/RTR crucially dominates DEP-RTR. Given that, the ranking of DEP-RTR over the ALIGN([RTR]; Wd) constraints also establishes NUC-C$]_\sigma$/RTR >> ALIGN([RTR], L; Wd, L), ALIGN([RTR], R; Wd, R), as claimed in (103).

The ranking ALIGN([RTR], L; Wd, L), ALIGN([RTR], R; Wd, R) >> DEP-LINK was established in §2.4.4. Given that, the ranking DEP-RTR >> ALIGN([RTR], L; Wd, L), ALIGN([RTR], R; Wd, R), discussed above, also establishes DEP-RTR >> DEP-LINK.

The data that have been examined provide no evidence that NUC$]_{Stm}$/*RTR and NUC$\mu\mu$ /*RTR are crucially ranked with respect to DEP-IO, MAX-RTR, and MAX-LINK. For this reason, these constraints are assumed to be non-crucially equally ranked.

2.5. Palestinian Uvularisation Harmony

Palestinian uvularisation harmony has been examined, under the label 'emphasis spread' by Card (1983), Davis (1993, 1995), Herzallah (1990), and Younes (1982, 1993, 1994). The dialects represented in the studies just listed are a Jerusalem *fellāhi* (that is, rural dialect) (Card), a southern Palestinian dialect (Davis), and the Dar Younes (Younes, Davis) and Yaʕbad (Herzallah) *fellāhis*. An Optimality treatment of the harmony, based on data in Davis (1995), is presented by McCarthy (1997). McCarthy's account is developed under different featural and Correspondence assumptions than those adopted here. It will not be reviewed in detail, though an aspect of it will be addressed in §2.6. This portion of chapter 2 presents the properties of uvularisation harmony in the Abu Shusha dialect and proposes the constraint interaction responsible for it. Uvularisation harmony in the other dialects just mentioned will be discussed in §2.5.7. It will be shown that the major cross-dialectal differences are in the presence or absence of distinct leftward vs. rightward harmonies, and varying sets of harmony blockers.

2.5.1. Harmony with an Emphatic

2.5.1.1. Analysis

The data in (113) show the surface effects observed when an Abu Shusha word contains an emphatic, that is, one of /m b l ð s t r k/. (See also the forms containing emphatics in §2.4. Tableaux for (113a) and (113e) will be given in §2.5.2.)

(113) a. /tÆzÆ/	{ˈtɑ.zə}	'fresh (masc./fem. sg./pl.)'
b. /sÆħħÆ/	{ˈsʌħ.ħə}	'health'
c. /twÆ:l/	{twɐːl}	'tall (masc. pl.)'
d. /b-ʕÆtI-nÆ-ʃ/	{ˌb-ʕɜ˃.ti.-ˈnɐː-ʃ}	'he doesn't give (something) to us'
e. /ÆbÆ:t/	{ʔɜ˃.ˈbɐːt}	'to hug', 'hug' (N)
f. /mÆrÆ/	{ˈmɑ.rə}	'woman, wife'
g. /tÆwl-Æ:t/	{tauw.ˈl-ɐːt}	'tables'
h. /ʕÆjÆ:t/	{ʕai.ˈj.ɐːt}	'crying' (N)
i. /sjÆ:m/	{sjɐːm}	'fasting' (N)
j. /rÆjjÆħ/	{ˈraij.jɜ˃ħ}	'he rested'
k. /tÆjjÆb-Æt-nI/	{ˌtaij.jɜ˃.ˈb-ʌt.-ni}	'she made me become well'

These data show that when a word contains an emphatic, long /Æ:/ surfaces as backed {ɐː},[16] non-reduced short /Æ/ surfaces as back {ɑ}, reduced short /Æ/ surfaces as back {ɜ˃}, and underlyingly non-emphatic consonants surface emphatic. However, as was

[16]The long backed low vowel is here transcribed as non-rtr {ɐː} rather than rtr {ɑː}. This is based on the evidence, discussed in §2.4.3, that Palestinian long vowels do not pharyngealise.

shown in §2.4.3, if such a word contains a short vowel in a closed syllable, short primary-stressed /Æ/ surfaces as {ʌ}, as seen in (113b, k).

The effects observed in (113) are analysed as the result of uvularisation harmony triggered by the underlying emphatic in each form.

Three consonants do not undergo this harmony: /ʃ ʧ ʤ/. In §2.5.3 it will be shown that /ʃ ʧ ʤ/ are opaque to uvularisation harmony.

In §2.5.5, it will be argued that Palestinian non-low vowels are transparent to uvularisation harmony.

The data in (114) show that the harmony is not observed in forms that do not contain an emphatic. This is so even if the uvular gutturals /ʁ χ/ are present. That is, the class of triggers excludes primary uvulars. This is supported by the acoustic measurements to be reported in §2.5.1.2.

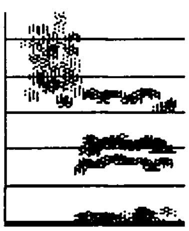
(114)

a. /wÆħÆd-Æːn-i/	{ˌwɜ.ħɜ.ˈd-æː.n-i}	(*{ˌw̙ɜ˃.ħ̙ɜ˃.ˈd̙-ɐː.n̙-i})	'lone, single (masc. sg.)'
b. /jÆʕnI/	{ˈjaʕ.ni}	(*{ˈj̙ʌʕ̙.n̙i})	'it means'
c. /ʁÆːz/	{ʁæːz}	(*{ʁ̙ɐːz̙})	'gas'
d. /hÆːðI/	{ˈha.ði}	(*{ˈh̙ɑ.ð̙i})	'that (fem.)'
e. /χÆːl-t-O/	{ˈχal.-t-o}	(*{ˈχ̙ʌl̙.-t̙-o})	'maternal auntie'
f. /b-ʔÆχχIr-nÆ-ʃ/	{bɪ.-ˌʔɜχ.χɪr.-ˈnæː-ʃ}	(*{b̙ɪ.-ˌʔ̙ɜ˃χ̙.χ̙ɪr̙.-ˈn̙ɐː-ʃ})	'he doesn't cause us to be late'
g. /tÆwwÆb-Æt-nI/	{ˌtauw.wɜ.ˈb-at.-ni}	(*{ˌt̙auw̙.wɜ˃.ˈb̙-ʌt̙.-n̙i})	'she made me repent'
h. /kÆs-Æːt/	{kə.ˈs-æːt}	(*{k̙ɜ˃.ˈs̙-ɐːt̙})	'cups'

2.5.1. Harmony with an Emphatic

The phrases in (115) show that Abu Shusha uvularisation harmony does not extend beyond the word. This confirms the word as the harmony domain. The same domain is shown for uvularisation harmony in other Palestinian dialects by Card (1983:60) and Younes (1982:130-137; 1993:126), and in Tunisian Arabic by Ghazeli (1977:100).

(115) a.	/fÆːs # t̙ÆwIːl/	{fæːs # t̙au.ˈw̙iː̙l̙}	(*{f̙ɐːs̙ # t̙au.ˈw̙iː̙l̙})	‘a long hoe’
b.	/dÆːr̙ # ÆmnÆ/	{d̙ɐːr̙ # ˈʔam.nə}	(*{d̙ɐːr̙ # ˈʔ̙ʌm̙.n̙ə})	‘Amna’s house’



2.5.1.2. Acoustic Support

The data on short /Æ/ presented earlier in Figure 2:18 are presented again in Figure 2:32, replotted according to the contexts relevant to Palestinian uvularisation harmony: (i) with no emphatic in the word; (ii) with an emphatic in the word, with a post-alveolar obstruent intervening between the vowel and an emphatic; (iii) in an open syllable with an emphatic in the word; (iv) in a closed syllable with an emphatic in the word. In the figure caption, contexts (i) - (iv) are referred to as ‘no emphatic’, ‘blocked’, ‘emphatic + open syllable’, and ‘emphatic + closed syllable’, respectively. This section will examine the tokens in contexts (i), (iii), and (iv). The tokens in context (ii) will be discussed in §2.5.3.

In Figure 2:32, IPA symbols identify clusters of tokens which are [æ], [ɑ], or [ʌ]. (Recall from §2.4.3.2 that the [æ]s include tokens of both non-rtr {æ} and rtr {a}, as those two surface vowels phonetically neutralise to [æ].) Ellipses enclose 90% of the tokens per allophone.

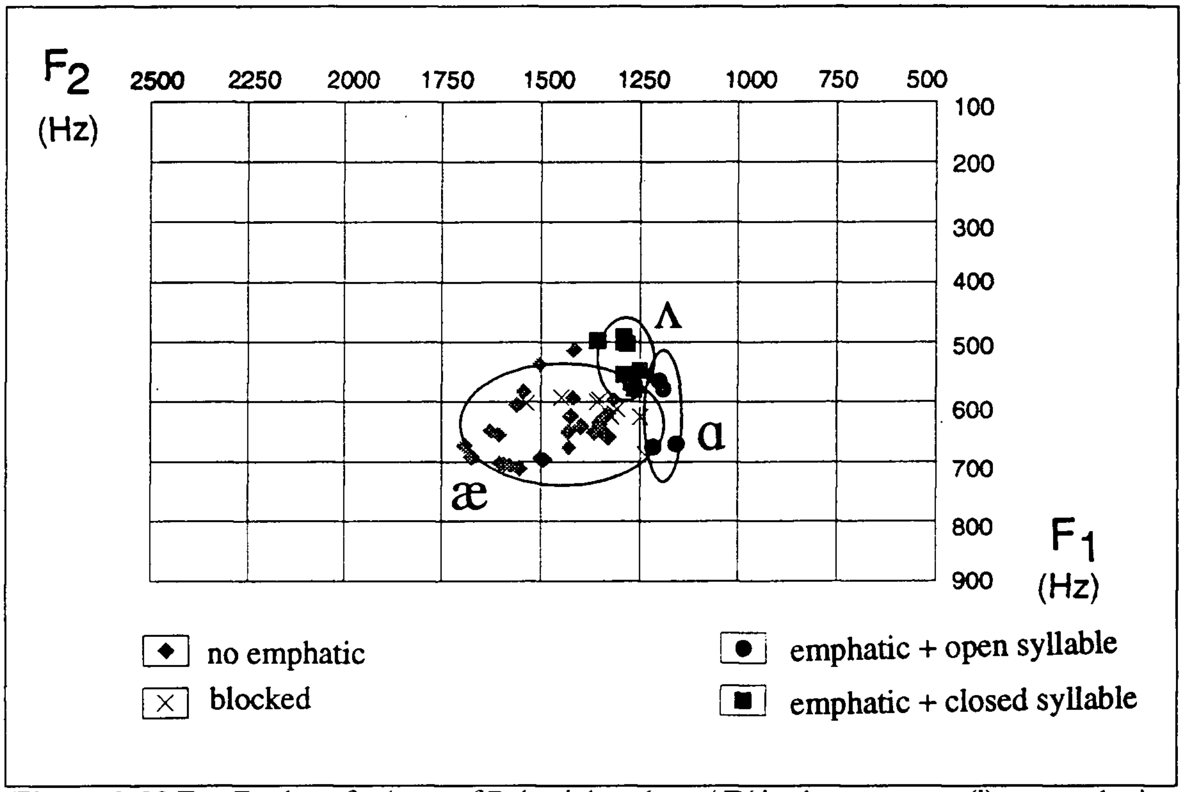


Figure 2:32 F_1 - F_2 plot of tokens of Palestinian short /Æ/ in the contexts: (i) no emphatic; (ii) blocked; (iii) emphatic + open syllable; (iv) emphatic + closed syllable

In Figure 2:32, the tokens in context (i), that is, those tokens occurring in a word that does not contain an emphatic, cluster together in a region of the F_1 - F_2 plane characterised by a higher F_2, and are [æ]. The tokens in context (iii), that is, in a word containing an emphatic, in which (non-blocked) /Æ/ occurs in an open syllable, cluster in a distinct region characterised by a lower F_2, and are[ɑ]. The tokens in context (iv), that is, in a word containing an emphatic in which (non-blocked) /Æ/ occurs in a closed syllable, cluster in a third distinct region characterised by a lower F_1 and an intermediate F_2, and are [ʌ].

In §1.4.3, the predicted F_1 and F_2 effects for a segment with uvularisation articulation were identified a medium or large F_1 rise and a large F_2 drop. In Figure 2:32, the tokens in context (iii) do not show a raised F_1. The lack of F_1 effect might be due to some phonetic factor mitigating against an F_1 rise for tokens of /Æ/ in general. This is suggested by the lack of F_1 rise also observed for tokens of rtr {a} in Figure 2:20; see §2.4.3.2 for discussion. However, the tokens in context (iii) do show the expected F_2 effect: based on the F_2 means reported in the caption for Figure 2:18, their F_2 is lowered by about 250 Hz which, according to Table 1:10 is a medium drop. Thus, with respect to F_2, the data in Figure 2:32 do not exactly match the expectations, but are roughly consistent with them. This is considered support for the assumption that the tokens in context (iii) were produced with a uvularisation articulation that the tokens in context (i) lacked. This, in turn, supports the phonological claim that /Æ/ uvularises in an open syllable in a word containing an emphatic.

In Figure 2:32, the tokens of /Æ/ in context (iv) have a small F_2 drop, based on the F_2 means reported in Figure 2:18. This drop, while not as large as expected, is considered to lend some support for an assumption that they were also produced with uvularisation. This is support for the phonological claim that /Æ/ uvularises also in a closed syllable in a word containing an emphatic.

2.5.1. Harmony with an Emphatic

Figure 2:33 replots the data on the long low vowel /Æː/ in Figure 2:29. It also presents tokens of Palestinian /Æː/ > backed {ɐː}. The tokens in Figure 2:33 are plotted according to the same four contexts distinguished for short /Æ/ in Figure 2:32. The tokens in contexts (i), (iii), and (iv) will be discussed below. Those in context (ii) will be addressed in §2.5.3. IPA symbols identify clusters of tokens that are [æː] or [ɐː]. Statistics for the [ɐː]s are presented in the caption.

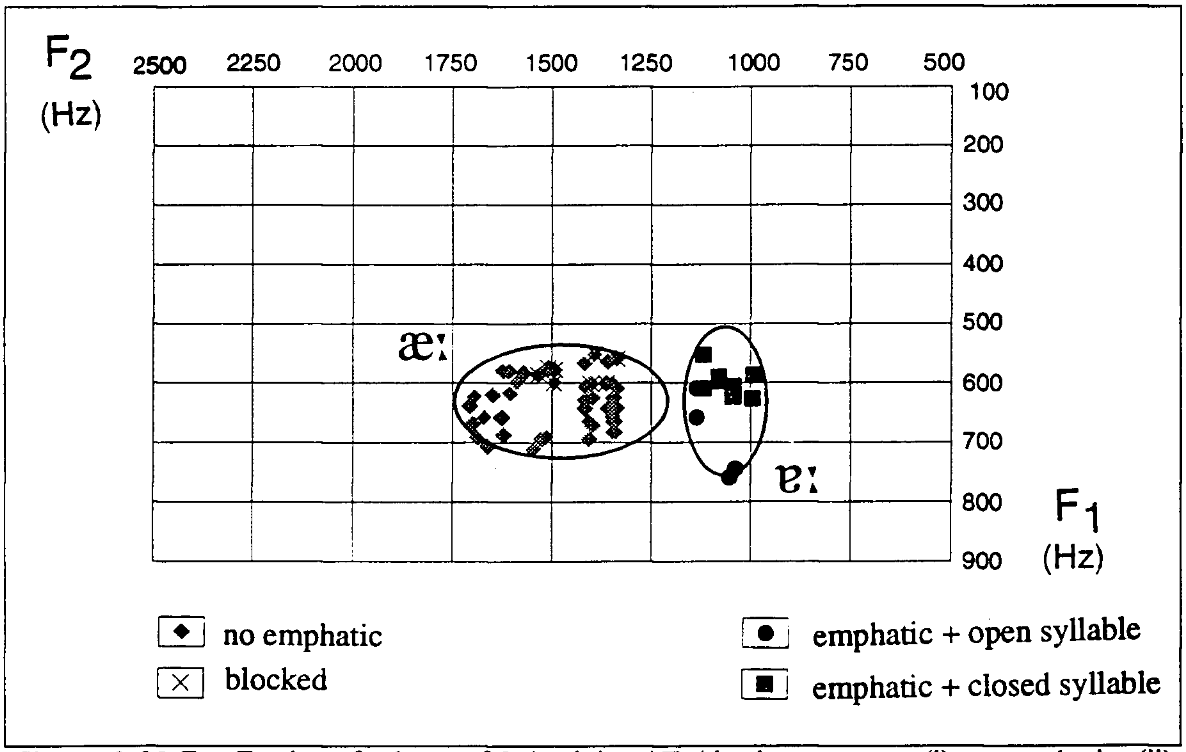


Figure 2:33 F_1 - F_2 plot of tokens of Palestinian /Æː/ in the contexts: (i) no emphatic; (ii) blocked; (iii) emphatic + open syllable; (iv) emphatic + closed syllable. Two speakers. [ɐː]: F_1 (mean = 630 Hz; s.d. = 60 Hz); F_2 (mean = 1070 Hz; s.d. = 48 Hz); 12 tokens.

In Figure 2:33, the tokens in context (i) cluster together in a region of the F_1, F_2 plane characterised by a higher F_2 and are [æː]. The tokens in contexts (iii) and (iv) cluster in a distinct region characterised by a lower F_2 and are [ɐː].

2.5.1. Harmony with an Emphatic

Based on the F_1 means reported in the captions for Figures 2:29 and 2:33, the tokens of {ɐː} do not have an F_1 rise. This is consistent with the lack of F_1 rise observed for the rtr [a]s and uvularised [ɑ], as discussed above with respect to Figure 2:32. However, based on the F_1 means reported for the tokens of {æː} in Figure 2:29 and the tokens of {ɐː} in Figure 2:33, F_2 of the tokens in contexts (iii) and (iv) is lowered by 400 Hz, a large drop according to Table 1:10. The F_2 effect expected for uvularisation, based on Table 1:11, is a large drop. The data in Figure 2:33 match this expectation. This is consistent with the assumption that the tokens of /Æː/ in contexts (iii) and (iv) were produced with a uvularisation articulation that the tokens in context (i) lacked. This, in turn, supports the phonological claim that long /Æː/ uvularises in a word containing an emphatic. (That no distinct intermediate F_1 - F_2 region distinguishes the open vs. closed syllable tokens of uvularised /Æː/ supports the observation that, unlike short /Æ/, uvularised long /Æː/ does not raise in a closed syllable.)

Four tokens of {ɐː} in Figure 2:33 occur in a word containing the uvular guttural /ʁ/. (This is seen the from list of carrier forms in Appendix III.) The fact that those tokens do not have an F_2 drop, and are front [æː], supports the assumption that they were not produced with uvularisation. This, in turn, supports the phonological claim that uvular gutturals do not trigger uvularisation harmony.

2.5.1. Harmony with an Emphatic

Figure 2:34 presents a wideband spectrogram of one token each of the words {ħræːm} 'blanket' and {ħ̣ɜ˃.ˈṛɐːṃ} 'shame' (N).[17] F_1 and F_2 of the [ɐː] and [æː], measured at the points indicated by the vertical lines in the spectrogram, are reported in the caption. As seen, F_2 of [ɐː] is about 300 Hz lower than F_2 of [æː]. The steady F_2 of both [ɐː] and [æː] is interpreted as showing that each vowel has reached and maintained its F_2 target.

Distinct formant targets which are reached and maintained are here interpreted as the phonetic implementation of some discrete phonological property. The distinct F_2 targets reached and maintained by [ɐː] and [æː] in Figure 2:24 are thus expected if [ɐː] and [æː] are tokens of phonologically distinct vowels: {ɐː}, which is phonologically uvularised, that is, specified for secondary-[DOR] and secondary-[DOR], and {æː}, which is not. The F_2 data in Figure 2:34 thus support the claim that Palestinian /Æː/ undergoes phonological uvularisation harmony. This constrasts with F_2 data for Palestinian non-low vowels in a uvularisation context, as will be discussed in §2.5.5.2.

[17]The analysis of Palestinian /ṛ/ in §2.2.1.3.2 predicts that /ṛ/ in {ħræːm} should surface emphatic, as it does not occur in a de-emphaticising context. However, with Herzallah (1990:160n6), it is assumed that historical /I/ (*cf.* Classical Arabic {ħɪ.ˈræːm}) is underlyingly present in this form and that /ṛ/ surfaces non-emphatic because of that /I/.

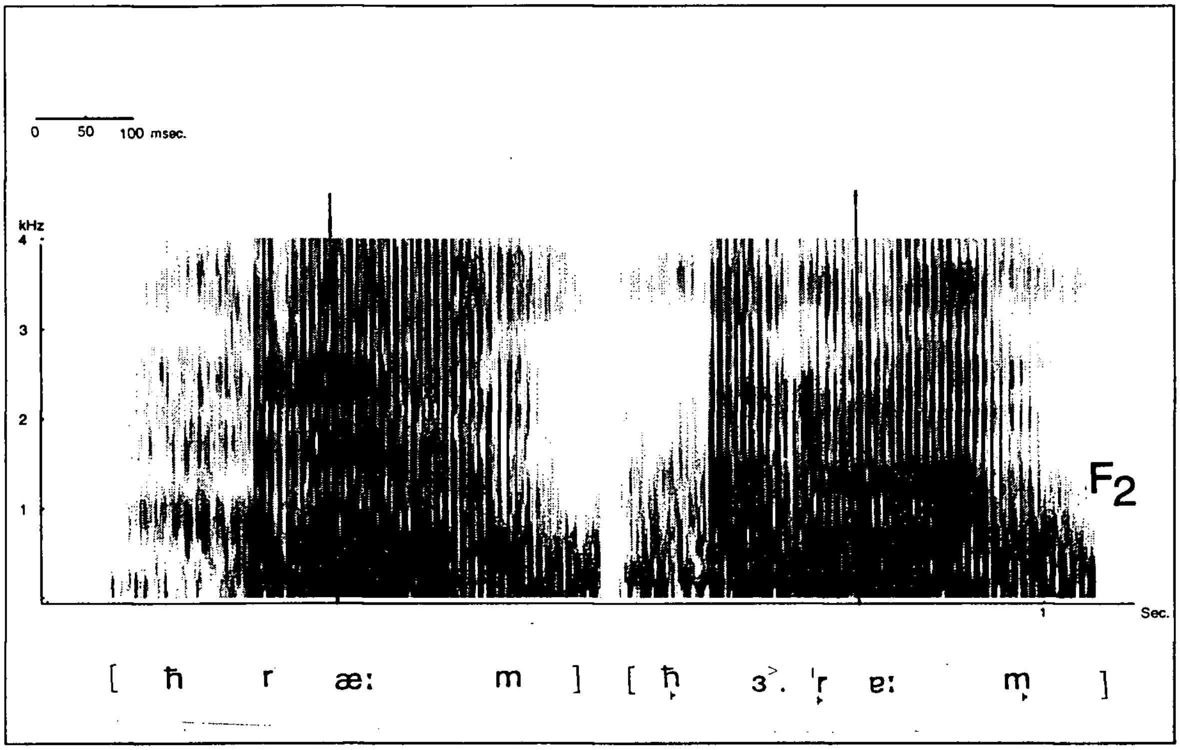


Figure 2:34 Wideband spectrogram of one token each of {ħræːm} 'blanket' and {ħ̙ɜ˃.ˈr̙ɐːm̙} 'shame' (N). (Formants measured at the points indicated by the vertical lines.)
[æː]: $F_1 = 626$ Hz; $F_2 = 1503$ Hz.
[ɐː]: $F_1 = 630$ Hz; $F_2 = 1193$ Hz.

Data showing the acoustic effects of a uvularisation context on consonants will now be presented. Figure 2:35 presents a wideband spectrogram showing one token each of /t/ > {t} and /t/ > surface emphatic {t̙}. The carrier forms are identified in the caption, which also reports the frequency of the burst of each token of /t/. (The bursts were measured using the procedure outlined in §2.3.1.1.)

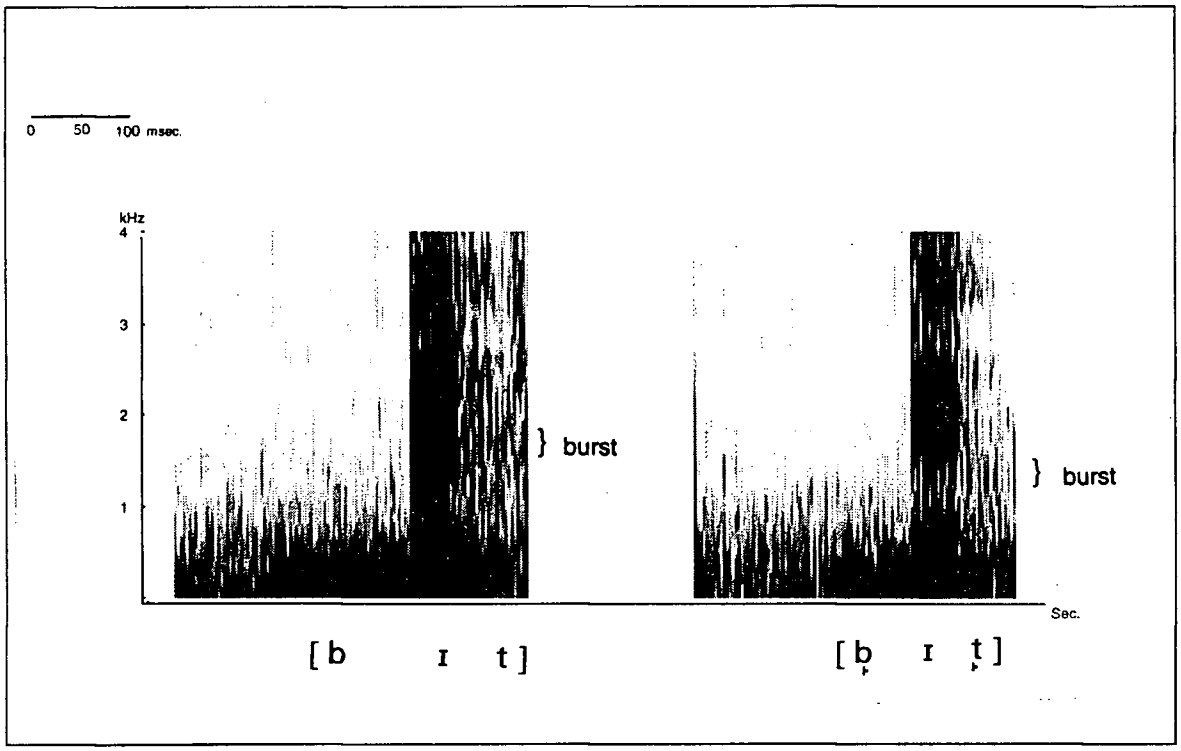


Figure 2:35 Wideband spectrogram showing one token each of /t/ > {t} and /t/ > {t̘}. The token of /t/ > {t} occurred in {b-ɪt.-ˈʕɪdd} 'she's counting', the token of /t/ > {t} in {b̘-ɪt̘.-ˈs̘ʊb̘b̘} 'she's pouring'.
Burst of [t] = 1668 Hz.
Burst of [t̘] = 1352 Hz.

In Figure 2:35, the burst of the token of /t/ > surface emphatic {t̘} is about 300 Hz lower than the burst of the token of /t/ > non-emphatic {t}. A lower concentration of burst energy as a characteristic of an emphatic plosive has been reported elsewhere, e.g., by Al-Ani (1970:45), who reports it for emphatic /t̘/ as compared to the burst for nonemphatic /t/. Given that, the lowered burst observed here for /t/ > {t̘} is consistent with an assumption that it was produced with uvularisation. This, in turn, supports the phonological claim that underlyingly non-emphatic consonants uvularise in a word containing an underlying emphatic.

The wideband spectrograms in Figures 2:36 - 2:40 show tokens of the gutturals /h/, /ʕ/, /ħ/, /ʁ/, and /χ/, respectively, in a non-uvularisation vs. uvularisation context. The figure captions identify the carrier forms for the tokens and report F_2. Arrows draw attention to the second formant of each guttural token. (No data on the laryngeal guttural /ʔ/ in the two contexts is presented here. The acoustic effects of uvularisation for /ʔ/ were not investigated for this thesis.)

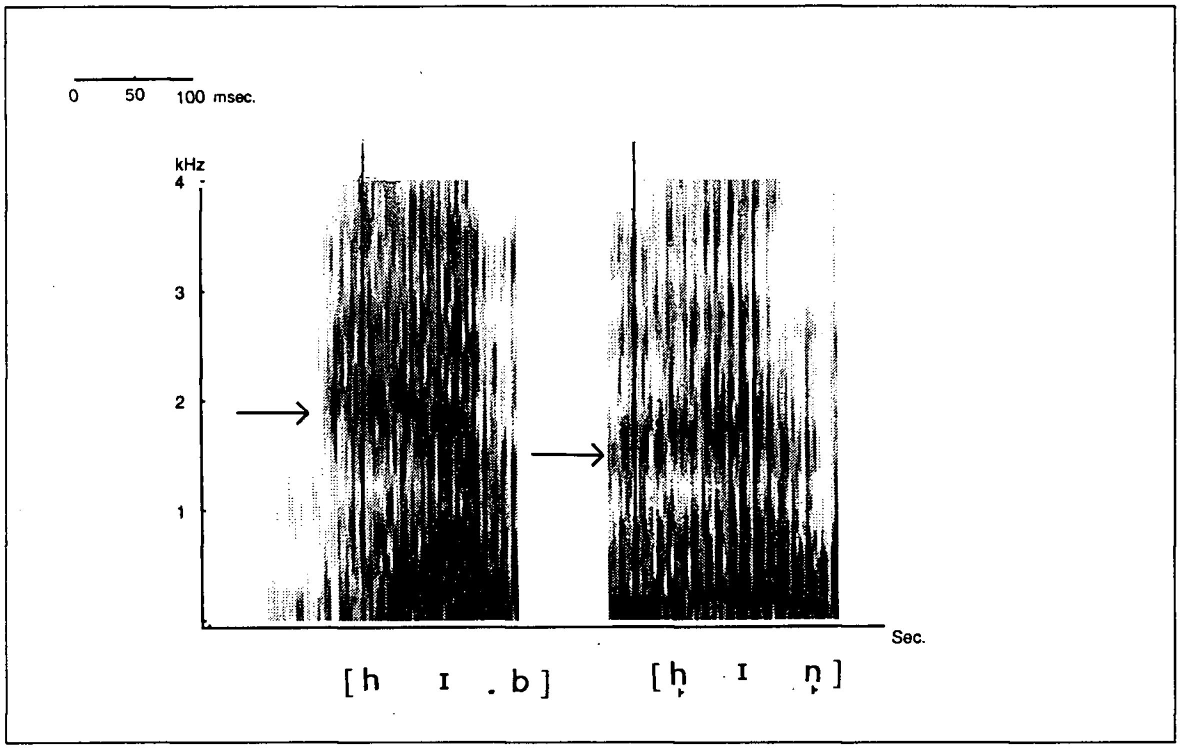


Figure 2:36 Wideband spectrogram showing one token each of {h} and {h̘}. The token of {h} occurred in {'hɪ.bə} 'Hiba' (fem. name); the token of {h̘} occurred in {b̘-ɪt̘.-'s̘ʊb̘.-h̘ɪn̘} 'she's pouring them (fem.)'. (Formants measured at the points indicated by the vertical lines.)

F_2 of [h] = 1899 Hz.

F_2 of [h̘] = 1544 Hz.

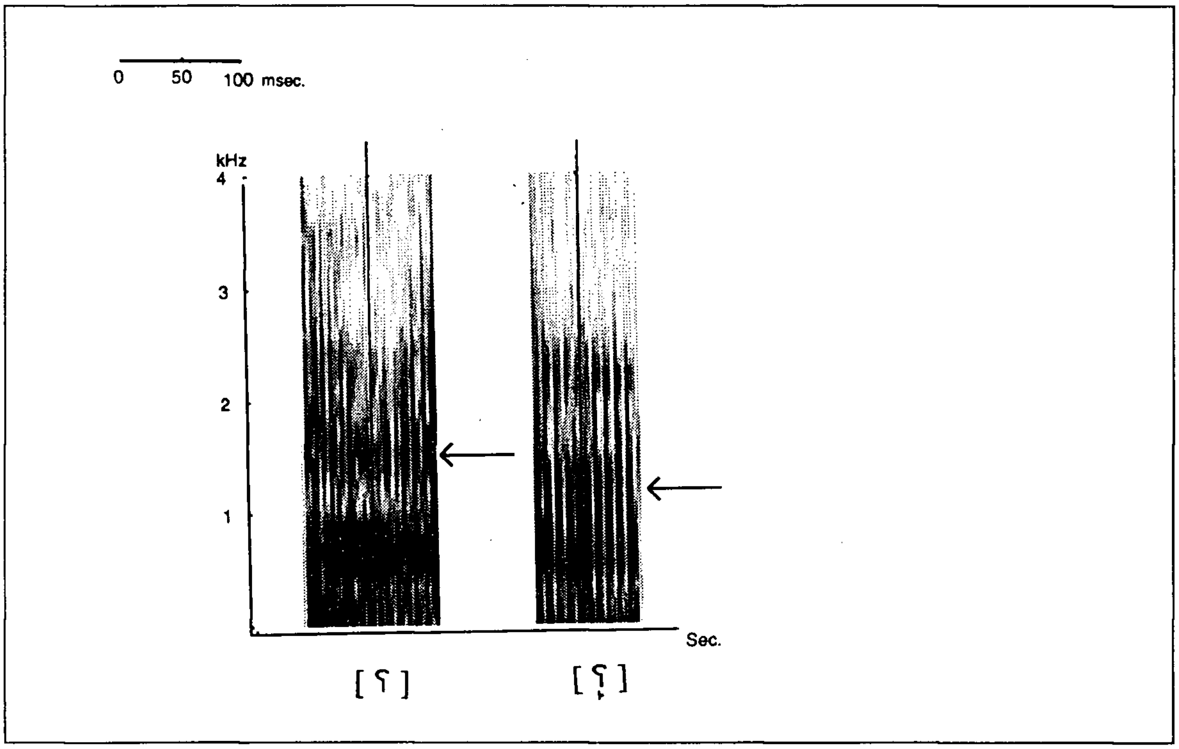


Figure 2:37 Wideband spectrogram showing one token each of {ʕ} and {ʕ̣}. The token of {ʕ} occurred in {'ʃbɪ.ʕɪt} 'full, satiated (masc. sg.)'; the token of {ʕ̣} occurred as the final-syllable {ʕ̣} in {ṃɜ˃ʕ̣.-'ḅɐːʕ̣ð̣} 'together'. (Formants measured at the points indicated by the vertical lines.)

F_2 of [ʕ] = 1513 Hz.

F_2 of [ʕ̣] = 1183 Hz.

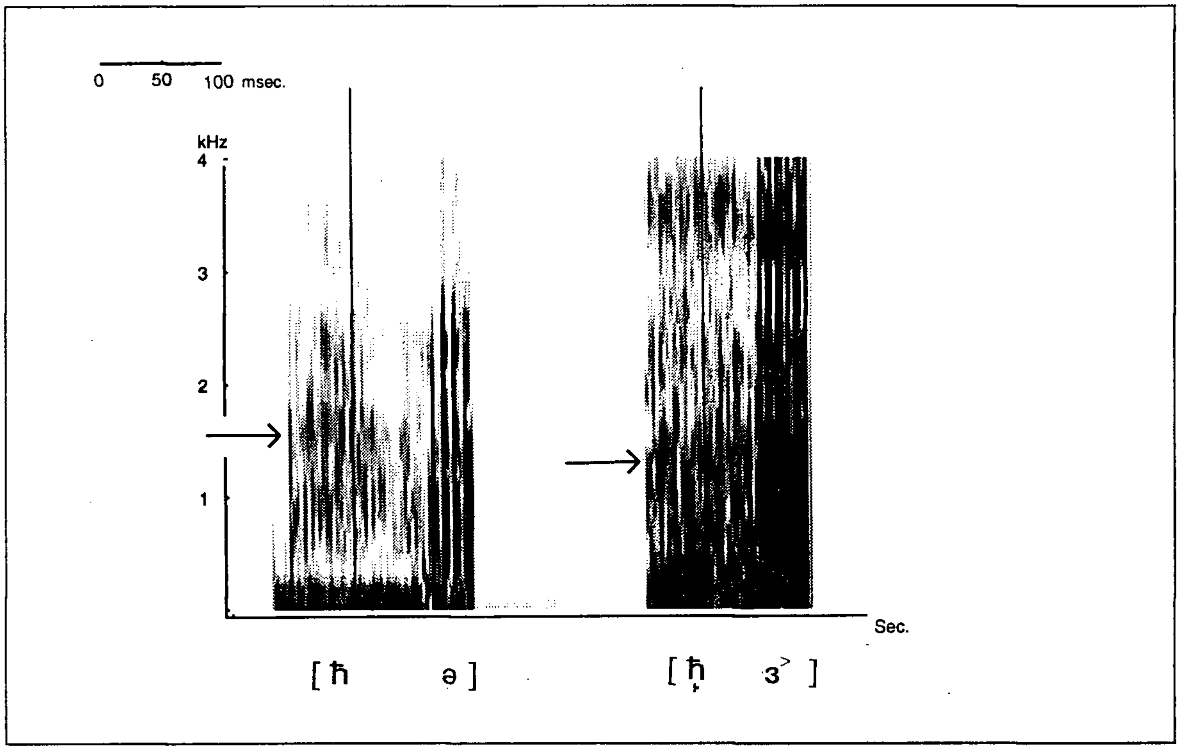


Figure 2:38 Wideband spectrogram showing one token each of {ħ} and {ħ̙}. The token of {ħ} occurred in {ˈma.sɜ.ħ-ə} 'he wiped it (masc.)'; the token of {ħ̙} occurred in {ħ̙ɜ˃.ˈr̙ɐːm̙} 'shame' (N). (Formants measured at the points indicated by the vertical lines.)

F_2 of [ħ] = 1587 Hz.

F_2 of [ħ̙] = 1308 Hz.

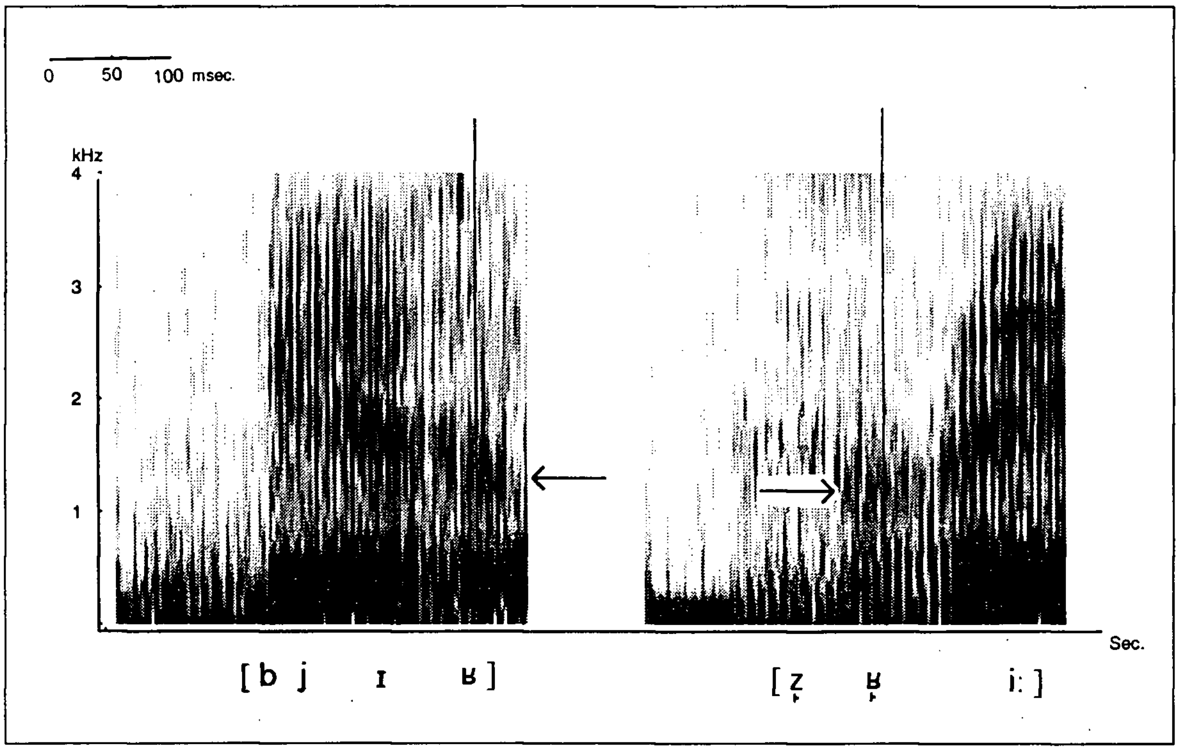


Figure 2:39 Wideband spectrogram showing one token each of {ʁ} and {ʁ̙}. The token of {ʁ} occurred in {ˈb-j-ɪʁ.li} 'he's boiling (something)'; the token of {ʁ̙} occurred in {s̙ʁ̙i:r̙} 'small (masc. sg.'). (Formants measured at the points indicated by the vertical lines.)

F_2 of [ʁ] = 1285 Hz.

F_2 of [ʁ̙] = 1186 Hz.

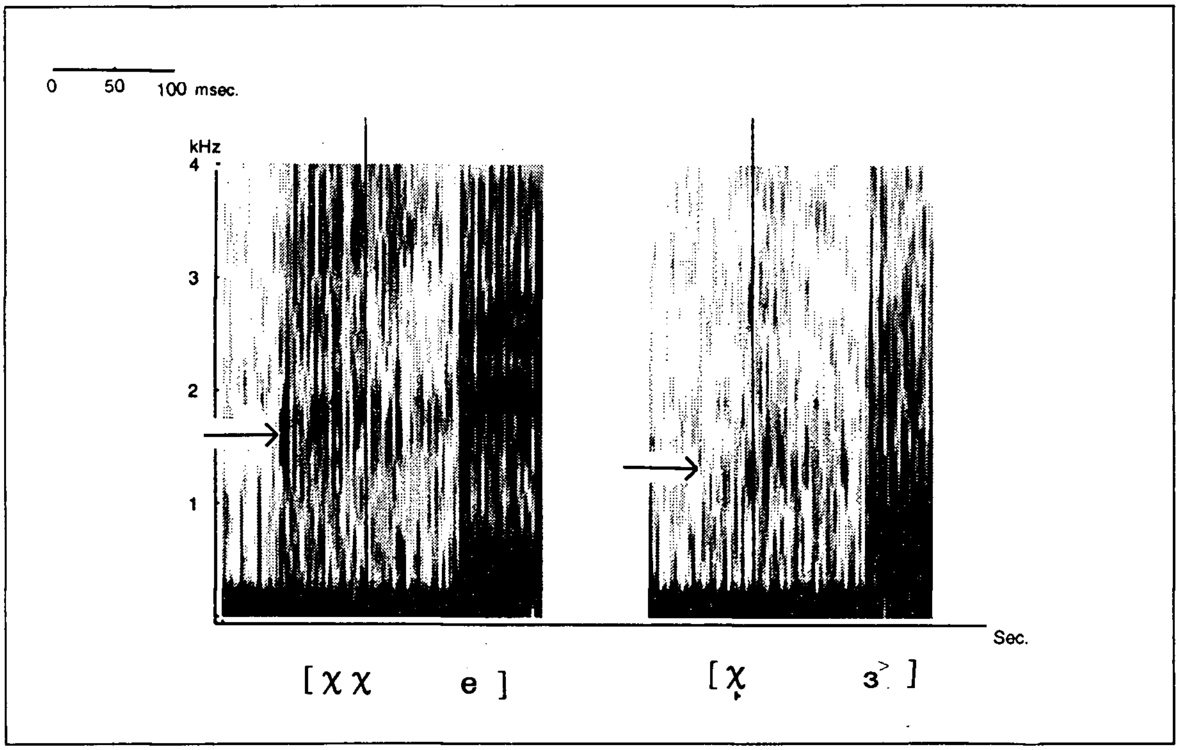


Figure 2:40 Wideband spectrogram showing one token each of {χχ} and {χ̣}. The token of occurred in {mɜ.-ˌʃɜχ.χ-e.-ˈnæː-ʃ} 'we didn't urinate/defecate'; the token of {χ̣} occurred in {ˈʔ̣ʌ̣ṛ.χ̣ɜ˃ṣ} 'cheaper (masc. sg.)'. (Formants measured at the points indicated by the vertical lines.)
F_2 of [χ.χ] = 1587 Hz.
F_2 of [χ̣] = 1314 Hz.

Figures 2:36 - 2:40 show that, for each guttural, the token which occurred in a uvularisation context has a small or medium F_2 drop, compared to F_2 of the token in a non-uvularisation context. This does not match the large F_2 drop expected for segments produced with uvularisation, but the change for F_2 is in the expected direction. For /h ħ χ/, which are produced with invariable frication due to their voicelessness (see §2.2.1.3.1), Figures 2:36, 2:38, and 2:40 show that there is a general downward shift in frequency of the fricative noise for the tokens in a uvularisation context, compared to the tokens in a non-uvularisation context. This downward shift has been reported elsewhere as a characteristic of emphatic fricatives: e.g., Al-Ani (1970:46) reports it for emphatic /ṣ/, compared to nonemphatic /s/. These observations are considered support for an assumption that the guttural tokens that occurred in a uvularisation context were produced with a uvularisation articulation that the tokens in a non-uvularisation context lacked. This lends support to the claim that Palestinian gutturals undergo uvularisation harmony.

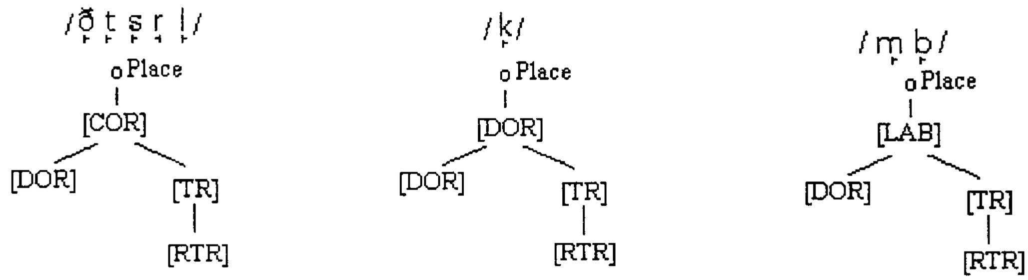
Younes (1993) proposes that Palestinian gutturals are transparent to uvularisation harmony (which he refers to as 'emphasis spread'). McCarthy (1997) solicits instrumental findings to help clarify whether they are transparent or whether they can undergo 'emphasis'. The latter is claimed by Davis (1995). The acoustic findings on gutturals discussed above support Davis' claim.

2.5.2. A Theoretical Account: Part I

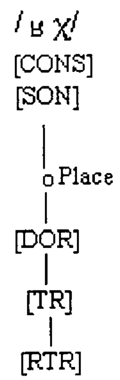
The representations of the Palestinian emphatics as proposed earlier in (47), are repeated in (116). The representation of uvular gutturals, as proposed in (44c), is repeated in (117).

(116) The Representations of Palestinian Emphatics

a. coronal emphatics b. dorsal emphatic c. labial emphatics



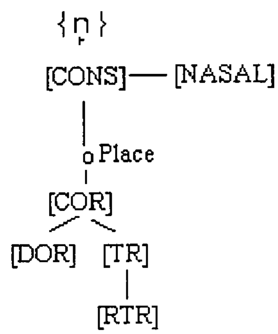
(117) The Representation of Palestinian Uvular Gutturals



The data in (114) showed that uvular gutturals are excluded from the class of uvularisation harmony triggers. On this basis, after the harmony typology proposed in §1.5, Palestinian uvularisation harmony is here analysed as secondary-[DOR] + secondary-[RTR] 'AS' harmony. That is, it is harmony triggered by segments specified for both secondary-[DOR] and secondary-[RTR]. As seen from (116) - (117), this criterion is met only by emphatics.

I propose that a segment which undergoes uvularisation harmony receives specification for both secondary-[DOR] and secondar-[RTR], which are represented with secondary status. This is illustrated for (/n/ >) {ṇ} in (118). The present proposal is that co-occurring secondary-[DOR] and secondary-[RTR] represent secondary uvular articulation. See §2.3.2 for further discussion.

(118)



For the vowels, the addition of [DOR] results in the eight new feature combinations seen boxed in (119), which define eight uvularised vowels. They are specified for both [DOR] and [RTR], which are represented with secondary status. (The basis for this claim with respect to featural status was discussed in §2.3.3.3.) Of the eight new vowels, Palestinian uses the two seen in double box. Given the length distinction for vowels in the language, the gain is the two short vowels {ɑ ʌ} and the long vowel {ɐː}. Short {ʌ} is analysed as underlying /Æ/ arising through loss of [LOW] specification, as discussed in §2.4.3. The full arguments in support of this claim will be presented in §2.6. In §2.4.5, it was shown highly ranked NUCμμ/*RTR prevents the long back vowel from surfacing rtr. Because of this effect, the Palestinian long back vowel surfaces as non-rtr {ɐː}. Under the present representational assumptions, specifically those in (48), this means that the long back vowel is phonologically velarised, not uvularised.

It will be argued in §2.5.6 that all other possible new vowels in (119) are prevented from surfacing in Palestinian by the highly ranked constraint 'HI/*Sec-DOR ∧ Sec-RTR ('A segment specified for [HI] is not specified for secondary-[DOR] and secondary-[RTR]').

(119)

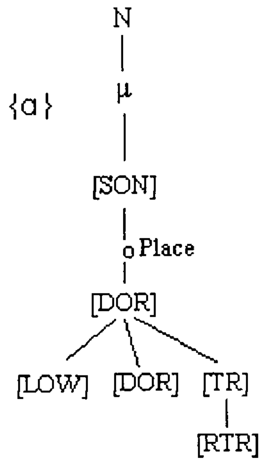
	{ə}	{ɜ}	{ʌ}	{i$_1$}	{ɪ$_1$}	{ᵻ$_1$}	{i$_2$}	{ɪ$_2$}	{ᵻ$_2$}	{æ}	{a}	{ɑ}
HI				+	+	+	+	+	+			
LO										+	+	+
LAB												
RTR		+	+		+	+		+	+		+	+
DOR			+			+			+			+

	{u$_1$}	{ʊ$_1$}	{ʊ$^>{}_1$}	{u$_2$}	{ʊ$_2$}	{ʊ$^>{}_1$}	{e}	{ɛ}	{ɛ$^>$}	{o}	{ɔ}	{ɔ$^>$}
HI	+	+	+	+	+	+	+	+	+	+	+	+
LO							+	+	+	+	+	+
LAB	+	+	+	+	+	+				+	+	+
RTR		+	+		+	+		+	+		+	+
DOR			+			+			+			+

Under the present assumptions, [RTR] is an integral part of the representation of a uvularised segment. Because of this, any uvularised segment is also pharyngealised, as was discussed in §2.3.1. This means that Palestinian's short low back vowel {ɑ} is both uvularised and pharyngealised. This is the basis for the claim made in §2.2.2.2 with respect to the surface vowel inventory in (19), *viz.*, that Palestinian has no non-rtr low back short vowel.

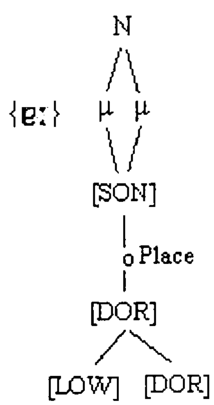
The representation of uvularised {ɑ} is presented below:

(120)



The representation of long back {ɐː} is seen in (121); {ɐː} differs from {æː} by being specified for secondary-[DOR].

(121)



An additional uvularised surface vowel not included in (119) is the uvularised variant of reduced /Æ/: {ɜ˃}, which is represented as in (122). As seen, it has the same representation as {ʌ}.

(122)

	{3˃}
HI	
LO	
LAB	
RTR	+
DOR	+

I propose that the data in (113) - (115) require the constraints in (123), which are ranked with DEP-IO, MAX-RTR, MAX-LINK, DEP-RTR, NUC]$_{Stm}$/*RTR, and NUCμμ/*RTR as seen in (124).

(123) a. ALIGN(Sec-[DOR] ∧ Sec-[RTR], L; Wd, L)
∀word, ∃secondary-[DOR] and ∃secondary-[RTR], the left edge of secondary-[DOR] and the left edge secondary-[RTR] coincide with the left edge of the word.
(The left edge of the word is aligned with the left edge of any secondary-[DOR] and the left edge of any secondary-[RTR].)

b. ALIGN(Sec-[DOR] ∧ Sec-[RTR], R; Wd, R)
∀word, ∃secondary-[DOR] and ∃secondary-[RTR], the right edge of secondary-[DOR] and the right edge secondary-[RTR] coincide with the right edge of the word.
(The right edge of the word is aligned with the right edge of any secondary-[DOR] and the right edge of any secondary-[RTR].)

c. MAX-DOR
Every [DOR] in the input corresponds to a [DOR] in the output.

d. DEP-DOR
Every [DOR] in the output corresponds to a [DOR] in the input.

2.5.2. A Theoretical Account: Part I

(124) DEP-IO, MAX-DOR, MAX-RTR, MAX-LINK, NUC$]_{Stm}$/*RTR, NUC$\mu\mu$ /*RTR, DEP-DOR >>

ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L),
ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], R; Wd, R) >>

DEP-RTR >>

DEP-LINK

ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L) requires that if both secondary-[DOR] and secondary-[RTR] are present in a word, then the left edge of some secondary-[DOR] and the left edge of some secondary-[RTR] should be aligned with the left edge of the word. ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], R; Wd, R) requires the same for the right edge of the word. These constraints are proposed here as syntagmatic Grounding constraints that are grounded in the slow movement of the tongue back and tongue root, an effect which is due to their relative large mass. The phonological consequence of this sluggishness is that secondary-[DOR] and secondary-[RTR] tend to span more than one segment in the word. Since ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L) ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], R; Wd, R) are equally ranked in Palestinian, together they require that co-occurring secondary-[DOR] and secondary-[RTR] span the word. These constraints are conjunctive. For arguments that conjunctive constraints must be recognised, see Hewitt and Crowhurst (1996).

By proposing (123a-b), the present account claims that Palestinian uvularisation harmony is due to constraints which reference secondary-[DOR] and secondary-[RTR] as a unit, not to separate sets of constraints, one requiring alignment of secondary-[DOR], the other requiring alignment of secondary-[RTR]. The basis for this claim will be presented at the end of this section.

The ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR]; Wd) constraints specify the secondary status of the harmonic features [DOR] and [RTR]. I propose that this is the formal machinery by which the harmony is implemented as secondary-[DOR] + secondary-[RTR] 'AS' harmony, that is, harmony (of co-occurring secondary-[DOR] and secondary-[RTR]) triggered only by segments that bear both those features as secondary specifications.

The fact that consonants and vowels undergo Palestinian uvularisation harmony indicates that the anchor for secondary-[DOR] and secondary-[RTR] is the root node. Because the anchor is the root node, the presence or absence of [DOR] and [RTR] on both consonants and vowels is considered when satisfaction of the ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR]; Wd) constraints is evaluated.

Tableaux illustrating the uvularisation harmony resulting from the ranking in (122) are presented in (125) and (126). (IO-FAITH abbreviates MAX-DOR, DEP-IO, MAX-RTR, and MAX-LINK); 'ALIGN-Sec-DOR-Sec-RTR-Wd' abbreviates ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L) and ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], R; Wd, R). All candidates in (126) violate IO-FAITH (DEP-IO) because they contain an epenthetic {ʔ}. That violation is forced by very highly ranked ONS-$_{\mathrm{Wd}}[\sigma$, which is not included in the tableau.)

(125)

input: /tÆzÆ/ / \ [DOR] [RTR] ‘fresh (masc./fem., sg./pl.)’; see (113)	I-O FAITH	NUC]$_{Stm}$/ *RTR	NUCμμ/ *RTR	DEP-DOR	ALIGN-Sec-DOR-Sec-RTR-Wd	DEP-RTR	DEP-LINK
1. {ˈtæ.zə}	*!***						
2. {ˈtæ.zə} / \ [DOR] [RTR]					**!*		
3. {ˈtɑ.zə} [DOR] [RTR]					**!		**
☞ 4. {ˈtɑ.zə} [DOR] [RTR]					*		****
5. {ˈtɑ.zɜ˃} [DOR] [RTR]		*!					**** **
6. {ˈtɑ.zə˃} [DOR] [RTR]					*		**** *!

(126)

input: /ÆbÆ:t/ [DOR] [RTR] 'to hug'; 'hug' (N); see (113)	I-O FAITH	NUC]$_{Stm}$/ *RTR	NUCμμ/ *RTR	DEP-DOR	ALIGN-Sec-DOR-Sec-RTR-Wd	DEP-RTR	DEP-LINK
1. {ʔə.ˈbæːt}	**!***						
2. {ʔə.ˈbæːt} [DOR] [RTR]	*				**!**		
3. {ʔə.ˈbɑːt} [DOR] [RTR]	*		*!		***		**
4. {ʔə.ˈbɑːt} [DOR] [RTR]	*		*!		**		****
5. {ʔɜ˞.ˈbɑːt} [DOR] [RTR]	*		*!		*		**** **
6. {ʔɜ˞.ˈbɑːt} [DOR] [RTR]	*		*!				**** ****
☞ 7. {ʔɜ˞.ˈbɐːt} [DOR] [RTR] [RTR]	*				*	*	**** ***
8. {ʔə˞.ˈbɐːt} [DOR] [RTR]	*				****		****
9. {ʔɜ˞.ˈbæːt} [DOR] [RTR] [DOR] [RTR]	*			*!	*	*	**** **

2.5.2. A Theoretical Account: Part I

The ranking of MAX-DOR, MAX-RTR, MAX-LINK over the ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR]; Wd) constraints is established by the winning candidates (125) - (126). In each winner, the emphatic surfaces linked to [DOR] and [RTR]. If the MAX constraints were not ranked above the alignment constraints, or if the two sets of constraints were equally ranked, the alignment constraints could be vacuously satisfied by deletion of [DOR] and [RTR] and their links with the emphatic. However, such deletion is non-optimal, as shown by the losing candidates 1 in each tableau.

The winning candidate 4 in (125) contains a non-harmonising final vowel, in violation of the ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR]; Wd) constraints but in satisfaction of NUC$]_{Stm}$/*RTR. This shows that violation of the ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR]; Wd) constraints is less serious than violation of NUC$]_{Stm}$/*RTR. The losing candidate 6 in the same tableau shows that partial harmony for the final vowel, a link with [DOR], is non-optimal because it results in an additional DEP-LINK violation.

The winning candidate 7 in (126) contains a partially-harmonising long vowel: the long vowel is linked with [DOR] but not with [RTR]. This violates the ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR]; Wd) constraints but satisfies NUC$\mu\mu$ /*RTR. This shows that violation of the the ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR]; Wd) constraints is less serious than violation of NUC$\mu\mu$/*RTR. In the losing candidate 9 in (124), the long vowel is not linked to [DOR]. However, this forces a DEP-DOR violation, as an additional instance of [DOR] is then necessary in order for the first three segments in the word to satisfy the the ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR]; Wd) constraints. The fact that candidate 9 loses shows that violation of DEP-DOR is more serious than violation of the the ALIGN(Sec-[DOR] ∧ Sec-[RTR]; Wd) constraints.

The foregoing observations establish the ranking NUC]$_{Stm}$/*RTR, NUCμμ/*RTR, DEP-DOR >> ALIGN(Sec-[DOR] ∧ Sec-[RTR], L; Wd, L), ALIGN(Sec-[DOR] ∧ Sec-[RTR], R; Wd, R).

Candidate 7 in (126) contains an additional instance of [RTR] so the first three segments in the surface form can link to [RTR]. This satisfies ALIGN(Sec-[DOR] ∧ Sec-[RTR], L; Wd, L) but violates DEP-RTR. The fact that candidate 7 is optimal shows that violation of DEP-RTR is less serious than violation ALIGN(Sec-[DOR] ∧ Sec-[RTR], L; Wd, L). This establishes ALIGN(Sec-[DOR] ∧ Sec-[RTR], L; Wd, L) >> DEP-RTR. ALIGN(Sec-[DOR] ∧ Sec-[RTR], R; Wd, R) is assumed to also dominate DEP-RTR. (In the surface form of /ÆbÆːt̙/, {ʔ̙ɜ˃.ˈb̙ɐːt̙}, the word-initial glottal stop is epenthetic. As it is epenthetic, it is assumed not to have an intrinsic [RTR] specification. This means that an inserted [RTR] is necessary, as occurs in candidate 7.)

Pulleyblank (1994a) argues that transparency effects derive from a higher ranking of constraints requiring featural alignment over constraints against feature insertion. In the winner (126), long /Æː/ shows partial transparency to uvularisation harmony: it does not link with one of the uvularisation harmony features, [RTR], but the three segments leftward of /Æː/ nevertheless do. The above account of this partial transparency follows Pulleyblank's approach.

The lowest ranking of DEP-LINK is established by the winning candidates in both tableaux. The winners contain several non-underlying links to [DOR] and [RTR] in (the best possible) satisfaction of the alignment constraints, but in multiple violation of DEP-LINK. This shows that violation of DEP-LINK is less serious than violation of the alignment constraints, and establishes the ranking ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L), ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], R; Wd, R) >> DEP-LINK.

Finally, the ranking DEP-RTR >> DEP-LINK was established in §2.4.6.

The remainder of this section presents the basis for the present claim that uvularisation harmony is imposed by conjunctive alignment constraints, which reference the features secondary-[DOR] and secondary-[RTR] as a unit. It will be argued below that non-conjunctive constraints would lead to an inadequate overall account of Palestinian postvelar harmony.

An alternative account of Palestinian uvularisation harmony would propose the constraints in (127) and the ranking in (128).

(127) a. ALIGN(Sec-[DOR], L; Wd, L)
$\forall$word, $\exists$secondary-[DOR], then the left edge of secondary-[DOR] and the left edge of the word coincide.
(The left edge of the word is aligned with the left edge of any secondary-[DOR].)

b. ALIGN(Sec-[DOR], R; Wd, R)
$\forall$word, $\exists$secondary-[DOR], then the right edge of secondary-[DOR] and the right edge of the word coincide.
(The right edge of the word is aligned with the right edge of any secondary-[DOR].)

c. ALIGN(Sec-[RTR], L; Wd, L)
$\forall$word, $\exists$secondary-[RTR], then the left edge of secondary-[RTR] and the left edge of the word coincide.
(The left edge of the word is aligned with the left edge of any secondary-[RTR].)

d. ALIGN(Sec-[RTR], R; Wd, R)
∀word, ∃secondary-[RTR], then the right edge of secondary-[RTR] and the right edge of the word coincide.
(The right edge of the word is aligned with the right edge of any secondary-[RTR].)

(128) DEP-IO, MAX-DOR, MAX-RTR, MAX-LINK, $NUC]_{Stm}$/*RTR, NUCμμ /*RTR, DEP-DOR >>

ALIGN(Sec-[DOR], L; Wd, L), ALIGN(Sec-[DOR], R; Wd, R), ALIGN(Sec-[RTR], L; Wd, L), ALIGN(Sec-[RTR], R; Wd, R) >>

DEP-RTR >>

DEP-LINK

ALIGN(Sec-[DOR], L; Wd, L) requires that if secondary-[DOR] is present in a word, then the left edge of some secondary-[DOR] should be aligned with the left edge of the word. ALIGN(Sec-[DOR], R; Wd, R) requires the same for the right edge of the word. Parallel edge alignments are required for [RTR] by ALIGN(Sec-[RTR], L; Wd, L) and ALIGN(Sec-[RTR], R; Wd, R). These four constraints would be assumed equal ranking so that together they require secondary-[DOR] and secondary-[RTR] to span the word.

The ranking in (128) produces the constraint interaction illustrated in (129). ('ALIGN-Sec-DOR-Wd' abbreviates ALIGN(Sec-[DOR], L; Wd, L) and ALIGN(Sec-[DOR], R; Wd, R); 'ALIGN-Sec-RTR- Wd' abbreviates ALIGN(Sec-[RTR], L; Wd, L) and ALIGN(Sec-[RTR], R; Wd, R).)

(129)

input: /ÆbÆ:t/ / \ [DOR] [RTR] 'to hug'; 'hug' (N); see (113)	I-O FAITH	NUC]Stm/ *RTR	NUC μμ/ *RTR	DEP-DOR	ALIGN-Sec-DOR-Wd	ALIGN-Sec-RTR-Wd	DEP-RTR	DEP-LINK
1. {ʔə.ˈbæːt}	**! ***							
2. {ʔə.ˈbæːt} / \ [DOR] [RTR]	*				**!**	****		
3. {ʔə.ˈbɑːt} [DOR] [RTR]	*		*!		**!*	***		**
4. {ʔə.ˈbɑːt} [DOR] [RTR]	*		*!		**!	**		****
5. {ʔɜ˃.ˈbɑːt} [DOR] [RTR]	*		*!		*	*		******
6. {ʔɜ˃.ˈbɑːt} [DOR] [RTR]	*		*!					********
☞7. {ʔɜ˃.ˈbɐːt} [DOR] [RTR] [RTR]	*					*	*	*******
8. {ʔɜ˃.ˈbɐːt} [DOR] [RTR]	*					**!**		****
9. {ʔɜ˃.ˈbæːt} [DOR] [DOR] [RTR] [RTR]	*			*!	*	*	*	******

This alternative account is adequate for uvularisation harmony. As seen, (129) predicts the grammatical surface form to be optimal. The problem emerges once pharyngealisation harmony is also considered. For Palestinian pharyngealisation harmony, this account predicts transparency where opacity is what is actually observed. This will now be explained.

In §2.4.5, it was shown that long vowels block pharyngealisation harmony; e.g. in /dInÆːr̙/ {d̙i.ˈn̙ɐːr̙}'dinar', the initial-syllable {i} is blocked from harmonising with {r̙} by the intervening long {ɐː}. In §2.4.6, this was argued to follow from the fact that (i) [RTR] cannot align with a short vowel if there is an intervening long vowel: if it did, the resulting configuration would be non-optimal because it would be gapped; (ii) insertion of an additional instance of [RTR] in order for the short vowel to align with [RTR] is ruled out by the ranking DEP-RTR >> ALIGN([RTR], L; Wd, L), ALIGN([RTR], R; Wd, R).

Thus, assuming the non-conjunctive uvularisation alignment constraints in (127), the pharyngealisation harmony ranking which is predicted is:

(130) DEP-IO, MAX-DOR, MAX-RTR, MAX-LINK, NUC$]_{Stm}$/*RTR, NUCμμ /*RTR, DEP-DOR >>

ALIGN(Sec-[DOR], L; Wd, L), ALIGN(Sec-[DOR], R; Wd, R), ALIGN(Sec-[RTR], L; Wd, L), ALIGN(Sec-[RTR], R; Wd, R) >>

DEP-RTR >>

ALIGN([RTR], L; Wd, L), ALIGN([RTR], R; Wd, R) >>

DEP-LINK

2.5.2. A Theoretical Account: Part I

Notice that in (130), there are two sets of constraints which require [RTR] alignment: the ALIGN(Sec-[RTR]; Wd) constraints, which require the aligning [RTR] to have secondary status, and the ALIGN([RTR]; Wd) constraints, which do not require it to have a particular (primary or secondary) status. Futher notice that the ALIGN(Sec-[RTR]; Wd) constraints dominate DEP-RTR. This means that any blocking that might have resulted from DEP-RTR >> ALIGN([RTR]; Wd) will be nullified by ALIGN(Sec-[RTR]; Wd) >> DEP-RTR. This is illustrated in (130), which is the tableau in (109) with the ALIGN(Sec-[RTR]; Wd) constraints added into the pharyngealisation harmony ranking. Candidate outputs which are not the actual surface form are marked with '*'. (Secondary-[DOR] specifications and DEP- LINK violations resulting from non-underlying links with secondary-[DOR] are ignored in (131).)

(131)

input: /dInÆ:r̙/ | [RTR] 'dinar'; see (97), (101)	I-O FAITH	NUC]$_{Stm}$/ *RTR	NUCμμ / *RTR	NUC-C]$_σ$/ RTR	ALIGN ([RTR], NUC)	ALIGN-Sec-RTR-Wd	DEP-RTR	ALIGN-RTR-Wd	DEP-LINK
1.{d̙i.ˈn̙ɐːr̙} | [RTR]				*	**	**!		**	
2.*{d̙i.ˈn̙ɑːr̙} \ | [RTR]			*!		*	*		*	*
3.*{d̙ɪ.ˈn̙ɑːr̙} \ \ | [RTR]			*!		*				**
4.*{d̙ɪ.ˈn̙ɑː.rɪ} \ | |/ [RTR]	*!	*	*						***
☞ 5.*{d̙ɪ.ˈn̙ɐːr̙} | | [RTR] [RTR]				*	**	*	*	*	*

As seen from the optimal candidate 5, the net effect of the ranking in (130) is that long vowels are transparent to pharyngealisation harmony. However, opacity is what is actually observed: candidate 1 is the actual surface form. On this basis, an account of uvularisation harmony in terms of alignment constraints that reference secondary-[RTR] and secondary-[DOR] separately is considered inadequate. It is concluded that uvularisation harmony is imposed by constraints that reference those features as a unit. This indicates that the phonology refers to co-occurring secondary [RTR] and secondary-[DOR], which has been proposed in this thesis as the representation of uvularisation articulation.

2.5.3. Opaque Post-alveolar Obstruents

2.5.3.1. Analysis

The post-alveolar obstruents /ʃ ʧ ʤ/ are opaque to uvularisation harmony. That is, they do not undergo it and they block its progression in the word. This is seen from the data in (132). (A tableau for (132a) will be presented in §2.5.4.)

(132)

a. /ʕÆʃÆr̙Æ/ {ˈʕa.ʃɜ˃.r̙ə} (*{ˈʕ̙ɑ.ʃ̙ɜ˃.r̙ə}) ‘ten’

b. /ʕÆt̙ʃÆːn/ {ʕ̙ɜ˃t̙.ˈʃæːn} (*{ʕ̙ɜ˃t̙.ˈʃ̙ɐːn̙}) ‘thirsty (masc. sg.)’

c. /mÆ-sÆʧʧÆr̙-hÆ-ʃ/ {mɜ.-ˌsɜʧ.ʧɜ˃r̙.-ˈh̙ɐː-ʃ} (*{m̙ɜ˃.-ˌs̙ɜʧ̙.ʧ̙ɜ˃r̙.-ˈh̙ɐː-ʃ̙})
‘he didn’t close it (fem.)’

d. /mÆ-r̙ÆʤʤÆʕ-nÆ-ʃ/ {m̙ɜ˃.-ˌr̙ɜ˃ʤ.ʤɜʕ.-ˈnæː-ʃ} (*{m̙ɜ˃.-ˌr̙ɜ˃ʤ̙.ʤ̙ɜ˃ʕ̙.-ˈn̙ɐː-ʃ̙})
‘we didn’t return (it)’

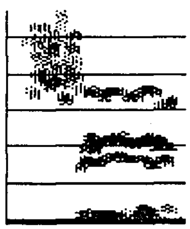
In certain forms, a non-root-internal, geminate /jj/ blocks the harmony, as seen in (133). (In the present corpus, the only exceptional forms of this type involve the suffix /-jjÆ/.)

(133) /t̙ÆbÆχ-l-nÆ-jjÆ-h/ {t̙ɜ˃.b̙ɜ˃.ˌχ-ɪ̙l̙.-n̙ə-j.ˈjæː-h}(*{t̙ɜ˃.b̙ɜ˃.ˌχ-ɪ̙l̙.-n̙ə-j̙.ˈj̙ɐː-h̙})
‘he cooked it (masc.sg.) for us’

The form in (134) contrasts with those seen earlier in (113h-k), in which /j(j)/ undergoes the uvularisation harmony. The data in (113h-k) are repeated below:

(134)	a. /ʕÆjÆːt̙/	{ʕ̙ai.ˈj̙eːt̙}	'crying' (N)
	b. /s̙jÆːm/	{s̙j̙eːm̙}	'fasting' (N)
	c. /r̙ÆjjÆħ/	{ˈr̙aij̙.j̙ɜ˃ħ̙}	'he rested'
	d. /t̙ÆjjÆb-Æt-nI/	{ˌt̙aij̙.j̙ɜ˃.ˈb̙-ʌt̙.-n̙i}	'she made me become well'

A theoretical account of the variable behaviour of Abu Shusha geminate /jj/, seen by forms such as that in (133), compared to forms such as those in (134c-d), will not be undertaken in this thesis.



2.5.3.2. Acoustic Support

This section readdresses the graphs on Palestinian /Æ/ and /Æː/ in uvularisation harmony contexts, presented earlier in Figures 2:32 and 2:33. The tokens of interest now are those in the blocked context. The blocked context tokens occurred in a word containing an emphatic, with a post-alveolar obstruent or /jj/ in /-jjÆ/ intervening between the vowel and an underlying emphatic. Figures 2:32 and 2:33 show that the tokens of /Æ/ and /Æː/ in the blocked context fall within the higher-F_2 region and are perceptually [æ] and [æː], respectively. They do not have a lowered F_2, as observed for the emphatic + open syllable and emphatic + closed syllable tokens in the graphs. This supports the assumption that the blocked tokens were not produced with uvularisation articulation.

This, in turn, supports the phonological claim that post-alveolar obstruents and /jj/ in /-jjÆ/ block Palestinian uvularisation harmony.

Figure 2:41 presents a wideband spectrogram showing two tokens of /t/ > {t}. The token on the right occurred in a blocked context. The caption reports the carrier form for each token and the frequency of the burst of each [t].

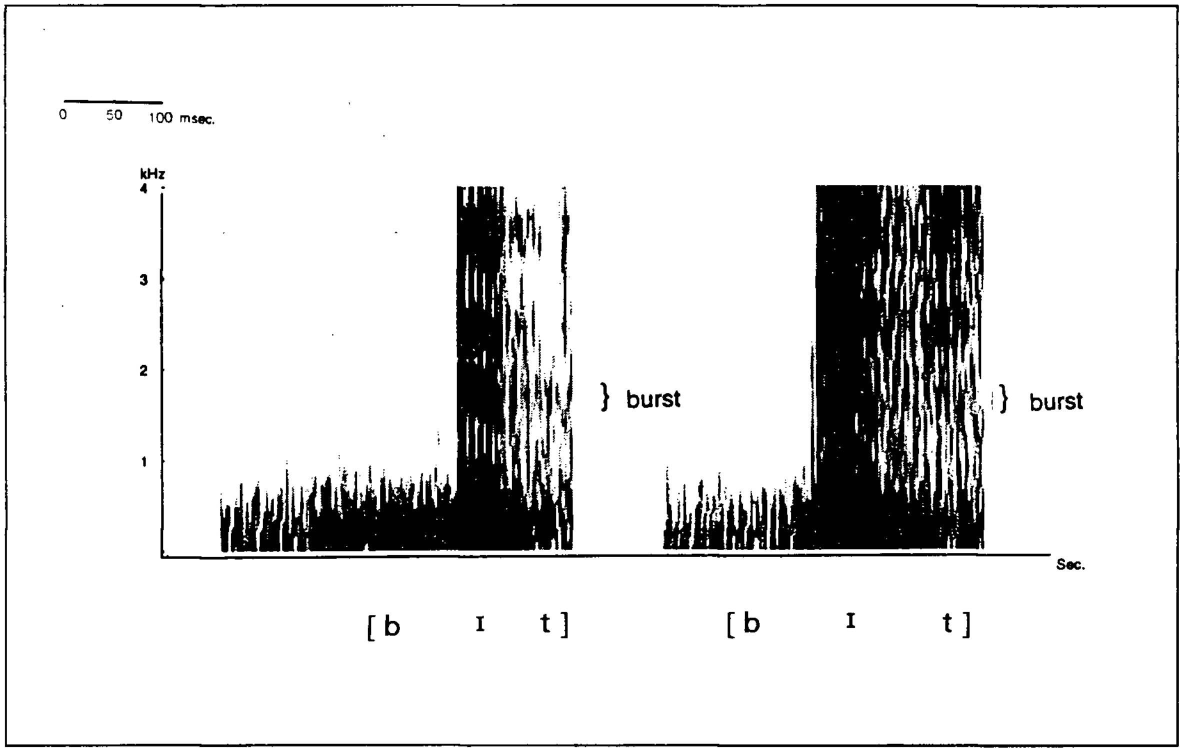


Figure 2:41 Wideband spectrogram showing one token each of {t} in a word containing no emphatic, and blocked {t}. The token on the left is a token of {t} in {b-ɪt.-ˈʕɪdd} 'she's counting'; the one on the right is a token of blocked {t} in {b-ɪt.-ˈmæʃ.ʃɪṭ} 'she's combing'.
Burst of the [t] on the left = 1668 Hz.
Burst of blocked [t] = 1625 Hz.

The figure above shows there is no downward shift in the resonance of the burst of the token of blocked {t}. This contrasts with surface emphatic {ṭ}: a downward shift was observed for a token of {ṭ} in Figure 2:34. That is, the token of blocked {t} does not have the lowered resonance expected for a uvularisation articulation. This supports the assumption that the blocked token in Figure 2:41 was not produced with uvularisation. This, in turn, further supports the phonological claim that post-alveolar obstruents block Palestinian uvularisation harmony.

2.5.4. A Theoretical Account: Part II

I propose that the representation of the Palestinian post-alveolar obstruents /ʃ ʧ ʤ/ is as seen in (135). (Only specifications relevant to the discussion are shown.)

(135) The Representation of the Palestinian Post-alveolar Obstruents /ʃ ʧ ʤ/

```
/ʃ ʧ ʤ/
[CONS]
   |
   o Place
   |
 [DOR]
   |
[FRONT]
```

I further propose that the constraint in (136) figures crucially in Palestinian to derive the opacity illustrated in (132).

(136) FRONT/*Sec-DOR ∧ Sec-RTR

A segment specified for [FRONT] is not specified for secondary-[DOR] and secondary-[RTR].

This constraint is proposed as a paradigmatic Grounding constraint which is grounded in the incompatibility of simultaneous fronted and uvularised gestures. Note that vowels which can be described 'front' along abstract or articulatory dimensions do not block uvularisation harmony in (Abu Shusha) Palestinian. The present claim is that in Palestinian, a segment specified for the phonological feature [FRONT] cannot also be specified for secondary-[DOR] and secondary-[RTR]. However, assuming the representations in (58) none of the Palestinian vowels is specified for [FRONT]. Furthermore, to my knowledge, there is no evidence that (Abu Shusha) Palestinian vowels ever receive specification for [FRONT]. Because the vowels do not bear [FRONT], they do not block uvularisation harmony.

Data such as those in (132) indicate the ranking:

(137) DEP-IO, MAX-DOR, MAX-RTR, MAX-LINK, NUC]$_{Stm}$/*RTR,
NUC$\mu\mu$ /*RTR, DEP-DOR, FRONT/*Sec-DOR $\wedge$ Sec-RTR >>

ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L),
ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], R; Wd, R) >>

DEP-RTR >>

DEP-LINK

The tableau in (138) illustrates the opacity effects which result from this ranking. (Each candidate in this tableau contains an initial-syllable rtr {a}. The {a} is linked to the [RTR] of {ʕ} (for which {ʕ} is underlyingly specified), in satisfaction of ALIGN([RTR], NUC), which is omitted in the tableau. (In the losing candidates 8 - 10, {a} is also linked to the [RTR] of {r}.) The additional instance of [RTR] which is linked to {a} and {ʕ} is omitted for all the candidates; ALIGN([RTR], NUC) is omitted in the tableau.)

(138)

input: /ʕÆʃÆrÆ/ [DOR] [RTR] 'ten' (see 132)	I-O FAITH	NUC]$_{Stm}$/ *RTR	NUCμμ/ *RTR	DEP-DOR	FRONT/ *Sec-DOR ∧ Sec-RTR	ALIGN-Sec-DOR-Sec-RTR-Wd	DEP-RTR	DEP-LINK
1. {ˈʕa.ʃə.rə}	**!**							
2. {ˈʕa.ʃə.rə} [DOR] [RTR]						*****!		
3. {ˈʕa.ʃə.rɜ˃} [DOR] [RTR]		*!				****		**
4. {ˈʕa.ʃə.rə˃} [DOR] [RTR]						*****!		*
☞ 5. {ˈʕa.ʃɜ˃.rə} [DOR] [RTR]						****		**
6. {ˈʕa.ʃɜ˃.rə} [DOR] [RTR]						****		***!
7. {ˈʕa.ʃɜ˃.rə} [DOR] [RTR]					*!	***		****
8. {ˈʕɑ.ʃɜ˃.rə} [DOR] [RTR]					*!	**		******
9. {ˈʕɑ.ʃɜ˃.rə} [DOR] [RTR]					*!	*		********
10. {ˈʕɑ.ʃɜ˃.rə} [DOR] [DOR] [RTR]				*!		**		*******

2.5.4. A Theoretical Account: Part II

In the winning candidate 5, /ʃ/ does not bear specification for secondary-[DOR] and secondary-[RTR]. This results in more violations of the ALIGN(Sec-[DOR] ∧ Sec-[RTR]; Wd) constraints than for the losing candidates 7-9, in which /ʃ/ is linked to those features. However, candidate 5 satisfies FRONT/*Sec-DOR ∧ Sec-RTR. This shows that violation of the alignment constraints is less serious than violation of FRONT/*Sec-DOR ∧ Sec-RTR, and establishes FRONT/*Sec-DOR ∧ Sec-RTR >> ALIGN(Sec-[DOR] ∧ Sec-[RTR], L; Wd, L), ALIGN(Sec-[DOR] ∧ Sec-[RTR], R; Wd, R).

As shown in §2.4.6 with respect to stem-final and long vowels in Palestinian pharyngealisation harmony, opacity derives from the ranking of DEP-F over word-alignment. This is so for the opacity observed in forms such as those in (132), as will now be explained.

The losing candidate 10 contains an inserted [DOR] so /ʕÆ/ can link to those features in greater satisfaction of the ALIGN(Sec-[DOR] ∧ Sec-[RTR]; Wd) constraints than the winning candidate 5. The additional [DOR] violates DEP-DOR. The fact that candidate 10 is non-optimal shows that violation of DEP-DOR is more serious than violation of the alignment constraints. This establishes the ranking DEP-DOR >> ALIGN(Sec-[DOR] ∧ Sec-[RTR], L; Wd, L), ALIGN(Sec-[DOR] ∧ Sec-[RTR], R; Wd, R). The surface effect of this is the post-alveolar opacity observed in the winning candidate 5, which contains no inserted [DOR].

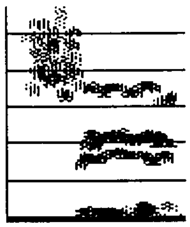
2.5.5. Transparent Non-low Vowels

2.5.5.1. Analysis

Palestinian non-low vowels are transparent to uvularisation harmony: they do not undergo it and they do not block it. Data illustrating this are presented in (139). Abu Shusha differs in this regard from other Palestinian dialects: Card (1983) and Davis (1995) show that high vowels block uvularisation harmony in some other Palestinian dialects; this will be discussed in §2.5.7. (A tableau for (139a) will be presented in §2.5.6.)

(139) a. /ṣUbb/	{ṣʊbḅ}	(*{ṣʊ˃bḅ})	'to pour'
b. /mUhṛ-Æːt/	{mʊ.hʊ.ˈṛ-ɐːṭ}	(*{mʊ˃.hʊ˃.ˈṛ-ɐːṭ)	'colts'
c. /fIð̣I/	{ˈfɪ.ð̣i}	(*{ˈfɪ.ð̣ɨ})	'emptied (masc. sg.)' (Adj)
d. /nð̣Iːf/	{ṇ.ˈð̣iːf}	(*{ṇ.ˈð̣ɨːf})	'clean (masc. sg.)' (Adj)
e. /b-ʕÆṭI-nÆ-ʃ/	{ˌḅ-ʕɜ˃.ṭi.-ˈṇɐː-ʃ}	(*{ˌḅ-ʕɜ˃.ṭɨ.-ˈnɐː-ʃ})	'he doesn't give (something) to us'

The evidence that non-low vowels do not undergo uvularisation harmony is phonetic. It will be discussed next.



2.5.5.2. Acoustic Support

This section presents data on Palestinian non-low vowels in a uvularisation context. Our focus will be on F_2, as the present dataset indicates that an F_2 drop is the most salient formant effect for segments which are presumably produced with uvularisation. It will be shown that, contrasting with the steady lowered F_2 observed for tokens of the low vowel in a uvularisation context, illustrated in Figure 2:34, no steady lowered F_2 is observed for non-low vowels in that context. This is noted by Al-Ani (1970) for Classical Arabic, and by Younes (1982, 1993) and Herzallah (1990) for Palestinian. Following Younes (1982) and Herzallah, it will be argued that the lack of a steady lowered F_2 for tokens of the non-low vowels is acoustic support for analysing the effect of a uvularisation context on non-low vowels as solely phonetic. This is the basis for the claim, made above, that Palestinian non-low vowels do not undergo uvularisation harmony.

Younes (1993:124) states: "two distinct variants of [the low] vowels are easily identifiable: back $\underline{a}$ (and its long counterpart $\underline{aa}$), and front *a* (with its long counterpart *aa*). This is not the case with respect to the other vowels where emphatic influence is generally marked by a transition into or from the emphatic, rather than by an entirely different target." (Younes' underlining, which denotes emphasis, is retained here.) Younes (1982) reports a lowered F_2 onset for non-low vowels immediately following an emphatic, but also reports that F_2 for those vowels rises toward its usual (non-uvularised) value after the onset transition. For example, his description [p.139] of the effect of emphasis on tokens of long /Iː/ is as follows:

> "The influence on ii is obviously phonetic, i.e., no target back ii is observed but backing is manifested only in the low F2 frequency in the portions of the vowel adjacent to the emphatic consonant. That frequency goes up in the rest of the vowel duration. On the other hand, the low vowels show steady state low F2 values throughout their duration next to an emphatic consonant."

Further interpreting the data of Younes (1982), Herzallah [p.68-69] states:

> "The vowels /ee/ and /ii/ are not affected to as great a degree in an emphatic environment. The vowels /ee/ [sic] in the word [seef]... and the vowel /ii/ in the word [tiin]... show a sharp upward F_2 transition which starts at about 1000 Hz and lasts for about one third of the segmental duration of the vowel until it reaches a steady state frequency at about 2000 Hz."

Herzallah cites Younes' (1982) observation that F_2 onset for tokens of /Uː/ shows no transition in the environment of an emphatic. The data on Palestinian /Uː/ presented earlier in Figure 2:31 indicate that F_2 is very low for an unconditioned [uː]. Younes's observation indicates that there may be some minimum limit on F_2 for Palestinian [uː], just as there may be an F_2 ceiling for Palestinian [æ], as hypothesised in §2.4.3.2. However, this hypothesis regarding [uː] will be developed no further here.

Herzallah continues [p.69]:

2.5.5. Transparent Non-low Vowels

> "Perceptually... only [a] is distinct from [ɑ], and no equivalent distinction is noticed in the case of /i/ and /u/... It is true that /i/ and /u/ next to the emphatic sound are auditorily darker and louder when compared to the plain non-emphatic counterparts, but no two distinct vocalic qualities are recognized by speakers of the language for either pair. It is only in the case of the low vowel that two steady state targets are recognized. The same generalisation holds of the long vowels /ii/, /ee/ and /uu/. There is only one target for these, although the first two show the sharp rise in their F_2 onset as mentioned before." [Herzallah denotes front æ as 'a'.]

Figures 2:42 - 2:43 show wideband spectrograms of tokens of non-emphatic/ emphatic {.CV}/{.C̙V} pairs, where 'C̙' = an emphatic, and 'V' = a non-low vowel. These pairs present the non-low vowels in a non-uvularisation and uvularisation context, respectively. The carrier forms are indicated in the figure captions, which also records F_2 for the vowel in the CV token (measured at midpoint), and F_2 for the vowel in the C̙V token, measured at the vowel onset and at the third quarter of the vowel.

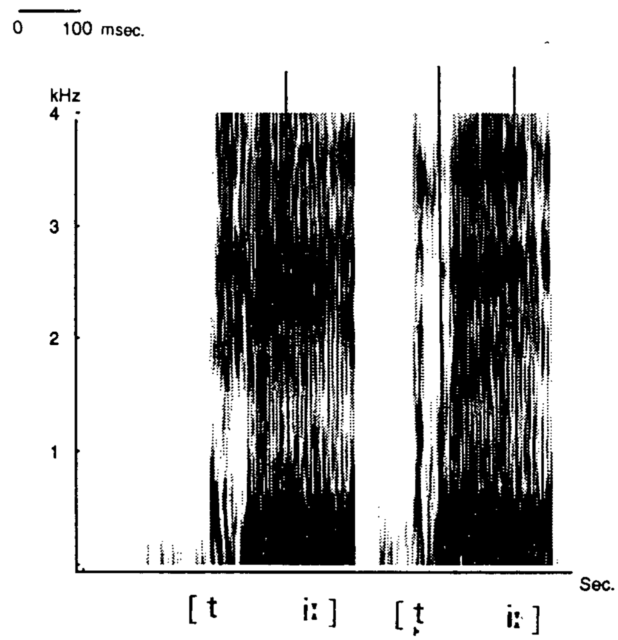


Figure 2:42 Wideband spectrogram of one token each of {tiː} and {ṭiː}. The token of {tiː} occurred in {tiːn} 'figs'; the token of {ṭiː} occurred in {ṭiːṇ} 'mud'. (Formants measured at the points indicated by the vertical lines.)

F_2 of [iː] in {tiː} = 2285 Hz.

F_2 of [iː] in {ṭiː} at onset = 1492 Hz, at third quarter = 2055 Hz.

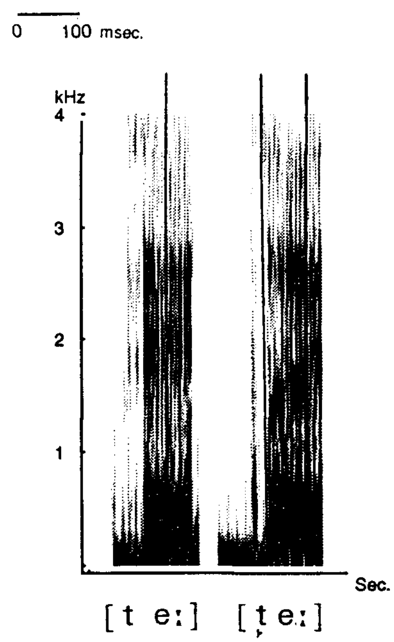


Figure 2:43 Wideband spectrogram of one token each of {teː} and {t̙eː}. The token of {teː} occurred in in {ˌfɜ.rɪʃ.ˈt-eː.-n-i} 'my two mattresses'; the token of {t̙eː} occurred in {mɪʃ.ˈt̙-eː.-n̙-i} 'my two combs'). (Formants measured at the points indicated by the vertical lines.)
F_2 of [eː] in {teː} = 1922 Hz.
F_2 of [eː] in {t̙eː} at onset = 1234 Hz, at third quarter = 1743 Hz.

The {.CV} tokens in Figures 2:42 - 2:43 illustrate the usual high F_2 of Palestinian [iː] and [eː] in a non-uvularisation context. However, as seen, the F_2 trajectory of the vowel in the {.C̙V} tokens is never steady, going from lower at onset to near target by the third quarter of the vowel. That the tokens of non-low vowels do not have a steady lowered F_2 is interpreted as showing that those vowels have not reached and maintained a lowered F_2 target. This is interpreted as showing that the effect of uvularisation on the non-low vowel tokens is not the implementation of a discrete phonological feature, but a non-discrete effect imposed solely in the phonetics. See §1.7.1 for discussion of non-discreteness as a criterion for identifying phonetic vs. phonological status for a given sound property.

Thus interpreted, the data in Figures 2:42 - 2:43 support the phonological claim that Palestinian non-low vowels do not undergo uvularisation harmony. This contrasts with data on the low vowels in a uvularisation context: as discussed in §2.5.1.1 with respect to Figure 2:34, a steady lowered F_2 is observed for such low vowel tokens; on that basis, the effect of a uvularisation context on low vowels was interpreted as the implementation of the phonological features secondary-[DOR] and secondary-[RTR].

2.5.6. A Theoretical Account: Part III

I propose that the data in (139) require the constraints in (140). (See Padgett 1995:407 for a schematic formulation of NO-GAP.)

(140) a. HI/*Sec-DOR $\wedge$ Sec-RTR
A segment specified for secondary-[DOR] and secondary-[RTR] is not specified for [HIGH].

b. NO-GAP
A multiply-linked feature is linked to adjacent segments.

This section will argue for the ranking:

2.5.6. A Theoretical Account: Part III

(141) DEP-IO, MAX-DOR, MAX-RTR, MAX-LINK, NUC]$_{Stm}$/*RTR, NUC$\mu\mu$ /*RTR, DEP-DOR, FRONT/*Sec-DOR $\wedge$ Sec-RTR, HI/*Sec-DOR $\wedge$ Sec-RTR >>

ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L),
ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], R; Wd, R) >>

NO-GAP, DEP-RTR >>

DEP-LINK

I propose that HI/*Sec-DOR $\wedge$ Sec-RTR is a paradigmatic Grounding constraint that is grounded in an incompatibility of simultaneous high and uvularised gestures. This constraint restricts the class of vowels which undergo Palestinian uvularisation harmony to the low vowels, since under the present assumptions both high and mid vowels are specified for [HI]; see §2.3.3.3 for further discussion.

This section will argue that in Palestinian, the optimal output can be gapped. This will be considered evidence that gapped configurations are not universally illformed, and that they are produced by *GEN*, countering the claims of Archangeli & Pulleyblank (1994a) and Pulleyblank (1994a). It will also be considered evidence that, as claimed by Padgett (1995) and McCarthy (1997), a constraint against gapping exists. That is, the fact that no gapping is sometimes not observed in Palestinian indicates that when it is observed, it is enforced by a violable constraint.

In §2.5.2, the Palestinian anchor for both secondary-[DOR] and secondary-[RTR] was identified as the root node, based on the fact that both consonants and vowels undergo uvularisation harmony. The relevance of this to NO-GAP is explained as follows: NO-

2.5.6. A Theoretical Account: Part III

GAP requires that a multiply-linked feature be linked to adjacent segments. Following Archangeli and Pulleyblank (1994a), adjacency is defined with respect to the anchor tier. Since the anchor for secondary-[DOR] and secondary-[RTR] is the root node, NO-GAP requires multiply-linked secondary-[DOR] and secondary-[RTR] to be linked to adjacent root nodes.

The definition of formal Adjacency for linked features, from Archangeli and Pulleyblank (1994a:35), is:

(142) <u>Adjacency for linked featues</u> (from Archangeli and Pulleyblank (1994a:35))
α is structurally adjacent to β iff
both α and β are associated to the same anchor tier and no anchor intervenes on that tier between the anchors to which α and β are associated.

The constraint interaction resulting from (141) is illustrated by the tableau in (143). (NUC-C]$_\sigma$/RTR, the constraint responsible for the link between [RTR] and /U/, is not included in the tableau. Constraint violation by the geminate consonant is assigned one violation mark, for the single root node of the geminate.)

(143)

input: /sUbb/ [DOR] [RTR] 'to pour' (see 139)	I-O FAITH	NUC]$_{Stm}$/ *RTR	NUCμμ/ *RTR	DEP-DOR	FRONT/ *Sec-DOR ∧ Sec-RTR	HI/ *Sec-DOR ∧ Sec-RTR	ALIGN-Sec-DOR-Sec-RTR-Wd	NO-GAP	DEP-RTR	DEP-LINK
1. {subb}	*!* **									
2. {subb} [DOR] [RTR]							*!*			
3. {subb} [DOR] [RTR]							*!*			*
4. {su˃bb} [DOR] [RTR]						*!	*			**
5. {su˃bb} [DOR] [RTR]						*!				** **
6. {subb} [DOR] [RTR] [DOR]				*!			*			** *
☞ 7. {subb} [DOR] [RTR]							*	*		** *

In candidate 7, the non-low vowel is specified for secondary-[RTR] but not for secondary-[DOR]. This satisfies HI/*Sec-DOR ∧ Sec-RTR but violates the ALIGN(Sec-[DOR] ∧ Sec-[RTR]; Wd) constraints. The fact that candidate 7 is optimal shows that violation of alignment less serious than violation of HI/*Sec-DOR ∧ Sec-RTR; hence HI/*Sec-DOR ∧ Sec-RTR >> ALIGN(Sec-[DOR] ∧ Sec-[RTR], L; Wd, L), ALIGN(Sec-[DOR] ∧ Sec-[RTR], R; Wd, R).

2.5.6. A Theoretical Account: Part III

In the winning candidate, the non-low vowel is transparent to uvularisation harmony. This transparency is due to its gapped configuration with respect to secondary-[DOR], as will now be explained.

Crucially, the ranking DEP-DOR >> the ALIGN(Sec-[DOR] ∧ Sec-[RTR]; Wd) constraints was established in §2.5.4, based on the opacity of post-alveolars to uvularisation harmony. Given that ranking, /bb/ cannot surface specified for secondary-[DOR] via insertion of insertion of [DOR]. Thus, candidate 6, which involves such insertion, is non-optimal. Assuming an undominated MAX-HI, which is indicated by the lack of reduction for Palestinian non-low vowels (see §2.2.2.5), this means that the optimal candidate is gapped: in the winning candidate 7, secondary-[DOR] is linked to non-adjacent {ṣ} and {ḅḅ}. This gapping occurs in violation of NOGAP, but in best satisfaction of the ALIGN(Sec-[DOR] ∧ Sec-[RTR]; Wd) constraints. This establishes the ranking ALIGN(Sec-[DOR] ∧ Sec-[RTR], L; Wd, L), ALIGN(Sec-[DOR] ∧ Sec-[RTR], R; Wd, R) >> NOGAP.

Finally, the data examined have provided no evidence for a crucial ranking between NOGAP and DEP-RTR. For this reason, they are assumed here to be non-crucially equally ranked. The same holds for HI/*Sec-DOR ∧ Sec-RTR with respect to DEP-IO, MAX-DOR, MAX-RTR, MAX-LINK, NUC]$_{Stm}$/*RTR, and NUCμμ /*RTR, DEP-DOR, and FRONT/*Sec-DOR ∧ Sec-RTR.

2.5.7. Uvularisation Harmony in Other Palestinian Dialects

The other Palestinian dialects for which uvularisation harmony has been closely investigated are a southern Palestinian (Davis 1993,1995), the Dar Younes (Younes 1982, 1993) and YaՙSbad (Herzallah 1990) *fellāhis*, and a Jerusalem *fellāhi* (Card 1983).[18] The first three of these dialects have distinct leftward vs. rightward uvularisation harmonies.

In the southern Palestinian, leftward harmony extends to the word boundary and has no blockers. Rightward harmony is blocked by /I j ʃ ʤ/. Forms showing this blocking are seen in (144), which are from Davis (1995:474). (Davis' transcription is retained here: uvularised segments are in capitals; underlying emphatics are denoted by a dot under the symbol. The surface form status of the data in this section is inferred from the studies from which they are cited.)

(144)	a. {BALLAAS}	'thief'
	b. {ʕATšaan}	'thirsty [masc.sg.]'
	c. {Tiin-ak}	'your [masc.sg.] mud'

In Dar Younes and Yaʕbad, leftward harmony is likewise unrestricted. Younes (1993) shows that rightward harmony is blocked by /j ʃ w/ and, after {ṛ}, by a morpheme

[18]Herzallah (1990:4) describes the Yaʕbad and Dar Younes dialects as "essentially the same...[t]he only prominent difference between the two is the realization of the reflex of the C[lassical] A[rabic] /k/. This sound is exclusively an affricate /č/ in Younes's [sic] but it varies between front velar /k/ to /č/ in mine".

boundary followed by a segment other than /Æ/ and pharyngeals and laryngeals. These properties are seen in the forms in (145), which are from Younes (1993:126-127). (Younes' transcription is retained; '+' denotes a morpheme boundary; underlying emphatics are denoted by a dot under the symbol; uvularisation is denoted by underlining.) The blocking after {ṛ} is seen in (145e), compared to (145d). As shown by (145d), leftward harmony does not always reach the beginning of the word in this dialect; Younes (1993:125) notes that 'emphatic influence' on inflectional prefixes is variable.

(145)	a. {ʕatlaan}	'broken, not working [masc. sg.]'
	b. {ʕatšaan}	'thirsty [masc. sg.]'
	c. {sjaam}	'fasting'
	d. {ma+ħašar+haa+š}	'he did not corner her'
	e. {ma+ħašar+t+haa+š}	'he did not corner her'

Davis (1995:483) differs from Younes in identifying two distinct rightward harmonies for the Dar Younes dialect. Herzallah summarises Yaʕbad rightward harmony as blocked by /j ʃ/ (/w/ is not included in her list).

Card (1983:118) does not identify distinct leftward vs. rightward harmonies in the Jerusalem *fellāhi*, but states: "emphasis clearly originates from one particular consonant in a word and optimally spreads throughout the word." Abu Shusha shares this property with Card's dialect. Card shows that uvularisation harmony is blocked in the Jerusalem *fellāhi* by /Iː j ʃ/ and word-final /I/.

An Optimality account of the several cross-dialectal differences in Palestinian uvularisation harmony will not be undertaken here. For an account of the optimisation responsible for the distinct leftward vs. rightward harmonies of the dialects studied by Davis and Younes, see McCarthy (1997). Finally, the differing sets of blockers across the dialects indicate a crosslinguistic reranking of the grounded constraints responsible for the various blockers: post-alveolar obstruents /ʃ ʧ ʤ/, the post-alveolar approximant /j/, the labiovelar approximant /w/, and the underlying high vowels /I:/ and /I/.

2.6. Summary and a Final Issue

This chapter has argued that Palestinian Arabic has two distinct postvelar harmonies: pharyngealisation harmony and uvularisation harmony. The distinct properties of these two harmonies were shown. Acoustic data which are interpretable as support for the two harmonies were presented. The distinction was argued to be grounded in distinct articulations: retraction of the tongue root as a primary or secondary articulation, for the former, and retraction of the tongue back as a secondary articulation, for the latter.

Pharyngealisation harmony was argued to be [RTR] 'A' harmony, that is, harmony of [RTR] triggered by segments that are specified for primary- or secondary-[RTR]. Uvularisation harmony was argued to be [DOR] + [RTR] 'AS' harmony, that is, harmony of [DOR] and [RTR] triggered by segments that are specified for secondary-[DOR] and secondary-[RTR].

Two distinct anchors were identified. The NUC was identified as the anchor for pharyngealisation harmony. The root node was identified as the anchor for uvularisation harmony.

The constraints which are responsible for the distinct properties of the two harmonies in Palestinian were proposed. Before a final ranking of the pharyngealisation and uvularisation harmony constraints is presented, an outstanding issue will be addressed.

This issue concerns the claim of §2.4, that Palestinian pharyngealisation harmony is imposed by two separate constraints, one requiring harmony under adjacency to a postvelar, the other requiring harmony with any (adjacent or non-adjacent) postvelar. The basis for this claim has not yet been presented. It will be presented below. Its explanation will entail proposal of the constraint interaction responsible for raising of Palestinian short /Æ/, which was discussed in §2.4.3.1.

By way of review, §2.4 claimed there are two crucial contexts for Palestinian pharyngealisation harmony. The first is adjacency to an underlying postvelar. Harmony in this context is illustrated by the forms in (146), which were seen earlier in (67).

(146) a.	/sUʔÆːl/	{sʊ.ˈʔæːl}	(*{su.ˈʔæːl})	'question'
b.	/hIbÆ/	{ˈhɪ.bə}	(*{ˈhi.bə})	'Hiba' (fem. name)
c.	/sbIṭÆːṛ/	{ṣḅɪ.ˈṭɐːṛ}	(*{ṣbi.ˈṭɐːṛ})	'hospital'

The second context is the presence of a postvelar in the word. This second context gives rise to non-local pharyngealisation harmony. The postvelar trigger for non-local harmony is either an underlying postvelar consonant, as illustrated by (147), or a pharyngealised vowel, as illustrated by (148). These data were seen earlier in (72) and (74), respectively.

(147)	a. /lIbUʔÆ/	{ˈlɪ.bʊ.ʔə}	(*{ˈli.bʊ.ʔə})	'lioness'
	b. /ʁInIm-Æ/	{ˈʁɪ.nɪ.m-ə}	(*{ˈʁɪ.ni.m-ə})	'goat'
	c. /ʁIlIbÆ/	{ˈʁɪ.lɪ.bə}	(*{ˈʁɪ.li.bə})	'bother' (N)
(148)	a. /fIlm/	{ˈfɪ.lɪm}	(*{ˈfi.lɪm})	'movie'
	b. /kUtb/	{ˈkʊ.tʊb}	(*{ˈku.tʊb})	'books'

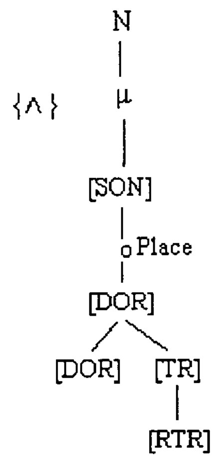
The basis for the distinction between the two pharyngealisation harmony contexts, which was not made explicit in §2.4, will now be explicated. This is important since, if there were no basis, (i) the harmony observed in (146) - (148) could be analysed as arising in a single context, *viz.*, in a word containing a postvelar (either an underlying postvelar consonant or a pharyngealised vowel); (ii) such data could all be accounted for with the ALIGN([RTR]; Wd) constraints, which impose harmony throughout the word and the ALIGN([RTR], NUC) constraints, which impose harmony under adjacency to a postvelar, could be eliminated.

The evidence that adjacency to a postvelar and the presence of a postvelar in the word are distinct contexts for pharyngealisation harmony comes from Palestinian /Æ/ > {ʌ} raising. Recall that Palestinian /Æ/ raises to {ʌ} when it is both pharyngealised and uvularised (and non-reduced). However, this occurs only if the /Æ/ undergoes closed syllable pharyngealisation. This is seen in (149), compared with the data in (150); these data sets were seen earlier in (82) and (83), respectively. In both (149) and (150) /Æ/ surfaces pharyngealised and uvularised. In (149) it undergoes closed syllable pharyngealisation. (In (149a) /Æ/ is pharyngealised in a closed syllable; in (149b) it is pharyngealised under non-local harmony with a closed-syllable-pharyngealised vowel.) In (150) it undergoes pharyngealisation harmony with an adjacent underlying postvelar. As seen, /Æ/ surfaces as {ʌ} in (149) but not in (150).

(149)	a. /mÆṣṛ/	{ṃʌṣṛ}		'Egypt'
	b. /ṭÆmṛ/	{ˈṭʌ.ṃɪṛ}		'datefruit''
	c. /ḳÆmÆṛ/	{ˈḳʌ.ṃɜ˃ṛ}		'moon'
(150)	a. /ṣÆlÆṭÆ /	{ˈṣɑ.ḷɜ˃.ṭə}	(*{ˈṣʌ.ḷɜ˃.ṭə})	'salad'
	b. /mÆṛÆ/	{ˈṃɑ.ṛə}	(*{ˈṃʌ.ṛə})	'woman, wife'

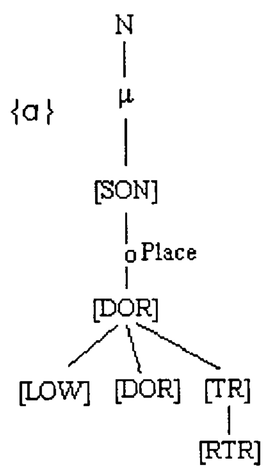
The /Æ/ > {ʌ} observed in (149) is assumed here to result from deletion of /Æ/'s underlying [LOW] specification. The representation of Palestinian {ʌ} is seen in (151).

(151)



The representation in (151) contrasts with that of Palestinian {ɑ}, which is specified for [LOW]. The representation of {ɑ}, seen earlier in (120), is repeated below:

(152)



The above claim with respect to Palestinian {ʌ} and [LOW] is based on crosslinguistic evidence from St'át'imcets Salish. The St'át'imcets epenthetic vowel surfaces as {ʌ} when it undergoes uvularisation harmony with an emphatic. (When it simultaneously undergoes uvularisation harmony and rounding harmony, it surfaces as {ɔ}.) Data showing this will be presented in §3.5. In §3.5 it will be argued that when the St'át'imcets epenthetic vowel is uvularised, it has the representation in (151): its specification for secondary-[DOR] and secondary-[RTR] result from its uvularisation; its specification for primary-[DOR] arises via node generation (Archangeli and Pulleyblank 1994a:23), that is, automatic generation of representational structure between a harmonic feature and its anchor. Since a primary-[DOR], secondary-[DOR], secondary-[RTR] vowel in St'át'imcets is {ʌ}, it is reasonable to assume that the same specifications yield {ʌ} in Palestinian. Since Palestinian /Æ/ must lose its specification for [LOW] in order to surface as (151), [LOW] is here identified as the deleted specification for Palestinian /Æ/ > {ʌ}.

I propose that data such as those in (149) require the additional constraints:

(153) a. LO/*Sec-DOR ∧ Sec-RTR
A segment specified for secondary-[DOR], and secondary-[RTR] is not specified for [LOW].

b. MAX-LO
Every [LOW] in the input corresponds to a [LOW] in the output.

b. MAX-LINK$_{LO}$
Every association with [LOW] in the input corresponds to an association with [LOW] in the output.

I propose that LO/*Sec-DOR ∧ Sec-RTR is a *COMPLEX constraint (see Prince and Smolensky 1993, Benua 1995, Padgett 1995) that is grounded in cognitive processing considerations, *viz.*, that simultaneous specification for [LOW], secondary-[DOR], and secondary-[RTR], is feature overload. The fact that the laden representation in (152) rarely occurs in Palestinian is considered support for this claim: it occurs only when /Æ/ occurs under primary stress in word that contains an emphatic and no short vowel in a closed syllable. In all other contexts, /Æ/ surfaces as {æ}, {ʌ}, {ə}, {ɜ}, or {ɜˤ}.

Palestinian /Æ/ > {ʌ} raising, and -reduction (see §2.2.2.5), indicate that in Palestinian, deletion of a link with [LOW], as distinct from links with other features like [DOR] and [RTR], is sometimes optimal. This implies that MAX-LINK decomposes into MAX-LINK$_F$ constraints, that is, that deletion of links is varyingly constrained, depending on the feature with which the link is associated. MAX-LINK$_{LO}$ is proposed here as a Correspondence constraint that prohibits deletion of a link specifically with [LOW]. All references to MAX-LINK earlier in this chapter are here clarified as MAX-LINK for links with features other than [LOW].

Since Palestinian /Æ/ > {ʌ} raising does not occur when /Æ/ is pharyngealised under adjacency to a postvelar, it occurs in only a subset of pharyngealisation harmony contexts. McCarthy (1997) discusses a similar problem with respect to uvularisation harmony in Dar Younes Palestinian: in Dar Younes, the properties of uvularisation harmony differ depending on whether the harmony is leftward or rightward; see §2.5.7 for a summary of the differences. McCarthy argues that the differential properties result from constraint ranking. The same will be argued below for Abu Shusha /Æ/ > {ʌ}.

The lack of /Æ/ > {ʌ} raising under pharyngealisation from an adjacent underlying postvelar indicates that /Æ/ is immune to the deletion of [LOW] imposed by LO/*Sec-

DOR ∧ Sec-RTR when its pharyngealisation is imposed by ALIGN([RTR], NUC). However, when it is imposed by NUC-C]$_\sigma$/RTR, the constraint requiring pharyngealisation in a closed syllable, LO/*Sec-DOR ∧ Sec-RTR must also be satisfied. This yields the ranking:

(154) ALIGN-L/R([RTR],NUC) >> LO/*Sec-DOR ∧ Sec-RTR >> NUC-C]$_\sigma$/RTR

The constraint interaction resulting from (154) is illustrated below:

(155)

input: /mÆsr/ [LOW] [DOR] [RTR] 'Egypt'; see (83), (149)	ALIGN ([RTR], NUC)	LO/ *Sec-DOR ∧ Sec-RTR	NUC-C]$_\sigma$ /RTR	MAX-LO	MAX-LINK$_{LO}$
☞ 1. {mʌsr} [DOR] [RTR]				*	*
2. {mɑsr} [LOW] [DOR] [RTR]		*!			

In §2.4.6, the ranking NUC-C]$_\sigma$/RTR >> ALIGN([RTR]; Wd) was established based on evidence that in Palestinian, NUC-C]$_\sigma$/RTR >> DEP-RTR and DEP-RTR >> ALIGN([RTR]; Wd). (The dominance of NUC-C]$_\sigma$/RTR over DEP-RTR permits insertion of [RTR] on a closed syllable vowel; the dominance of DEP-RTR over

ALIGN([RTR]; Wd) derives the opacity effects of Palestinian stem-final vowels.) That is, the more complete ranking relevant to the discussion at hand is:

(156) ALIGN([RTR], NUC) >>

LO/*Sec-DOR + Sec-RTR >>

NUC-C]$_\sigma$/RTR >>

DEP-RTR >>

ALIGN([RTR]; Wd)

The important finding is that the constraint which imposes harmony under adjacency to a postvelar — ALIGN([RTR], NUC) — crucially dominates the constraint which imposes harmony throughout the word — ALIGN([RTR]; Wd). This is evidence that in Palestinian, harmony with an adjacent underlying postvelar and harmony with a postvelar in the word are imposed by separate constraints. This means that the two contexts are referred to distinctly in the phonology. This is the basis for the present claim that there are two crucial contexts for Palestinian pharyngealisation harmony: adjacency to a postvelar vs. the presence of a postvelar in the word.

The distinct phonological properties of pharyngealisation and uvularisation harmonies in (Abu Shusha) Palestinian are listed in Table 2:4 with the constraints that were argued to impose them.

Table 2:4

The distinct properties of (Abu Shusha) Palestinian's two postvelar harmonies

	PHARYNGEALISATION HARMONY	UVULARISATION HARMONY
1. triggers	emphatics gutturals closed-syllable-pharyngealised vowels	emphatics
	MAX-RTR; MAX-LINK (for features other than [LOW]); NUC-C]$_{\sigma}$/RTR	MAX-DOR; MAX-RTR; MAX-LINK (for features other than [LOW])
2. undergoers	short vowels	(short and long) low Vs consonants
	ALIGN-L([RTR], NUC); ALIGN-R([RTR], NUC); ALIGN([RTR], L; Wd, L); ALIGN([RTR], R; Wd, R)	ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L); ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], R; Wd, R)
3. transparent segments	(none)	non-low vowels long vowels (partially transparent)
		HI/*Sec-DOR $\wedge$ Sec-RTR; NUC]$_{Stm}$/*RTR; NUC$\mu\mu$ /*RTR
4. opaque segments	stem-final vowels long vowels	post-alveolar obstruents /ʃ ʧ ʤ/
	NUC]$_{Stm}$/*RTR; NUC$\mu\mu$ /*RTR	FRONT/*Sec-DOR $\wedge$ Sec-RTR

Deleted [LOW] for closed-syllable-pharyngealised and uvularised /Æ/ > {ʌ} - LO/*Sec-DOR $\wedge$ Sec-RTR

The constraints that interact to effect the properties in specific contexts are presented in their final ranking in (157). No integrated ranking of (157a) and (157b) will be proposed here, as an integrated ranking would require examination of more complex constraint interaction than has been studied in this chapter.

(157) Constraint Ranking Responsible for Pharyngealisation and Uvularisation Harmonies in Palestinian Arabic

a. Pharyngealisation Harmony Ranking

DEP-IO, MAX-RTR, MAX-LINK (for features other than [LOW]),
NUC]$_{Stm}$/*RTR, NUC$\mu\mu$ /*RTR >>

ALIGN-L([RTR], NUC), ALIGN-R([RTR], NUC) >>

LO/*Sec-DOR + Sec-RTR >>

NUC-C]$_{\sigma}$/RTR >>

DEP-RTR >>

ALIGN([RTR], L; Wd, L), ALIGN([RTR], R; Wd, R) >>

DEP-LINK, MAX-LOW, MAX-LINK$_{LO}$

b. Uvularisation Harmony Ranking

DEP-IO, MAX-DOR, MAX-RTR, MAX-LINK, NUC]$_{Stm}$/*RTR,
NUC$\mu\mu$ /*RTR, DEP-DOR, FRONT/*Sec-DOR $\wedge$ Sec-RTR,
HI/*Sec-DOR $\wedge$ Sec-RTR >>

ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L),
ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], R; Wd, R) >>

NO-GAP, DEP-RTR >>

DEP-LINK

Chapter 3:

Pharyngealisation Harmony and Uvularisation Harmony in St'á'timcets

3.1. The Language and the Data

St'át'imcets is an Interior Salish language. It has two dialects, Upper and Lower St'át'imcets, which differ in syntax, phonology, and lexicon; see van Eijk (1985, 1987) for further discussion of the dialectal differences.

Salish is a family of indigenous North American languages spoken in a geographic region spanning western Canada and the northwestern U.S.: from coastal British Columbia and Washington through central British Columbia, Washington, and Oregon, to Western Montana. The classification of Salish languages is given in Appendix IV. For their geographic locations, see Appendix V.

All Salish languages are extremely endangered. The term 'endangered' is used here in the sense of both Shaw (1996c) and Krauss (1992). Shaw defines endangered as 'up to 600 speakers'. Kinkade (1991) estimates the number of St'át'imcets speakers to be 300-400. Henry Davis (p.c.) estimates the number of fluent speakers to be 200. (These figures include speakers of both dialects.) Krauss' definition is in terms of the language viability classes in (1):

3.1. The Language and the Data

(1) Language Viability Classes (Krauss 1992)

safe:	100,000 or more speakers; being acquired by children
endangered:	presently being acquired by children, but will cease to be acquired by children in the next century
moribund:	no longer being acquired by children
extinct:	no speakers

First language acquisition of St'át'imcets is now rare. However, many revitalisation efforts are currently in place for the language. (See Duff 1964, Levine & Cooper 1976, and Gardner 1989 on the former suppression of Salish languages, a large factor in their present endangerment.)

The St'át'imcets data for this thesis were gathered by the author during periodic fieldwork in Vancouver, Lillooet, and Mission, British Columbia, 1995-1996. The consultants were six native speakers: three females, aged 50-65, and three males, aged 45-55. The total corpus is approximately 500 words. About half of these were tape-recorded from one female and two male consultants. Given the small size of the corpus, van Eijk (1985, 1987) was consulted for further data. Where data in this chapter are van Eijk's, this is indicated.

Unless otherwise noted, data illustrating St'át'imcets postvelar harmony will be given in the Lower dialect. Glosses are from van Eijk (1987); for forms not found in that dictionary, glosses are as provided by my consultants. The St'át'imcets acoustic study analysed both Lower dialect and Upper dialect data, for the sake of dialectal differences that might show up. What do show up are a distinction between emphatic /ɹ̣ ɹ̣'/ in the Lower dialect vs. non-emphatic /ɹ ɹ'/ in the Upper dialect, differences in epenthesis, and a few lexical differences. Issues regarding Lower /ɹ̣ ɹ̣'/ vs. Upper /ɹ ɹ'/ will be discussed in §3.2.1.5.1 The differences in epenthesis will be summarised in §3.2.2.2. Differences of all three types are documented in Appendix VI, which lists the St'át'imcets carrier forms that were used for the acoustic study. The acoustic data were tape-recorded from a male native speaker of the Lower dialect, aged 52, and a male native speaker of the Upper dialect, aged 45.

The data in this chapter will be presented according to the transcription system outlined in §1.7.1: underlying phonological forms appear between slashes ('//'), surface phonological forms between the braces '{}', phonetic forms between square brackets ('[ ]'). However, syllable breaks and lexical stress will usually not be transcribed. That is, although St'át'imcets syllabification and stress assignment are recognised as phonological and predictable and therefore an integral part of St'át'imcets transcription, syllable breaks and stress will be omitted from most surface and phonetic forms to be presented in this chapter. They are omitted because St'á'timcets syllable structure and stress assignment do not immediately bear on the postvelar harmony to be examined.

The data in this chapter and the carrier forms used in the St'át'imcets acoustic study are presented again in Appendix VII, for the sake of further documentation. In the appendix, they are presented in underlying form, output form, phonetic form, and orthography.

3.2. Phonemic Inventory

3.2.1. Consonantal Inventory

3.2.1.1. The St'át'imcets Underlying Consonantal Inventory

The Lower St'át'imcets underlying consonantal inventory is presented in (2). The same underlying inventory is recognised for the Upper dialect. However, the Upper dialect has underlyingly non-emphatic /ɹ ɹ'/ instead of emphatic /ɹ̙ ɹ̙'/; data supporting this claim will be presented in §3.2.1.5.1.

The post-alveolars /ʃ tʃ/ are produced with apical articulation, unlike, eg., English /ʃ tʃ/, which are produced with laminal articulation. (See Ladefoged and Maddieson (1996:14-15) for discussion of apical vs. laminal post-alveolars.) Glottalised /tʃ'/ and emphatic /ʃ̙/ are produced with alveolar articulation; that is, they are phonetically [ts'] and [s̙], respectively.

The relatively large size of the underlying consonantal inventory is due in part to the use of labialisation secondary articulation (e.g., on /kʷ/) and superimposed glottalic egressive airstream, also referred to as 'glottalisation' or 'ejection' (e.g., on /k'/); these are sometimes combined (e.g., on /k'ʷ/). This chapter will argue that St'át'imcets also makes use of secondary uvularisation, also referred to as 'emphasis' (e.g., on /k̙/, transcribed in other works on St'át'imcets, e.g., van Eijk 1985, as /q/). This will be based on phonological evidence and supporting acoustic and perceptual findings. Secondary uvularisation is sometimes combined with labialisation and/or glottalisation (e.g., on /k̙'ʷ/, transcribed elsewhere as /q'ʷ/).

(2) The (Lower) St'át'imcets Underlying Consonantal Inventory

	LAB	DENT	ALV-LAT	POST-ALV	PAL	VEL	UV	GL
<u>*OBSTRUENTS*</u>								
STOPS:								
	p	t				k k̙		
	p'					k' k̙'		
						kʷ k̙ʷ		
						k'ʷ k̙'ʷ		
AFFRICATES:								
			t͡ɬ'	tʃ t̙ʃ̙				
				tʃ'				
FRICATIVES:								
			ɬ	ʃ ʃ̙				
						x x̙		
						xʷ x̙ʷ		
<u>*RESONANTS*</u>								
NASALS:								
	m	n						
	m'	n'						
APPROXIMANTS:								
								ʔ
		ɹ̙	l l̙		j	ɰ	ʁ	h
		ɹ̙'	l' l̙'		j'	ɰ'	ʁ'	
						ɰʷ	ʁʷ	
						ɰ'ʷ	ʁ'ʷ	

3.2.1. Consonantal Inventory

Tables 3:1 and 3:2 present the IPA symbols used in this thesis for certain St'át'imcets consonants, alongside their corresponding symbols in the North American (NA) transcription.[1] (Consonants not included in the tables are denoted by the same symbol in both systems.) NA transcription has been used by most previous studies of the language, the foremost of which is van Eijk (1985). The IPA will be used here instead primarily because it provides a broader set of symbols for encoding the various phonological and phonetic distinctions between St'át'imcets segments. However, data in the text and data sets in numbered examples will usually be presented in both transcriptions to facilitate comparision of the observations and arguments of this chapter with those of previous works on Salish. (Where both traanscriptions are presented in the text, they are separated by '□'. Where appropriate, a retraction dot will be included in the NA transcription of the dental approximants, whereas previous studies have standardly not used a retraction dot for those segments.)

This chapter will argue for a re-interpretation of certain St'át'imcets consonants, as noted in the tables below. (The surface form status of the segments denoted by van Eijk 1985 as 'c̣ ṣ ḷ ḷ' ' is inferred from his discussion.)

[1]In Table 3:2, the consonants which van Eijk (1985) analyses as laryngeal glides are referred to as 'approximants'. Van Eijk (1985) refers to non-nasal resonant consonants as 'glides', whereas in this thesis, they are referred to as 'approximants'.

Table 3:1

Correspondence between IPA and NA transcription: obstruents

Analysis in this Chapter		IPA	NA	van Eijk (1985) Analysis
	a.	/tʃ'/	/c'/	
	b.	/t͡ɬ'/	/ƛ'/	
	c.	/tʃ/	/c/	
coronal emphatic	d.	/tʃ̙/	{c̣}	retracted
	e.	/ʃ/	/s/	
coronal emphatic	f.	/ʃ̙/	{ṣ}	retracted
	g.	/k̙/	/q/	
velar	h.	/k̙'/	/q'/	uvulars
emphatics	i.	/k̙ʷ/	/qʷ/	
	j.	/k̙'ʷ/	/q'ʷ/	
	k.	/x̙/	/x̌/	
	l.	/x̙ʷ/	/x̌ʷ/	

Table 3:2

Correspondence between IPA and NA transcription: resonants

Analysis in this Chapter		IPA	NA	van Eijk (1985) Analysis
	a.	/ɹ/ (Upper dialect)	/z/	
	b.	/ɹ'/ (Upper dialect)	/z'/	
coronal emphatics	c.	/ɹ̙/ (Lower dialect)	/ẓ/	retracted (implied)
	d.	/ɹ̙'/ (Lower dialect)	/ẓ'/	
coronal emphatics	e.	/l̙/	{ḷ}	retracted
	f.	/l̙'/	{ḷ'}	
	g.	/j/	/y/	
	h.	/j'/	/y'/	
	i.	/ɰ/	/ɣ/	
	j.	/ɰ'/	/ɣ'/	
rounded velar approximants	k.	/ɰʷ/	/w/	rounded laryngeal glides (approximants)
	l.	/ɰ'ʷ/	/w'/	
	m.	/ʁ/	/ʕ/	
	n.	/ʁ'/	/ʕ'/	
	o.	/ʁʷ/	/ʕʷ/	
	p.	/ʁ'ʷ/	/ʕ'ʷ/	

3.2.1. Consonantal Inventory

The St'át'imcets underlying and surface vowels are presented in (3) and (4) to provide a frame of reference for the vowels that occur in the data to be presented in this section. The surface inventory is the inventory at the output of the phonology (not at the output of the phonetics). The vocalic inventories will be addressed in detail in §3.2.2. The featural values represented by '/I Æ U/' in (3) and by the IPA symbols in (4) will be discussed in §3.4.2. St'át'imcets has an epenthetic vowel, the variant surface quality of which will be represented by the following six symbols: non-rtr mid central non-rd {ɘ}, non-rtr mid central rd {ɵ}, rtr mid central non-rd {ɜ}, rtr mid central rd {ɞ}, rtr mid back non-rd {ʌ}, and rtr mid back rd {ɔ}, which represent discrete variants occurring in particular phonological contexts. The featural values of the epenthetic vowel will be discussed in §3.4.2.

(3) The St'át'imcets Underlying Vocalic Inventory

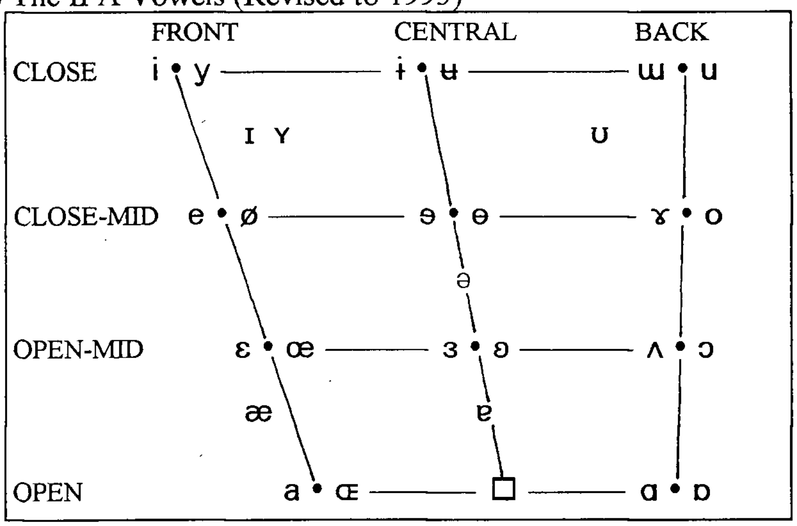
	FRONT		BACK
HIGH	I		U
LOW		Æ	

(4) The St'át'imcets Surface Vocalic Inventory

	FRONT				CENTRAL				BACK			
	NON-RTR		RTR		NON-RTR		RTR		NON-RTR		RTR	
	NON-RD	RD	NON-RD	RD	NON-RD	RD	NON-RD	RD	NON-RD	RD	NON-RD	RD
HIGH	i		ɪ							u		ʊ
MID					ɘ	ɵ	ɜ	ɞ			ʌ	ɔ
LOW	æ		a								ɑ	

The IPA vowel chart in (5) shows the placement of the St’át’imcets mid and low surface vowels in the IPA vowel space. The symbol ‘□’, which I have placed in open central position, will be explained in §3.2.1.3.

(5) The IPA Vowels (Revised to 1993)



3.2.1.2. The St’át’imcets Surface Consonantal Inventory

In St’át’imcets, underlyingly non-emphatic /tʃ n/ surface as emphatic ⟨tʃ̙ n̙⟩ via uvularisation harmony with an underlying emphatic. Data showing this, and supporting acoustic findings for ⟨tʃ̙⟩, will be presented in §3.5.1. On these grounds, the surface consonantal inventory is analysed here as containing one additional emphatic: ⟨n̙⟩. To my knowledge, this differs from all previous analyses of the language.

An exhaustive investigation of the effect of St’át’imcets uvularisation harmony on consonants was not undertaken in this thesis. Such investigation might reveal that consonants other than /ʧ/ and /n/ undergo the harmony. If so, the surface consonantal inventory might contain additional emphatics besides {n̡}. Because this issue is not settled in this thesis, the complete surface consonantal inventory will not be identified here.

Contrary to van Eijk's claims, the data investigated here show that the Lower St'át'imcets surface inventory contains two types of dental approximants: non-emphatic {ɹ ɹ'} and emphatic {ɹ̡ ɹ̡'}. Data on which this claim is based will be presented in §3.2.1.5. I will argue that non-emphatic {ɹ ɹ'} arise through de-emphaticisation of {ɹ̡ ɹ̡'} in the context of /l/, an effect similar to the de-emphaticisation of Palestinian /r̡/, discussed in §2.2.1.3.2.

3.2.1.3. Previous Analyses of the St'át'imcets Consonantal System

Van Eijk's (1985:2) analysis of the surface consonantal inventory is presented in (6). (The surface form status of the segments in (6) is inferred from his discussion.)

(6) The van Eijk (1985) Analysis of the St'át'imcets Surface Consonantal Inventory[2]

		Obstruents			Resonants		
		Plosives		Fric.			
		Plain	Glott.		Plain	Glott.	
Labial		p	p'		m	m'	Nasals
Dental-lateral	Dental	t			n	n'	
	Lateral		ƛ'	ɬ	l ḷ	l' ḷ'	Liquids
Dental-Palatal	Dental		c'		z	z'	
	Palatal	c c̣		s ṣ	y	y'	
Velar	Unrounded	k	k'	x	ɣ	ɣ'	
	Rounded	k^w	k'^w	x^w			
Uvular	Unrounded	q	q'	x̌	ʕ	ʕ'	Glides
	Rounded	q^w	q'^w	$\check{x}^w$	$ʕ^w$	$ʕ'^w$	
Laryngeal	Unrounded				h	ʔ	
	Rounded				w	w'	

The major classificational division in (6), and in (2), is between obstruents and resonants. The obstruent or resonant status of each St'át'imcets consonant can be determined based on two phonological criteria, as identified by van Eijk (1985:3,6-7): (i) obstruents are not targeted by morphologically-conditioned glottalisation, whereas resonants are; this is illustrated by /m/ in the reduplicative form: /RED, mÆt-ḳ/[3] {mæ-m'-t-əḳ} □ /RED, mÆt-q/ {ma-m'-t-əq} 'to go for a walk'; *cf.* non-reduplicative: /mÆt-ḳ/ {mæt-ḳ} □ /mÆt-q/ {maṭ-q} 'to walk, go on foot'; (ii) obstruents occur interconsonantally and post-consonantally in word-final position, whereas resonants do

---

[2]As mentioned in the previous note, van Eijk (1985) uses 'glides' where 'approximants' is used in this thesis.

[3]In underlying representations, 'RED' will denote a reduplicative morpheme. See van Eijk (1985) for discussion of St'át'imcets reduplicative morphology.

not. However, the usefulness of (ii) as a clear diagnostic is diminished by the fact that both obstruents and resonants are frequently immediately preceded by an epenthetic vowel when they are C_2 in a /$C_1C_2C_3$/ or /C_1C_2 #/ cluster. This epenthesis will be discussed in §3.2.2.2.

Van Eijk (1985:3) claims a third criterion for resonant status, stating that "[t]he dental, velar and uvular glides (z̦ z̦' ɣ ɣ' ʕ ʕ' ʕʷ ʕ'ʷ) are classed as resonants, rather than as voiced fricatives, because... they oppose plain vs. glottalized members (like m m' n n' l l' ḷ ḷ' y y' w w', but unlike the fricatives)." However, as noted by Remnant (1990:46-47), this criterion is non-sufficient: it cannot distinguish resonants from obstruents because the stops and affricates also oppose plain and glottalized members.[4]

In (2), the consonants which van Eijk analyses as rounded laryngeal approximants are here classified instead as rounded velar approximants. This is because, based on perceptual and acoustic observations, these segments are phonetically [w w'], that is, labio-velars. They are not [hʷ h'ʷ] (rounded laryngeals), as would follow from van Eijk's classification of them as laryngeal in (6). Van Eijk (1985:15) in fact suggests the analysis adopted here, stating in a note: "[w]e could also class w w' as the rounded counterparts of ɣ ɣ' ". Notice that St'át'imcets is one of the very few languages of the world that have velar approximants — Ladefoged and Maddieson (1996:322) state that, while labiovelar /w/ is very common, occurring in 76% of the world's languages, /ɰ/ is crosslinguistically

[4]See Blake (1992, 1995) for phonological criteria for determining the obstruent or resonant status of consonants in Sliammon (Central Salish).

more rare than other rare approximants such as labial-palatal /ɥ/, which occurs in less than 2% of the world's languages.

The articulation of the consonants which will be argued in this chapter to be emphatics, *viz.*, (d,f-l) in Table 3:1 and (c-f) in Table 3:2, will now be described. This will be based on perceptual observations, primarily those of van Eijk 1985, since, as noted in §1.4, there are no articulatory (x-ray, etc.) data on Salish. Previous theoretical analyses of those consonants will then be summarised.

Van Eijk (1985:11) describes the articulation of the uvular obstruents as follows: "The point of articulation of the uvulars is quite close to that of the velars; the fricatives x̌ x̌ʷ have a rather sharp friction which sets them apart from the velars x xʷ (in the same way, q' q'ʷ are mainly distinguished by their fricative offglide from k' k'ʷ)." Regarding vowel quality in the environment of these segments, he notes [p.12]: "the main variants of ...a i u are [ɛ e o] when not in the position —(ʔ)Q, but [a ɛ/ɛ̈ ɔ] when in the position —(ʔ)Q." Van Eijk states [p.3] that 'ɛ̈' "resembles the vowel of German 'mehr' ". The qualities [a ɛ/ɛ̈ɔ] are the same as those which he ascribes [p.3] to ⟨ạ ị ụ⟩ which he refers to as 'retracted' vowels. Van Eijk's generalisation, then, is that /a i u/ surface retracted in the context —(ʔ)Q.

Van Eijk explains [p.8] that he uses 'Q' to denote "any uvular". The description of vowel quality quoted in the preceding paragraph implies that /I Æ U/ have a retracted quality immediately preceding both the uvular obstruents and the uvular approximants. The St'át'imcets database for this thesis, both phonological and acoustic, indicates otherwise, with respect to /Æ/: based on the present database, /Æ/ surfaces as backed {ɑ} immediately preceding the uvular obstruents (which will be reanalysed in this chapter as emphatic velars), but not immediately preceding the uvular approximants. In the latter context, it surfaces as front {æ}; this will be shown in §3.2.1.5.4 and, in greater detail, in §3.5.1. Acoustic data to be presented in §3.5.1 indicate that St'át'imcets {ɑ} is phonetically central. That is, it corresponds phonetically to some vowel symbol which could appear in the position of '□' in (5), rather than to IPA back 'ɑ'.

Under the classificational system of Ladefoged and Maddieson (1996), the St'át'imcets dental approximants are rhotics. As Ladefoged and Maddieson discuss, the rhotic class comprises consonants of varying manner and place of articulation: e.g., **r** (voiced dental or alveolar trill), ɾ (voiced dental or alveolar tap or flap), ɹ (voiced dental or alveolar approximant), ɽ (voiced post-alveolar flap), ɻ (voiced post-alveolar approximant), ʀ (voiced uvular trill), ʁ (voiced uvular approximant). They discuss [p.244-245] the elusiveness of the phonetic property which might unite the rhotic class.

Van Eijk (1985:4) describes the St'át'imcets dental approximants as:

> "lax fricatives, varying from a purely dental articulation (with the tongue-tip more forward than in English "z") to an interdental pronunciation (where z z' sound somewhat like lax variants of English voiced "th"); the former pronunciation is generally more common in the Fountain dialect (F)

> [Upper St'át'imcets], the latter in the Mount Currie dialect (M) [Lower St'át'imcets]... after vowels, z' in M allows the variant [l'] besides [z']."[5]

The frication that is frequently observed for these segments is here considered attributable to either aerodynamic coincidence or to their identity as rhotics. It is possibly due to aerodynamic coincidence because frication is frequently observed for approximants in a voiceless context: the voiceless context can induce phonetic devoicing of the approximant, resulting in turbulent airflow; see §2.2.1.3.1 for further discussion. It is possibly attributable to their identity as rhotics, because, as observed by Ladefoged and Maddieson (1996:232), "[t]he family of rhotics also includes [besides trills] members in which there is no contact, but instead only an approximation between the articulators. In some instances the typical production is accompanied by friction, in others an approximant is produced." Based on Ladefoged and Maddieson's survey, frication for a rhotic is not unusual. Determination of whether the frication of the St'át'imcets approximants is confined to a voiceless context or is a free variable property is left for future study.

Their occasional lateral articulation is assumed here to follow from the fact that they are rhotics, as rhotics in several languges have been documented with varying lateral and rhotic articulation. Ladefoged and Maddieson (1996:243) cite as examples rhotics in several of the West African languages discussed by Ladefoged (1968), and in Japanese, as described by Shimizu and Dantsuji (1987).

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[5]Van Eijk (p.c.) defines 'lax' as meaning that "there is an almost complete relaxing of the tongue muscles, with just enough energy left to make the required articulation". This is interpreted here as a description of one aspect of approximant manner of articulation.

Van Eijk (1985:8) notes that in Lower St'át'imcets, retracted {ạ ụ} are observed immediately preceding the dental approximants, but retracted {ị} and {ə̣} are not. Based on this generalisation with respect to {ạ ụ}, Egesdal and Thompson (1993) refer to the St'át'imcets dental approximants as 'retracting' consonants and describe them as 'velarised'.

Egesdal and Thompson note a dialectal variation, *viz.*: in certain St'át'imcets forms, the low vowel does not occur retracted immediately preceding a dental approximant. Van Eijk's (1985:8) descriptive generalisation is: the Lower dialect has {ạ} where the Upper dialect has {a}, immediately preceding one of these consonants. Egesdal and Thompson's (1993:100,103) analysis is: "Li [Lillooet, i.e., St'át'imcets] *z* retracts preceding vowels"; the Upper dialect pattern results from a dental approximant that "may be losing its retractive effect on a preceding vowel." In §3.2.1.5, I will argue that (i) St'át'imcets has two types of these segments: in the terms of van Eijk (1985) and Egesdal and Thompson (1993), non-retracting (henceforth, 'non-retracted') vs. retracted; (ii) the Upper dialect has only non-retracted /z z'/ underlyingly, while the Lower dialect has only retracted /ẓ ẓ'/ underlyingly.

Van Eijk (1985:3) describes the post-alveolars {c̣ ṣ} and alveolar laterals {ḷ ḷ'} as 'velarised', stating that {ṣ} "resembles Arabic *sād* [ص = ṣ]." This identification of Salish retraction with Arabic emphasis suggests that van Eijk (and Egesdal and Thompson, as noted above) may have used 'velarised' to mean 'uvularised'. As noted in §1.4.2, 'velarised' is a term used to describe Arabic emphatics in early studies such as Obrecht (1968).

Following Kuipers (1973, 1981), van Eijk (1985:40-42) describes {ç ṣ ḷ ḷ'} as occurring in 'retracted roots'. He distinguishes four types of retracted roots, as summarised in (7). (In this chapter, where data are presented from a source other than my fieldnotes, the transcription of the other source is retained. The underlying, surface, or phonetic form status of the data is inferred from the discussion in the other source.)

(7) Van Eijk's (1985:40) Four Types of Retracted Roots

a. roots in which retraction affects all phonemes which take part in the retraction, i.e., vowels and /c s l l'/; e.g., √{qə̣ḷ} 'bad'
b. roots in which retraction is only partially effected, that is, in which phonemes that occur retracted in other forms do not occur retracted; e.g., √{c'ḷip'} 'to pinch', which contains {i}, not {ị}
c. roots which contain a retracted vowel and only neutral consonants, i.e., consonants other than /c s l l'/; e.g., √{pə̣m} 'fast'
d. roots which contain only neutral consonants, but which act as retracted roots; e.g., √{c'n'- ạ ḷ -us-əm} 'to take aim', in which √{c'n'} co-occurs with a suffix that contains retracted segments

Van Eijk implies that words which contain retracted vowels or {ç ṣ ḷ ḷ'}, for which the retraction of those segments cannot be attributed to any segmental source, that is, to an immediately following uvular obstruent or a Lower dialect dental approximant, must be analysed as 'retracted roots'. His discussion does not indicate how retracted roots might be formally represented underlyingly.

3.2.1. Consonantal Inventory

Previous theoretical studies of St'át'imcets postvelar harmony, Remnant (1990) and Bessell (1992), assume that the underlying consonantal inventory contains all the segments in (6), except {c̣ ṣ ḷ ḷ'}. They analyse {c̣ ṣ ḷ ḷ'} as surface retracted consonants, the outputs of morphemic retraction triggered by retracted roots as identified by van Eijk. Remnant and Bessell analyse vowel alternations in the context of an immediately following uvular obstruent or dental approximant as retraction of the vowels induced by those consonants.

3.2.1.4. Guttural Postvelars

St'át'imcets is analysed here as having 16 underlying postvelars: four gutturals /ʁ ʁ' ʁʷ ʁ'ʷ/, and 12 emphatics, /t̙ʃ̙ ʃ̙ ɹ̙ ɹ̙' l̙ l̙' k̙ k̙' k̙ʷ k̙'ʷ x̙ x̙ʷ/. The dental approximants, that is, /ɹ̙ ɹ̙'/, are analysed as emphatic only for the Lower dialect; the evidence for this will be presented in §3.2.1.5.1.

The gutturals are discussed in this section. The emphatics will be discussed in §3.2.1.5. For discussion of the OT derivation of St'át'imcets' underlying postvelars, see §3.3.2. Finally, the St'át'imcets laryngeals /h ʔ/, lacking any articulation, are excluded from the postvelar class. (The laryngeals lack articulation because, under the definition of 'articulation' assumed in this thesis, as discussed in §1.3.1, laryngeal gesture does not constitute an articulation.)

The uvular approximants /ʁ ʁ' ʁʷ ʁ'ʷ/ are gutturals because they are wholly articulated in the postvelar region of the vocal tract. Van Eijk (1985) classifies them as uvulars, although he describes them [p.4] as "lax... pharyngeal glides pronounced with a wide aperture (the articulation of ʕ ʕ' ʕʷ ʕ'ʷ is farther back than that of the uvular obstruents)." The present database indicates that while their articulation is sometimes post-uvular, it is usually uvular. (An example of a form in which the less frequent post-uvular articulation often occurs is /ʁʷUj't/ ⟨ʁʷuj't⟩ [ᵥʁʷoj't] ▯ /ʕʷUy't/ ⟨ʕʷuy't⟩ [ᵥʕʷoy't] to sleep', where 'ᵥ' denotes a more posterior articulation.) The post-uvular articulation is here considered a phonetic effect, although further research is needed to confirm this and to identify the phonetic context(s) to which it can be attributed. (Alternatively, further study might reveal a phonologically determined complementary distribution between the two articulations on which basis the post-uvular variant could be recognised as part of the surface consonantal inventory.)

The approximant manner of articulation of Salish /ʁ ʁ' ʁʷ ʁ'ʷ/ was observed by Kinkade (1967). It is addressed by Bessell (1992, 1993a, 1993b). In the present acoustic study, tokens of St'át'imcets /ʁ ʁ' ʁʷ ʁ'ʷ/ were observed to be high amplitude, with robust formant structure. These acoustic features, which support their classification as approximants, are seen in Figure 3:8 in §3.3.1. Word-initially, they are occasionally initially devoiced and, for the voiceless interval, produced with frication. See Bessell (1992, 1993b) for spectrograms showing the acoustic properties just mentioned for voiced gutturals in Shushwap (Northern Interior Salish), and Colville, Nxa'amxcin, Spokane, Kalispel, and Coeur d'Alene (Southern Interior Salish).

3.2.1.5. Emphatic Postvelars

The aim of this section is to show that St’át’imcets has 12 emphatics: /t̙ʃ̙ ʃ̙ ɹ̙ ɹ̙’ l̙ l̙’ k̙ k̙’ k̙ʷ k̙’ʷ x̙ x̙ʷ/.

The label ‘emphatic’ has analytical implications: it implies that the St’át’imcets segments just listed form a phonological class which is found in other languages, such as Arabic. It also has theoretical implications: this chapter will claim that, as emphatics, they have certain phonological representations, which are grounded in particular presumed articulations: (i) a primary non-postvelar articulation, (ii) uvularisation, and (iii) pharyngealisation. See §1.4.2 for data on which these articulatory claims are based. The representations of St’at’imcets emphatics will be proposed in §3.3.1.

Emphatics are postvelars because, given gestures (ii) and (iii), they are partly articulated in the postvelar region of the vocal tract. However, the emphatic velars /k̙ k̙’ k̙ʷ k̙’ʷ x̙ x̙ʷ/ are analysed as exceptions in that they lack gesture (i) and are produced with primary uvular articulation and pharyngealisation. It is assumed that, for each of /k̙ k̙’ k̙ʷ k̙’ʷ x̙ x̙ʷ/, the phonological primary velar and secondary uvular components are phonetically realised as a single primary uvular articulation. The same is assumed for Arabic /k̙/; see §1.4.2 for discussion. Thus, although /k̙ k̙’ k̙ʷ k̙’ʷ x̙ x̙ʷ/ are phonologically emphatics, like the gutturals, they are wholly articulated in the postvelar region of the vocal tract.

In §3.4 and §3.5, I will argue that the presence of emphatics in St'át'imcets, as in Palestinian Arabic, gives rise to postvelar harmony triggered by the emphatics, the effect of highly ranked constraints in the grammar.

The identification of St'át'imcets' emphatics is based on phonological evidence and supporting acoustic and perceptual findings. The discussion that follows first clarifies preliminary issues that are relevant to the emphatic status of the Lower dialect dental approximants, and the consonants which have been previously analysed as retracted {c̣ ṣ ḷ ḷ'}. It then presents perceptual support for the assumption that the dental approximants, {c̣ ṣ ḷ ḷ'}, and the uvular obstruents are emphatics. Next, and most importantly, it presents phonological evidence for this. Two remaining issues are then discussed: the de-emphaticisation of Lower dialect /ɹ̣ ɹ̣'/; exceptional forms which, it will be argued, involve a floating uvularisation ('emphasis') feature, as proposed (under the label 'retraction feature') by Kuipers (1973, 1981). Finally, the acoustic support is presented.

3.2.1.5.1. Dialectal Variation in Dental Approximant Retraction

Examples (8) and (9) present Lower dialect and Upper dialect forms in which /Æ/ occurs immediately preceding a dental approximant. (In order to keep the presentation of these data pre-analytic, the consonants at issue are transcribed in (8) and (9) without any retraction diacritic.) The forms in (8) show that in the Lower dialect, /Æ/ surfaces as backed {ɑ} (NA {ạ}) immediately preceding a dental approximant. The forms in (9) show that in the same context in the Upper dialect, /Æ/ surfaces as front {æ} (NA {a}). (In this chapter, where a form occurs only in one St'á'timcets dialect, the dialect in which it occurs is noted. The vowel epenthesis observed in forms like (8c) will be discussed in §3.2.2.2.)

(8) Lower St'át'imcets Forms

a. IPA /t͡ɬʼlÆɹ'/	{t͡ɬʼlɑɹ'}	(*{{t͡ɬʼlæɹ'})	'canoe'
NA /ƛ'lÆz/	{ƛ'lạz'}	(*{ƛ'laz})	
b. IPA /xnIɹ'-Æɹ'/	{xniɹ'-ɑɹ'}	(*{xniɹ'-æɹ'})	'gooseberry bush'
NA /xnIz'-Æz'/	{xniz'-ạz'}	(*{xniz'-az'})	
c. IPA /mxÆɹ/	{məxɑɹ}	(*{məxæɹ})	'huckleberry' (Lower dialect)
NA /mxÆz/	{məxạz}	(*{məxaz})	

(9) Upper St'át'imcets Forms

a. IPA /t͡ɬʼlÆɹ'/	{t͡ɬʼlæɹ'}	(*{t͡ɬʼlɑɹ'})	'canoe'
NA /ƛ'lÆz/	{ƛ'laz}	(*{ƛ'lạz})	
b. IPA /xnIɹ'-Æɹ'/	{xniɹ'-æɹ'}	(*{xniɹ'-ɑɹ'})	'gooseberry bush'
NA /xnIz'-Æz'/	{xniz'-az'}	(*{xniz'-ạz'})	
c. IPA /ʃ-ʁÆɹ-xÆl/	{ʃ-ʁæɹ-xæl}	(*{ʃ-ʁɑɹ-xæl})	'something that one has piled up'
NA /sʕÆz-xÆl/	{sʕaz-xal}	(*{sʕạz-xal})	

This dialectal difference is observed by Egesdal and Thompson (1993:103), who cite the forms in (8a) and (9a) to illustrate it. They analyse the lack of {ɑ} preceding /ɹ'/ in (9a) as indicating a dental approximant that is "losing velarisation". No diachronic claim will be made here. The difference illustrated by forms like those in (8) and (9) is here analysed as showing that the synchronic nature of these consonants differs across the two dialects, *viz*., in the terms of van Eijk, and Egesdal and Thompson, and under the analysis 'a retracted consonant retracts an immediately preceding vowel', that only underlyingly retracted /ẓ ẓ'/ occur in the Lower dialect and only underlyingly non-retracted /z z'/ occur in the Upper dialect. Acoustic support for this analysis will be presented in §3.2.1.5.7.

3.2.1.5.2. Underlying Retracted /c̣ ṣ ḷ ḷ'/

As discussed above, previous analyses of St'át'imcets (van Eijk 1985, Remnant 1990, Bessell 1992) have claimed that retracted {c̣ ṣ ḷ ḷ'} occur in 'retracted roots'. Remnant and Bessell hypothesise that they are the product of morphemic retraction. That is, they claim that underlying non-retracted /c s l l'/ surface as {c̣ ṣ ḷ ḷ'} via a floating retraction feature which is lexically associated with specific roots. A retraction feature associated with certain root morphemes has been proposed by Kuipers (1973, 1981, 1990) for Salish languages, including Nxa'amxcin, Okanagan, Colville, Spokane and Coeur d'Alene (all Southern Interior Salish). Doak (1992) adopts Kuiper's analysis for Coeur d'Alene.

However, Bessell and Czaykowska-Higgins (1991:5-7) argue on the basis of distributional evidence that Salish retracted consonants are actually underlyingly retracted. Discussing retracted roots in Nxa'amxcin (Interior Salish), they state:

> "In Nxa'amxcin retraction on alveolar consonants and on vowels... is not predictable in roots... Of these 56 roots [their retracted root corpus], 22 contain no underlying vowel. The existence of so many vowelless retracting roots indicates that retraction cannot be underlyingly associated with vowels. There thus remain two options: 1) that it is a floating feature;

> 2) that it is associated with consonants underlyingly... [E]very retracting root in Nxa'amxcin contains at least one alveolar consonant... Given the correlation between retraction and the presence of an alveolar in the root, we suggest that retraction is an underlying property of alveolar consonants, and that, therefore, Nxa'amxcin has two series of alveolars, one retracted and the other unretracted."

Statistics on retracted roots in the van Eijk (1987) St'át'imcets dictionary are as follows: the dictionary contains 172 retracted roots and three retracted suffixes.[6] Of the 175 retracted forms, 44 are vowelless roots. (For this check, roots were identified as vowelless if their only vowel is one transcribed by van Eijk as 'ə̣' or 'ə', based on the evidence of Kinkade (1993, to appear), Czaykowska-Higgins (1993, 1995), Matthewson (1994), and Shaw (1996d) that those vowels are not an underlying part of the root. This issue will be discussed in §3.2.2.2 for further discussion.) Of the 44 vowelless retracted roots, 29 contain one of retracted {c̣ ṣ ḷ ḷ'}. Those 29 are listed in (10). The remaining 15 vowelless retracted roots will be discussed in §3.2.1.5.6. (For roots in (10) which van Eijk does not gloss, an example word containing the root is provided. The symbol '*' marks a rarely used form. Page numbers refer to van Eijk (1987).)

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[6]This count does not include Lower dialect forms in which a vowel that van Eijk transcribes as retracted occurs immediately preceding a dental glide, e.g., {pạẓisnak} 'young bird of any kind' (Lower dialect) [p.40], as the retraction of such a vowel is attributable to the immediately following {ẓ}. (Van Ejjk 1987 contains no retracted roots in which the retracted vowel immediately precedes a uvular obstruent. If there were such roots, the retraction would be attributable to the immediately following uvular.)

(10) St'át'imcets Vowelless Retracted Roots Containing One of { c̣ ṣ ḷ ḷ'} (from van Eijk (1987))

a. /p ṣ /	(?) *cf.* {n-pəṣ-pəṣ-ɬni w't}* 'soft spot on side of body, between lowest rib and hip' [p.29]
b. /p ḷ xʷ/	*cf.* {pəḷxʷ-an} 'to stick something out (from something) (tr.)' [p.34]
c. /p' ṣ /	'protruding (?)' [p.42]
d. /m' ṣ /	*cf.* {m'əṣ-m'əṣ} 'willow grouse, ruffed grouse' (Lower dialect) [p.48]
e. /t ṣ /	*cf.* {təṣ-p}'to trill, vibrate (like something hollow being struck or a table when hit with a fist; sound made by a squlirrel' [p.56]
f. /t ḷ /	*cf.* {təḷ-ən} 'to spin string from a ball (tr.)' [p.58]
g. /c̣m'qʷ/	*cf.* {c̣əm'-c̣m'əqʷ} 'to sink into the mud; (road) is muddy' [p.68]
h. /c̣c̣ḷṣ/	*cf.* {ṣ-c̣ə c̣əḷṣ}* '(deerhoof) rattle' [p.69]
i. /c̣ḷ/	(?) *cf.* {c̣ḷ-aqs-tən}* 'nose of moose' [p.70]
j. /c̣k/	*cf.* {c̣ək-a-c̣ək-a} 'bluejay; sound made by a bluejay when bringing bad news (esp., when announcing that someone will die') [p.71]
k. /c̣'ṣ/	(?) *cf.* {c'əṣ-ẓ-əqs}* 'nostrils of moose' [p.82]
l. /c̣'ḷ/	(?) *cf.* {n-c̣'ḷ-ạn?-am} 'to be really listening' [p.84]
m. /c̣'ḷ s/	'kingfisher' [p.85]
n. /ṣ p ḷ /	'shovel' (Lower dialect; borrowing from English) [p.96]
o. /ṣ ƛ'/	*cf.* {ṣ əƛ'-p} 'deflated, air has gone out of something' [p.99]
p. /ṣ ḷ/	(?) *cf.* {ṣḷ-ạḷc} 'cliff, bluff, drop-off' [p.101]
q. /ṣw/	'to take or peel off (?)' [p.108]
r. /ƛ'ṣ/	*cf.* {ƛ'əṣ-ən} 'to trample something down, to pack something down (e.g., soil on grave) (tr.)' [p.123]
s. /ƛ' ḷ/	(1); *cf.* {ƛ'əḷ-p} 'noisy' [p.126]
t. /ƛ' ḷ/	(2); *cf.* {ka-ƛ'ḷ-əp-a} 'to get sprained' [p.126]
u. /ƛ' ḷ/	(3); *cf.* {ƛ'ḷ-iḷx} 'to hover' [p.126]
v. /ɬc̣/	'to cave in, to get caved in' [p.135]
w. /ɬṣ/	'to cave in' [p.146]
x. /kḷ'/	*cf.* {ka-kəḷ'-s-as-a} 'to catch sight of something, to catch a glimpse of something (tr.)' [p.157]
y. /k' ḷ/	*cf.* {k'əḷ-xal} 'to make a mark by scratching something, by cutting into it (intr., tr.)' [p.169]

z. /kʷ ḷ/ *cf.* {kʷḷ-iʔ} 'green' [p.181]

aa. /xʷ ḷ/ *cf.* {xʷə̣ḷ-p} 'breeze is blowing, draft is coming through' [p.200]

bb. /q ḷ/ 'bad; old, worthless (e.g., clothing)' [p.212]

cc. /w ḷ/ *cf.* {wə̣ḷ-wə̣ḷ-əm} 'shiny (like a window reflecting in the sun)' (Upper dialect) [p.280]

The data in (10) constrast with a great number of St'át'imcets forms which contain one of {c s l l '} and no retracted segments: e.g., {tʃutʃin} 󰀀 {cucin} 'mouth'; {kæɬæʃ} 󰀀 {kaɬas} 'three'; {n-kəl-kluʃ} 󰀀 {n-kəl-klus} 'to go in front of the houses'; {k'æl'-æn'} 󰀀{k'al'-an'} 'to listen (intr.)', etc.

A first hypothesis with respect to (10) is that the retraction observed in each root is underlyingly the property of the retracted consonants, in other words, that St'á'timcets {c̣ ṣḷḷ'} are underlyingly /c̣ ṣ ḷ ḷ'/. This is the conclusion of Bessell and Czaykowska-Czaykowska-Higgins (1991) for Nxa'amxcin, as discussed above, based on their examination of Nxa'amixcin data parallel to those in (10). A second hypothesis is that the retraction is underlyingly a floating feature associated with the root morpheme. As noted earlier, this analysis was proposed by Kuipers (1973, 1981, 1990).[7] It will be argued below that a consonantal analysis is tenable and a floating feature analysis is not.

The crucial observation from (10) is that each root contains a consonant from the set: {c̣ ṣ ḷ ḷ'}. A floating feature analysis would claim that (i) the St'át'imcets underlying

[7]A third hypothesis with respect to retracted roots in general is that the retraction is underlyingly the property of a vowel. Because the roots in (10) are vowelless, this hypothesis is disqualified with respect to (10). The possibility that St'át'imcets retraction might be underlyingly the property of a vowel in some roots will be discussed shortly.

consonantal inventory contains non-retracted /c s l l'/ and does not contain retracted /ç ṣ ḷ ḷ'/; (ii) each underlying root in (10) contains a floating retraction feature; (iii) /c s l l'/ participate in a phonological alternation whereby they surface as retracted {ç ṣ ḷ ḷ'} in roots which contain a floating retraction feature and as non-retracted {c s l l'} in roots which do not.

However, the problem is that St'át'imcets /c s l l'/ do not form a natural class. The discussion that follows first reviews the notion 'natural class'. It then shows that St'át'imcets /tʃ ʃ l l'/ □ /c s l l'/ are not a natural class. Finally, it explains why this is a problem for a floating feature analysis of (10).

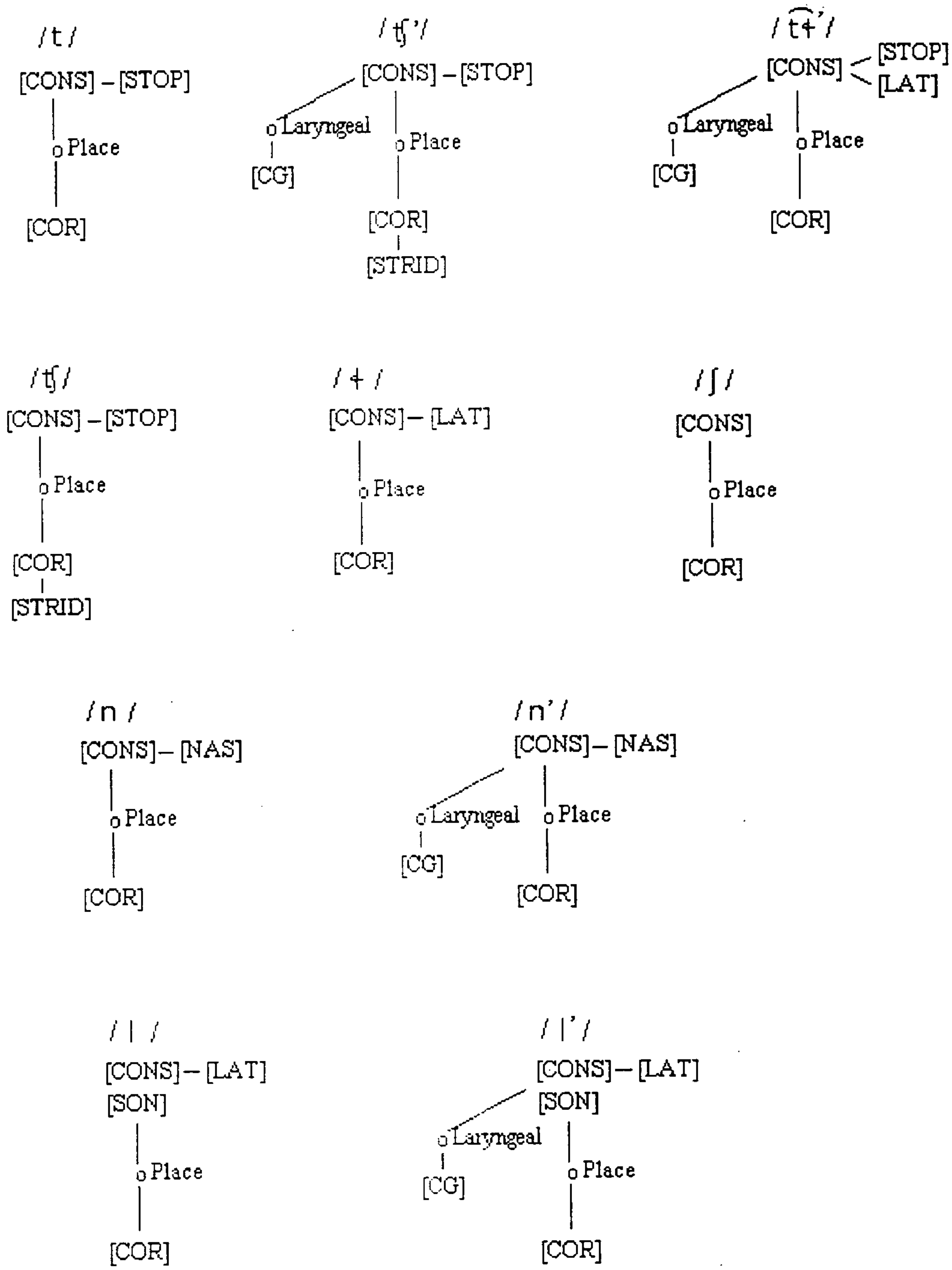
A natural class is defined by Kenstowicz (1994:18) as a grouping of phonological sounds that tend to pattern together in the overall fabric of any given language. In this thesis, phonological sounds are referred to as '(phonological) segments'. A natural class is comprised of segments that can be referred to by the phonology to the exclusion of all other segments. (See Kenstowicz (1994:93) for discussion of a Serbo-Croatian natural class consisting of /r/ and /n/ to the exclusion of /t/.) In generative phonology, natural classes are defined in terms of phonological features: a natural class includes all segments that are specified for a certain feature or set of features and excludes all those that are not.

Consider the representations in (11), which are here assumed for the St'át'imcets coronals /t tʃ' t͡ɬ' tʃ ɬ ʃ n n' l l'/. (The [STRID] specification for the affricates follows Shaw 1989, 1991 and LaCharité 1993.)

Assuming (11), /tʃ ʃ l l'/ are not a natural class: they are not the class of (primary) [COR] consonants, as /t tʃ' t͡ɬ' ɬ n n'/ are also specified for [COR]. Nor are they a natural [COR] subclass. St'át'imcets has several [COR] subclasses: e.g., the class of segments specified for ([COR] and) [STOP], [LAT], [CG], [STRID], [SON], and [NAS], respectively. As seen from (11), the segments in /tʃ ʃ l l'/ are not all specified for a certain one of these features, or a certain set of these features, where that feature or set of features is not borne by any of /t tʃ' t͡ɬ' ɬ n n'/.

3.2.1. Consonantal Inventory

(11) The Representations of St’át’imcets Coronals /t ʧ’ t͡ɬ’ ʧ ɬ ʃ n n’ l l’/



Kenstowicz (1994:19) summarises two fundamental roles that natural classes have in phonology: they define the set of segments participating in a phonological alternation and define a conditioning environment for the alternation. Stated differently, claim (iii) of a floating feature analysis is that /tʃ ʃ l l'/ □ /c s l l'/ is the set of segments participating in a retraction alternation conditioned by the environment of a floating retraction feature. However, the obvious problem is that since /tʃ ʃ l l'/ □ /c s l l'/ are not a natural class, they cannot participate in a phonological alternation. Claim (iii) of a floating feature analysis is thus considered untenable. On this basis, a floating feature analysis of (10) is rejected here.

On the other hand, the fact that /tʃ ʃ l l'/ □ /c s l l'/ are not a natural class confirms a consonantal analysis, as follows: since they are not a natural class, the St'át'imcets phonology cannot reference them to the exclusion of all other segments. A retraction feature thus cannot become associated with them in the phonology. In other words, the association between a retraction feature and each of /tʃ ʃ l l'/ □ /c s l l'/ cannot be predictable. This means it is unpredictable. Because unpredictable phonological sound properties are underlying, it is here concluded that {c̣ ṣ ḷ ḷ'} in (10) are underlyingly retracted /c̣ ṣ ḷ ḷ'/.

A relevant question at this point is: are {c̣ ṣ ḷ ḷ'} underlyingly retracted also in roots which contain an underlying vowel? Or can the retraction in such roots be analysed as underlyingly the property of the vowel? Further statistics from van Eijk (1987) are: of the 175 retracted morphemes, 131 contain an underlying vowel. Of those 131, 104 contain one of {c̣ ṣ ḷ ḷ'}. Some of the 104 are presented in (12). (The remaining 27 will be discussed in §3.2.1.5.6.).

(12) St'át'imcets Retracted Roots Containing an Underlying Vowel and One of
{ç̣ ṣ ḷ ḷ'} (from van Eijk (1987))

a. /pÆḷ/ (?) *cf.* {paḷ-pəḷ-t} 'stubborn' [p.33]

b. /mUḷ/ (?) *cf.* {muḷ'-k} 'to stand or lie back to back' [p.51]

c. /q'yÆṣ/ 'protruding (?)' [p.229]

d. /x̌ʷÆṣ/ *cf.* {x̌ʷạ-x̌ʷ-ṣ} 'forked (e.g., frame of a slingshot)' [p.259]

Younes (1982:41-46,60-71) addresses this issue with respect to emphasis in Palestinian Arabic. He rejects a vocalic analysis of Palestinian emphasis on two grounds. His arguments will be summarised next. The data in (12) will then be discussed in light of his arguments.

Younes' first argument is acoustic and concerns the Palestinian non-low vowels: acoustic data, which he provides, show that in the context of an emphatic, the non-low vowels do not have a steady lowered F_2. (This is also shown by the spectrograms in Figures 2:42 and 2:43.) He interprets a steady lowered F_2 as an emphatic acoustic target; this is also the interpretation of the present study, as discussed in §2.5.5.2. His finding, then, is that tokens of the non-low vowels do not have an emphatic target. He argues that this is a problem for a vocalic analysis because if the non-low vowels were the underlying source of the emphasis, an emphatic target would be expected. Because the acoustic data show no emphatic target, he concludes that the non-low vowels are not underlyingly emphatic.

Younes' second argument is distributional and concerns the low vowels: the backed variants of the Palestinian low vowels occur in a word containing an emphatic; the front variants do not. (Blocked contexts are ignored here). That is, the two variants are in complementary distribution. He takes this as strong indication that the backing of the low vowels is an effect due to the emphatic consonant.

Returning to the data in (12), a vocalic analysis would claim that retracted high vowels in roots like (12b) are underlyingly retracted, e.g., that (12b) is underlyingly /mỤl/, not /mUḷ/. This predicts that tokens of such high vowels have a retracted acoustic target. This prediction awaits testing elsewhere. (It was not tested in the present study due to lack of data.)

With respect to the non-high vowels, (13) presents pairs of forms from van Eijk (1987) in which the epenthetic vowel and /Æ/ occur immediately preceding one of non-retracted {c s l l'}, vs. immediately preceding one of retracted {c̣ ṣ ḷ ḷ'} in a retracted root.

(13) (data from van Eijk (1987))

a.	i. /c'l/	{c'əl}	'edge, rim, fence' [p.84]
	ii. /c'ḷs/	{c'ə̣ḷs}	'kingfisher' [p.85]
b.	i. /ɬc-xÆl/	{ɬəc-xál}	'to pile up big objects (intr., tr.)' [p.135]
	ii. /ɬc̣/	{ɬə̣c̣}	'to cave in, to get caved in' [p.135]
c.	i. /mÆl-n/	{mál-ən}*	'to raid (them) (tr.)' [p.50]
	ii. /mÆḷ-ÆlUs/	{mạ́ḷ-alus}	'raccoon' [p.51]
d.	i. /ɬÆsm/	{ɬásəm}*	'Indian rice'
	ii. /ɬÆṣ/	{ɬạṣ}	'driftnet' [p.135]

The generalisation illustrated by (13) is: the epenthetic vowel and /Æ/ surface non-retracted when immediately preceding one of non-retracted {c s l l'}; when immediately preceding one of retracted {c̣ ṣ ḷ ḷ'} in a retracted root, they surface retracted. That is, for each non-high vowel, the non-retracted and retracted variants are in complementary distribution. Given this, following Younes (1982), the retracted vowels in each (ii) form in (13) are here analysed as conditioned by the immediately following retracted consonant. This counters a vocalic analysis of data such as those in (12).

However, the following grounds alone are here considered sufficient to disqualify a vocalic analysis: a vocalic analysis would claim that /c s l l'/ participate in a phonological alternation whereby they surface as retracted {c̣ ṣ ḷ ḷ'} in roots which contain an underlying retracted vowel. This claim is considered untenable. As argued above, /c s l l'/ cannot participate in a phonological alternation because they are not a natural class.

Based on the foregoing arguments, it is concluded that (i) vowels in retracted roots like those in (12) are not underlyingly retracted; (ii) {c̣ ṣ ḷ ḷ'} are underlying /c̣ ṣ ḷ ḷ'/ also in retracted roots that contain a vowel.

3.2.1.5.3. Perceptual Support For the Claim that the Retracted Consonants and Uvular Obstruents are Emphatics

This section presents preliminary perceptual support for the claim that the St'át'imcets retracted consonants and uvular obstruents are emphatics. In a pilot perceptual study, four literate native Arabic speakers (three Palestinian speakers, one Syrian speaker) judged whether tokens of St’át’imcets retracted consonants, and uvular and velar obstruents were Arabic *sīn* (س = /s/) or *sād* (ص = /s̙/), *thal* (ذ = /ð/) or *thā* (ظ = /ð̙/), *lam* (ل, = /l)/) or *lam mfaxxama* (= /l̙/ as in ⟨ ʔʌ̙́l̙.l̙ɜ˃h̙⟩ ‘God’, which was denoted by the judges as ‘ل̣’),[8] *kāf* (ك = /k/) or *qāf* (ق = /k̙/). (Recall that St’át’imcets /ʃ̙/ is produced with alveolar articulation like Arabic /s̙/.) All the judges were linguistically untrained. They were presented with two tokens each of nine real St’át’imcets words, each of which contained a retracted consonant, or a uvular or velar obstruent. The words were spoken by a native speaker of Lower St’át’imcets who also acquired the Upper dialect as an adult.[9] The subjects were instructed to pay attention to a specified consonant sound in each word and to write the Arabic letter corresponding to what they perceived it to be. They were permitted to listen to the tokens of each word up to four times. The carrier words and the subjects’ written responses are presented in Table 3:3. (‘J’ = judge.)

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[8]There is no Arabic letter to denote /l̙/ as distinct from non-emphatic /l/.

[9]The bidialectal speech of the consultant showed up in the tape-recorded carrier words, in a varying alveolar lateral ~ interdental articulation of /ɹ̙ ɹ̙’/. As noted in §3.2.1.3, the former articulation is typical for the Upper dialect, the latter for the Lower dialect.

Table 3:3

Arabic judgments of St’át’imcets retracted consonants, and uvular and velar obstruents

CARRIER WORD			JUDGMENT			
Task: Please write the Arabic sound you hear…			J1	J2	J3	J4
1.	right after n in: {n̙- ʃ̙ɑ̙l̙’-l̙’-əʧ} {ṇ-ṣạ ḷ’-ḷ’əc}	‘to drool, slobber (e.g., like cows)’	ص (/ṣ/)	ص	ص	ص
2.	that’s like l in the middle of: {n̙- ʃ̙ɑ̙l̙’-l̙’-əʧ} {ṇ-ṣạ ḷ’-ḷ’əc}	‘to drool, slobber (e.g., like cows)’	ل (/ḷ/)	ل	ل	ل
3.	at the end of: {məxɑɹ̙} {məxạẓ}	‘huckleberry’ (Lower dialect)	ظ (/ð̣/)	ظ	ذ (/ð/)	ظ
4.	at the end of: {ʧ’ʊk̙ʷɑ̙ɹ} {c’uqʷạẓ}	‘fish, (any kind of) salmon’	ظ	ظ	س (/s/)	ظ
5.	at the beginning of: {k̙ʌ̙l̙} {qə̣ḷ}	‘bad: old, worth- less (e.g., clothing)’	ق (/ḳ/)	ق	ق	ق
6.	at the end of: {k̙ʌ̙l̙k̙} {qə̣ḷq}	‘rose’	ق	ق	ق	ق
7.	at the end of: {mʌk̙’} {mə̣q’}	‘to get stuffed, to eat too much’	ق	ق	ق	ق
8.	at the beginning of: { keɰʷæʔtu} { kəwaʔtu}	(fem. name)	ك (/k/)	ك	ك	ك
9.	right after n in: { n-k’æx-æɬʧ’æʔ} { n-k’ax-aɬc’aʔ}	‘constipation’	ك	ك	ك	ك

As seen in the table, the judgments were identical for all the judges, except for minor disagreement with respect to /ɹ̘ ɹ̘’/. The interesting result is that the overall rate of emphatic identification was high. This is preliminary indication that it makes sense to describe the St’át’imcets retracted consonants and uvular obstruents as emphatics, and constitutes some support for assuming that they are produced with articulation similar to that of Arabic emphatics.

Another interpretation of the results is possible, *viz*., that they do not show that the retracted consonants and uvulars were perceived as emphatics, only that given the forced-choice task, the Arabic emphatics were just the closest thing around. However, because the judgments for /ʃ̘ l̘ l̘’ k̘ k̘’/ were absolutely clear, this interpretation is rejected here.

In a fuller perceptual study, the procedure might be refined as follows: acceptability judgments could be elicited for Arabic carrier words into which St’át’imcets /ʃ̘ ɹ̘ ɹ̘’ l̘ l̘’ k̘ k̘’/ had been spliced; they could also be elicited from St’át’imcets speakers for St’á’t’imcets carrier words into which Arabic emphatics had been spliced. It is hypothesised that such further testing would confirm the preliminary results reported here.

3.2.1.5.4. Phonological Evidence

This section presents phonological evidence that St’át’imcets retracted consonants and uvular obstruents comprise a class of underlying coronal and velar emphatics, /tʃ̘ ʃ̘ ɹ̘ ɹ̘’ l̘ l̘’/ and /k̘ k̘’ k̘ʷ k̘’ʷ x̘ x̘ʷ/, respectively.

This claim, with respect to the retracted consonants, is not entirely new: previous literature has suggested a connection between Salish retracted consonants and Arabic emphatics. Van Eijk (1985:42) cites Kuipers (1973) as using the term 'emphatic' in reference to Salish retraction. Van Eijk (1985:3) describes St'át'imcets' retracted {ṣ} as 'velarised', resembling the Arabic emphatic *sād* (ص = ṣ). The term 'velarised', which is also used by Egesdal and Thompson (1993), was used in early studies of Arabic to describe Arabic emphatics; see §1.4.2. Bessell (1992:74) states that Salish and Arabic both have 'pharyngealised' consonants. The term 'pharyngealised' has frequently been used to describe Arabic emphatics, as discussed in §1.4.2. Bessell and Czaykowska-Higgins (1991:7) describe the phonetic and phonological effects of retraction as "similar to those of Arabic emphasis". They describe retracted consonants as "parallel" to Arabic emphatics. The phonetic similarity is observed also by Bessell (to appear).

To my knowledge, the claim that the uvular obstruents are emphatic velars is new. It has analytical and theoretical implications, as discussed in §3.2.1.5.

The discussion that follows first presents independent evidence that St'át'imcets retracted consonants and uvular obstruents form a natural class. It then shows that they function as a class in triggering a harmony which will be identified as uvularisation harmony ('emphasis spread'). It will be argued that the triggering class is coherent only if the retracted coronals and uvular obstruents are recognised as emphatics.

The independent evidence that the retracted consonants and uvular obstruents are a natural class comes from a morpheme structure co-occurrence constraint noted by van

Eijk (1985:9): in St'át'imcets, roots of the type Ç VQ are banned, where 'Ç ' denotes a retracted consonant and 'Q' denotes a uvular obstruent.[10] This co-occurrence constraint indicates that the retracted consonants and uvular obstruents share some phonological feature(s) on the basis of which they form a natural class to the exclusion of all other consonants, including the uvular resonants.

Acoustic findings on St'át'imcets retracted consonants will be reported in §3.2.1.5.7. As will be discussed, the findings support the assumption that they are produced with the postvelar gestures of emphatics: uvularisation and pharyngealisation. Based on those findings and on the perceptual findings of §3.2.1.5.3, it is here claimed that the retracted consonants are emphatics with the representation in (14). (Only specifications relevant to the discussion are shown.)

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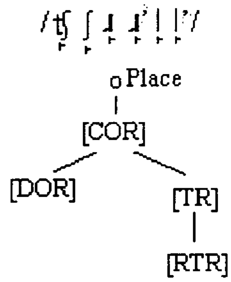
[10]In van Eijk's formulation of this constraint, 'Q' denotes any uvular. However, there are data which establish that this 'Q' class must be delimited to obstruents: e.g., in the Lower forms in (i), /ɹ̠/ □ /ẓ/ is C_1 and a uvular resonant is C_2. This shows that the uvular resonants are excluded from the constraint.

(i) a. {ɹ̠ɜʁ-ən} 'to growl at someone, to fight with someone (tr.)' (√ɹ̠ʁ)
{ẓəʕ-ən}

b. {ɹ̠i-'-ɹɜʁ'} 'each one, every one' (√ɹ̠Iʁ') (see §3.2.1.5.5 for discussion of why the rightmost /ɹ̠/ in this form is analysed as {ɹ}, not {ɹ̠})
{ẓi-ʔ-zəʕ'}

c. {ɹ̠ɜʁm-æ-mn'ək} 'sidehill' (√ɹ̠ʁm).
{ẓəʕm-a-mn'ək}

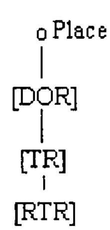
(14) The Representations of St'át'imcets Coronal Emphatics /tʃ̙ ʃ̙ ɹ̙ ɹ̙ʼ l̙ l̙ʼ/



In chapter 2, simultaneous specification for [DOR] and secondary-[RTR], as in (14), was proposed as the representation of secondary uvular articulation. It was further proposed that, as that representation includes the representation of secondary pharyngeal articulation (*viz.*, secondary-[RTR]), the pharyngealisation of emphatics automatically follows from their uvularisation. See §2.3.1 for further discussion.

The representations which are here assumed for primary velar and primary uvular segments are presented in (15); these representations are based on the evidence discussed in §2.3.1.

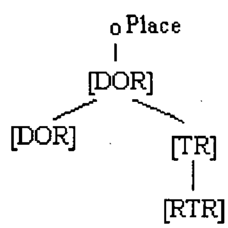
(15) a. primary velar b. primary uvular



Assuming (14) - (15), there are two ways for St'átimcets emphatic coronals and uvulars obstruents to form a natural class to the exclusion of all other segments. The uvulars could be just that: primarily uvularised consonants represented as (15b). In that case, they would pattern with emphatics by virtue of specification for secondary-[TR]. (I know of no data which indicate that [ATR] is active in St'át'imcets. Assuming [ATR] is not active, [TR] suffices to identify the St'át'imcets segments that are specified for [RTR].) Note that they could not pattern exclusively with emphatics based on [DOR], as [DOR] patterning between them would be 'A' harmony, that is, harmony of either primary- or secondary-[DOR]. [DOR] A harmony would necessarily include primary velars, as seen from (15a).

Alternatively, the uvulars could be emphatic velars, *viz.*, (16). (For previous discussion of the representation in (16), see §2.3.1.) Emphatic velars can pattern with other emphatics on the basis of secondary-[DOR] and/or secondary-[TR].

(16) The Representation of Emphatic Velars



Thus, the question here concerns the nature of the uvular obstruents. Are they simple uvulars or dorsal emphatics? Acoustic findings on the uvular obstruents to be presented in §3.2.1.5.7 support the assumption that the uvular obstruents are produced with primary uvular articulation and pharyngealisation. However, as previously noted, primary uvulars and velar emphatics are assumed to be produced with the same articulations, *viz.*, primary uvular articulation and pharyngealisation. Thus, the acoustic findings on the uvular obstruents shed no light on the question just posed. Given the same articulation presumed for the two types of segments, it is assumed that the answer to the question will have to be based on phonological evidence.

Phonological evidence is provided by forms like those in (17), compared to those in (18). In (17), the coronal emphatics and uvular obstruents function as a natural class in triggering a harmony. This harmony affects the epenthetic vowel and /Æ/, and at least /ʧ/ and /n/: when immediately preceding a uvular obstruent or a coronal emphatic, the epenthetic vowel surfaces as backed {ʌ} or {ɔ}, /Æ/ surfaces as backed {ɑ}, and underlyingly non-emphatic /ʧ/ and /n/ surface respectively as emphatic {ʧ̙} and {n̙}. (Evidence that {ʧ̙} in (17f) is underlying non-emphatic /ʧ/ will be presented in §3.5.1.)

(17)

a. IPA /tx̙/	{tʌx̙}	'bitter'
NA /tx̌/	{tə̣x̌}	
b. IPA /mk̙/	{mʌk̙}	'to get stuffed, to eat too much'
NA /mq/	{mə̣q}	
c. IPA /ʃ-pl̙xʷ/	{ʃ-pʌ̙lxʷ}	'to stick out from something (e.g., from a pocket or a house)'
NA /s-pḷxʷ/	{s-pə̣ḷxʷ}	
d. IPA /mÆk̙Æʔ/	{mɑk̙æʔ}	'snow'
NA /mÆqÆʔ/	{mạqaʔ}	
e. IPA /mxÆɹ̙/	{məxɑɹ̙}	'huckleberry' (Lower dialect)
NA /mxÆẓ/	{məxạẓ}	

f. IPA /tʃk̙ʷ-ÆnÆʔ/	{ t̙ʃk̙ʷ-ænæʔ }	'lynx'
NA /cqʷ-ÆnÆʔ/	{c̣qʷ-anaʔ}	
g. IPA /RED, n-ʃ̙Æl̙'-tʃ/	{ n̙-ʃ̙ɑl̙'-l̙'-ətʃ }	'to drool, slobber (e.g., like
NA /RED, n-ṣÆḷ'-c/	{ṇ-ṣạ ḷ'-ḷ'əc}	cows)'

No other consonants trigger this harmony, including uvular /ʁ ʁ' ʁʷ ʁ'ʷ/. This is illustrated by the data in (18). Full justification of the analysis just summarised and acoustic findings which support it will be presented in §3.5.

(18)

a. IPA /ptʃkɬ/	{ pətʃkəɬ }	(*{ pʌtʃkəɬ }, *{ pət̙ʃkəɬ })	'leaf''
NA /pckɬ/	{pəckəɬ}	(*{ pəckəɬ }, *{ pəc̣kəɬ })	
b. IPA /kÆɬÆʃ/	{ kæɬæʃ }	(*{ kɑɬɑʃ }, *{ kɑɬæʃ }, *{ kæɬɑʃ })	'three'
NA /kÆɬÆs/	{kaɬas}	(*{kạɬạs}, *{kạɬas}, {kaɬạs})	
c. IPA /t͡ɬ'pÆʔ/	{ t͡ɬ'pæʔ }	(*{ t͡ɬ'pɑʔ })	'marrow'
NA /ƛ'pÆʔ/	{ƛ'paʔ}	(*{ƛ'pạʔ})	
d. IPA /tʃʁ-n/	{ tʃɜʁ-ən }	(*{ tʃʌʁ-ən })	'to rip, tear
NA /cʕ-n/	{cəʕ-ən}	(*{cəʕ-ən})	something (tr.)'
e. IPA /s-p'Æʁ'/	{ s-p'aʁ }	(*{ s-p'ɑʁ })	'burned forest, any
NA /s-p'Æʕ/	{s-p'aʕ}	(*{s-p'ạʕ})	area where a fire went through'

f. IPA /t͡ɬ'Æk/	{t͡ɬ'æk}	(*{t͡ɬ'ɑk})	'to go (not always in a specified direction)'
NA /ƛ'Æk/	{ƛ'ak}	(*{ƛ'ạk})	

g. IPA /n-k'Æx-Æɬtʃ'Æʔ}   'constipation'

{n-k'æx-æɬtʃ'æʔ}   (*{n-k'ɑx-æɬtʃ'æʔ}, *{n̺-k'æx-æɬtʃ'æʔ}, *{n-k'æx-ɑɬtʃ'ɑʔ}, etc.)

NA /n-k'Æx-Æɬc'Æʔ/

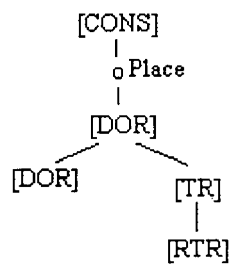
{n-k'ax-aɬc'aʔ}   (*{n-k'ạx-aɬc'aʔ}, *{ṇ-k'ax-aɬc'aʔ}, *{n-k'a x-ạɬc'ạʔ}, etc.)

The exclusion of /ʁ ʁ' ʁʷ ʁ'ʷ/ from the triggering class is here taken as evidence that the uvular obstruents are specified for some phonological feature which the coronal emphatics also bear but the uvular resonants do not. Viewed from another angle, the argumentation is: there are two kinds of uvulars: one that patterns with emphatics, e.g., in triggering a harmony such as that illustrated by (17), and one that does not. Crosslinguistic evidence for these two types of uvulars comes from Arabic; e.g., the Palestinian Arabic uvular resonants /χ ʁ/ do not pattern with coronal emphatics in triggering a harmony similar to that in (17), but the segment which is phonetically uvular [q] does. This was shown in §2.5.1.1. On this basis, following the conclusions of Trubetzkoy (1969), Jakobson (1978), and Delattre (1971), as discussed in §1.4.2, Palestinian [q] was analysed in chapter 2 as velar emphatic /k̺/. In order to account for the fact that S't'átimcets /ʁ ʁ' ʁʷ ʁ'ʷ/ do not pattern with emphatics but the segments which are phonetically [q q' qʷ q'w χ χʷ] do, it is here claimed that the latter set, like

Palestinain [q], are phonologically uvularised, not primary uvular. That is, that they are dorsal emphatics /k̘ k̘' k̘ʷ k̘'ʷ x̘ x̘ʷ/, represented as in (19). The uvular resonants are phonologically primary uvulars, represented as in (20). (In (19) and (20), only specifications relevant to the discussion are shown.)

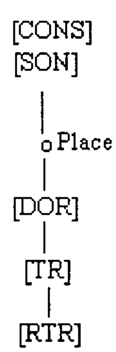
(19) The Representation of the St'át'imcets Dorsal Emphatics (a.k.a. uvular obstruents)

/ k̘ k̘' k̘ʷ k̘'ʷ x̘ x̘ʷ /



(20) The Representation of the St'át'imcets Uvular Resonants

/ʁ ʁ' ʁʷ ʁ'ʷ/



Under this analysis, /ʁ ʁ' ʁʷ ʁ'ʷ/ are excluded from the natural class comprised of the coronal and dorsal emphatics because they lack specification for secondary-[DOR]. By result, they do not trigger the harmony illustrated in (17).

A question at this point is: is the difference between the two types of uvulars necessarily representational? Could it instead be the surface effect of the constraint responsible for the harmony? An account which assumes the latter would claim: (i) the two types of uvulars are both represented as in (20), without [SON] for the uvular obstruents; (ii) the harmony observed in (17) is [DOR] A harmony, that is, harmony of [DOR] triggered by consonants which are specified for [DOR] as either a primary specification (the 'two types' of uvulars) or secondary specification (the coronal emphatics). The harmonic constraint would require that the trigger bear [DOR] but not [SON], unless it bear both [COR] and [SON], as is here assumed for the resonant /ɹ̟ ɹ̟'/. The resonants /ʁ ʁ' $ʁ^w$ $ʁ'^w$/ would be excluded from the triggering class because they bear [SON] but not also [COR].

Note, crucially: this alternative account predicts that the velar obstruents /k k' k^w k'^w x x^w/ will also trigger the harmony because, assuming (15a), they bear [DOR] and not [SON]. However, this prediction is not borne out. Velar /k k' k^w k'^w x x^w/ do not trigger the harmony. This is seen from forms like (18f-g). On this basis, a constraint account of (17) is rejected here. It is concluded that the difference between the two types of uvulars is representational.

Support for the claim that the uvular obstruents are dorsal emphatics comes from the following observation: the harmony illustrated in (17) gives rise to backed non-high vowels and surface emphatic consonants. Palestinian uvularisation harmony is triggered by emphatics, and also gives rise to backed non-high vowels and surface emphatic consonants. Based on the parallel effects for the harmony in Palestinian and in St'át'imcets, the harmony illustrated in (17) is here identified as uvularisation harmony ('emphasis spread').

In summary, this section has presented phonological evidence that St'át'imcets, has 12 emphatics: /tʃ̙ ʃ̙ ɹ̙ ɹ̙' l̙ l̙ ' k̙ k̙' k̙ʷ k̙'ʷ x̙ x̙ʷ/. Based on this evidence, on the perceptual support of §3.2.1.5.4, and on the anticipated acoustic support of §3.2.1.5.7, it is here claimed that the consonants which been previously analysed as retracted coronals and uvular obstruents are emphatics.

3.2.1.5.5. /ɹ̙ ɹ̙'/ De-emphaticisation in Lower St'át'imcets

In the Lower dialect forms in (21), /I/ surfaces immediately preceding one of /tʃ̙ ʃ̙ l̙ l̙' k̙ k̙' k̙ʷ k̙'ʷ x̙ x̙ʷ/. ('GLOT' denotes a morpheme which surfaces as infixal {-'-}; see van Eijk (1985:82-85) for further discussion. Van Eijk (1985, 1987) transcribes forms with a GLOT morpheme as containing a glottal stop rather than a glottalised vowel, yielding, e.g., the transcription {ki̩-ʔ-x̌} for (21d). The basis for their present transcription with a glottalised vowel will be presented in §3.5.6.)

(21) Lower dialect forms

a. IPA /n-ʃ-p'x̙I̙l'/	{ n-ʃ-p'x̙ɪ̙l'}	(*n-ʃ-p'x̙il̙ '})	'stingy'
NA /n-s-p' x̌Iḷ/	{n-s-p'x̌ịḷ}	(*{n-s-p'x̌iḷ})	
b. IPA /mIx̙Æɬ/	{ mɪx̙æɬ}	(*{ mix̙æɬ})	'black bear'
NA /mIx̌Æɬ/	{mịx̌Æɬ}	(*{mix̌Æɬ})	
c. IPA /tʃIk̙-In'/	{ tʃɪk̙-in'}	(*{ tʃik̙-in'})	'to stab someone (tr.)'
NA /cIq-In'/	{cị q-in'}	(*{ciq-in'})	
d. IPA /GLOT, kIx̙/	{ kɪ-'-x̙}	(*{ ki-'-x̙})	'cranky (child), fussing
NA /GLOT, kIx̌/	{kị-'-x̌}	(*{ki-'-x̌})	(because it wants attention or is sick)' or is sick)'

The generalisation illustrated by (21) is that Lower dialect /I/ surfaces as rtr { ɪ} immediately preceding an emphatic. In §3.4, this rtr effect will be analysed as tongue-root-retraction ('pharyngealisation') harmony with the following emphatic. It will be shown that St'át'imcets pharyngealisation harmony is triggered by both gutturals and emphatics.

In the Lower dialect forms in (22), /I/ surfaces immediately preceding one of /ɹ̙ ɹ̙'/. In this context, /I/ surfaces as non-rtr { i}. In (22), the dental approximants which immediately follow /I/ are transcribed as surface non-emphatic. The reason for this will be explained below.

(22) Lower dialect forms

a. IPA /xnIɹ̙ʾ-Æɹ̙'/	{xniɹ'-ɑɹ̙'}	(*{xnɪɹ̙'-ɑɹ̙'})	'gooseberry bush'
NA /xnIẓ'-Æẓ'/	{xniz'-ạẓ'}	(*{xnị ẓ'-ạẓ'})	
b. IPA /GLOT, ɹ̙Iʁ'/	{ɹ̙i -'-ɹɜʁ'}	(*{ɹ̙ɪ-'-ɹ̙ɜʁ'})	'each one, every one'
NA /GLOT, ẓIʕ'/	{ẓ'i-'-zəʕ'}	(*{ẓ'ị-'-ẓəʕ'})	

The generalisation from (21) and (22) is that Lower dialect /I/ surfaces as rtr {ɪ} immediately preceding an emphatic, except when the emphatic is rhotic /ɹ̙/ or /ɹ̙'/. This has been observed by van Eijk (1985:8) and Egesdal and Thomspon (1993:103). (Both those studies refer to rtr {ɪ} as 'retracted ị'.)

The exceptional behaviour observed for Lower dialect /I/ in (22) is analysed here as the result of de-emphaticisation of Lower dialect /ɹ̙ ɹ̙'/ in the context of an immediately preceding /I/. That is, /ɹ̙ ɹ̙'/ surface as non-emphatic /ɹ ɹ'/ immediately preceding /I/. This is supported by data such as those in (23). In each form in (23), /ɹ̙(')/ functions as an emphatic by triggering uvularisation harmony on the immediately preceding /Æ/. This shows that Lower dialect /ɹ̙(')/ behaves as an emphatic when not in the context of an immediately preceding /I/.

(23) Lower dialect forms

a. IPA /mxÆɹ̘/	{məxɑɹ̘}	(*{məxæɹ})	'huckleberry'
NA /mxÆẓ/	{məxạẓ}	(*{məxaz})	
b. IPA /ʧ'Ụkʷ̘Æ̘ɹ̘'/	{ʧ'ʊ̘kʷ̘ɑɹ̘'}	(*{ʧ'ʊkʷ̘æɹ'})	'fish, (any kind of)
NA /c'Uqʷ Æẓ/	{c'ụqʷạẓ}	(*{c'ụqʷ az})	salmon'
c. IPA /xnI̘ɹ̘'-Æɹ̘'/	{xniɹ'-ɑɹ̘'}	(*{xniɹ'-æɹ'})	'gooseberry bush'
NA /xnIẓ'-Æẓ'/	{xniz'-ạẓ'}	(*{xniz'-az'})	

Alternatively, the effects in (23) could be analysed as showing emphaticisation of an underlyingly non-emphatic /ɹ(')/ in the context of an immediately preceding /Æ/. Under this analysis, the effects in (22) would not show de-emphaticisation, but the expected non-emphatic behaviour of a non-emphatic /ɹ(')/.

This alternative analysis is not adopted here because it leads to a theoretical account which is less economical and therefore less desirable than the one to be presented later in this chapter on the basis of the proposed analysis: an account based on the alternative analysis would claim that /ɹ(')/ in (22) surfaces emphatic under harmony with an immediately preceding underlyingly emphatic /Æ̘/. Such a claim entails an enrichment of the St'át'imcets underlying vowel inventory and leads to a more complex account of the derivation of the underlying vowel inventory than that to be proposed in §3.4.2.

The de-emphaticisation of the Lower dialect rhotics is similar to the de-emphaticisation of the Palestinian rhotic /r̘/. As discussed in §2.2.1.3.2, Palestinian /r̘/ also de-emphaticises in the context of /I/. For St'át'imcets, the de-emphaticisation means that the Lower dialect surface consonantal inventory contains both emphatic {ɹ̘ ɹ̘'} and non-emphatic {ɹ ɹ'}. Acoustic data which are consistent with this analysis will be presented in §3.1.2.5.7.

A theoretical account of the analysis described in this section will not be presented in this chapter. (An account of Palestinian /r/ de-emphaticisation was likewise not undertaken in chapter 2.) Van Eijk (1985:8) states that of 'retracted ə̣' and 'ə', only the latter occurs immediately preceding a dental glide in both Lower and Upper dialects. This further observation will not be pursued here. Close investigation of the behaviour of Lower /ɹ̙ ɹ̙'/ and Upper /ɹ ɹ'/ in the context of the epenthetic vowel, and /U/, is deferred for work elsewhere; but see §3.2.2.3 for a preliminary observation on Lower /ɹ̙ ɹ̙'/ immediately following /U/.

3.2.1.5.6. Forms with a Floating Emphasis Feature

This section discusses the St'át'imcets retracted roots that were left unexamined in §3.2.1.5.2, *viz.*, those which do not contain one of (what were identified in §3.2.1.5.4 as) underlying emphatic /ʧ̙ ʃ̙ l̙ l̙'/. The van Eijk (1987) dictionary lists 42 such roots. Fifteen are vowelless. They are presented in (24). The surface forms in (24) show the vowel effects documented by van Eijk, on which basis he classifies these roots as retracted.

3.2.1. Consonantal Inventory

(24) St'át'imcets Vowelless Retracted Roots without /tʃ̣ ʃ̣ ḷ ḷ'/ (from van Eijk (1987))

a. /pm/ *cf.* {pə̣m-p} '(to go) fast, (to be) quick' [p.27]

b. /pt/ (1); *cf.* {ka-pə̣t-a} 'to get squished, squashed' [p.27]

c. /pt/ (2); *cf.* {pə̣t-ạt-ət} 'to make a bubbling, gurgling noise' [p.27]

d. /p'ƛ'/ *cf.* {p'ə̣ƛ'-ən} 'to plop something down (tr.)' [p.43]

e. /mmp/ *cf.* {mə̣mp} 'sound made by tires on a road' [p.46; possibly reduplication of /mp/]

f. /mc'/ *cf.* {mə̣c'-ən}* 'to put something under something, tr.' [p.48]

g. /c'n/ *cf.* {c'ə̣n'-p} '(to make a) ringing sound' [p.82]

h. /ƛ'p/ *cf.* {ƛ'ə̣p} 'to sprain' [p.121]

i. /ɬp'/ *cf.* {ka-ɬə̣p'-a} 'to flop over something (e.g., over a log), to just lie there, to do nothing (lazy person)' [p.134]

j. /ɬmk/ *cf.* {ɬə̣mk} 'broken, not useable any more' [p.135]

k. /ɬn/ *cf.* {ɬə̣n-p} 'sound of things vibrating (e.g., when a logging truck passes a house)' [p.135]

l. /ɬƛ'/ *cf.* {ka-ɬə̣ƛ'-a} 'to get soaking wet (e.g., clothes in the rain)' [p.135]

m. /ɬk/ *cf.* {ka-ɬə̣k-a} 'to get pooped, to conk out' [p.136]

n. /k'ɬ/ *cf.* {k'ə̣ɬ} 'mud, thick liquid' [p.169]

o. /ɣn'/ *cf.* {ɣə̣n'-p} 'to freeze (persons), to freeze to death' [p.207]

Of the remaining 27 which contain an underlying vowel, 17 are presented in (25). The other 10 of those 27 roots are here considered outside the regular phonology: 9 are analysed as unassimilated borrowings; one is an interjection.[11]

(25) St'át'imcets Vowel-ful Retracted Roots without /ʧ̙ ʃ̙ l̙ l̙'/ (from van Eijk (1987))

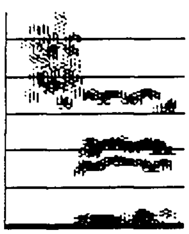
a. /p'Iɬ/	*cf.* {p'ịɬ} 'flat, low' [p.43]
b. /mÆc'Ul/	*cf.* {mạ́c'ụl} 'pus' [p.48]
c. /tÆɬÆʔ/	*cf.* {tạ́ɬạʔ} 'tongue' [p.58]
d. /tʊk^{w}Æy'/	*cf.* {tụ́-tk^{w}ạy'} 'to shoot the target (as a sport)' [p.60]
e. /tÆʔ/	*cf.* {tạʔ} 'no!; don't' (nursery term) [p.66]
f. /c'Æp/	(1) *cf.* {c'ạ-ʔ-p} 'sour (from fermentation)' [p.80]
g. /c'Æp/	(2) *cf.* {c'ạ́-c'p} 'whitefish' [p.80]
h. /c'ÆʔmIq^{w}/*	*cf.* {c'ạ́ʔmiq^{w} # c'ə́-c'paʔ} 'great-grandfather' [p.95]
i. /ƛ'Uc'/	*cf.* {n-ƛ'ục'-al-ús-əm} 'to wink (intr.)' [p.122]
j. /ɬUt/	*cf.* {ɬụ́t-xal} 'to squish something (esp., a bug) (intr, tr.)' [p.135]
k. /ɬUƛ'/	*cf.* {ɬụ́ƛ'-əƛ'} 'sound made when drinking (gurgling, bubbling), sound of something boiling' [p.135]
l. /x^{w}ʔÆz/	*cf.* {x^{w}ʔạz} 'no, not (it is not the case that...); nothing; to be gone' (Upper dialect) [p.205]
m. /x̌^{w}Uƛ'/	*cf.* {x̌ụ́ƛ'-l-əqs-am'} 'to make a noise through one's nose' [p.248]
n. /x̌^{w}Uptx/	*cf.* {s-x̌^{w}ụ́ptəx} 'stupid; not strong' (Upper dialect) [p.257]
o. /yIt/* (?)	*cf.* {yətạʔyíʔtạʔ} 'mud-trampling game' [p.285]
p. /ʔIstÆʔ/	*cf.* {ʔístạʔ} (possibly means something like 'go on!') [p.311]
q. /-ÆyÆ/	*cf.* {x^{w}ic'-am-ạ́ya} 'teeter-totter' [p.357]

[11]The 9 borrowings and one interjection in van Eijk (1987) are:

(i) a	/pÆtÆk/	*cf.* {pạtạk} 'potato' (borrowing from French) [p.28]
b	/pÆy/	*cf.* {pạy} 'pie' (borrowing from English) [p.40]
c	/pÆyp/	*cf.* {pạyp} 'five' (borrowing from English) [p.40]
d	/pÆyt/	*cf.* {pạyt} 'to fight' (Lower dialect; borrowing from English) [p.40]
e	/tÆUn/	*cf.* {tạun} 'town' (borrowing from English) [p.57]
f.	/tÆktÆ/	*cf.* {tạkta} 'doctor' (borrowing from English) [p.59]
g	/tÆkn-Æm/	*cf.* {tạkn-am} 'to knit (intr.)' (borrowing from English '(knitted) stocking') [p.59]
h	/kÆh/	*cf.* {kạh} 'car, train' (borrowing from English) [p.161]
i.	/k^{w}ÆtÆ/	*cf.* {k^{w}ạta} 'quarter (coin)' (borrowing from English) [p.176]
j.	/wÆʔ/	*cf.* {wạʔ} (expression of disbelief used by men) [p.284]

The roots in (24) and (25) contain no perceptually emphatic consonants. The vowel effects observed in surface forms which contain these roots are assumed here to be due to a floating emphasis feature which surfaces linked to a vowel: either an epenthetic vowel as in (24), or an underlying vowel as in (25). Such a floating feature has been proposed for other Salish languages by Kuipers (1971, 1983, 1990) and is assumed by Doak (1989, 1992) as discussed in §3.2.1.5.1. (Kuipers and Doak refer to it as a 'retraction' feature.) Note that, under the present representational assumptions, the floating emphasis feature is actually two co-occurring features: secondary-[DOR] and secondary-[RTR].

A detailed analysis of the roots in (24) and (25) will not be developed here and no theoretical account of them will be presented. Such further work would require a phonological and phonetic database larger than that of the present study.



3.2.1.5.7. Acoustic Support

This section presents acoustic findings which bear on the presumed postvelar gestures of emphatic /t̙ʃ ʃ̙ ɹ̙ ɹ̙’ l̙ l̙’ k̙ k̙’ k̙ʷ k̙’ʷ x̙ x̙ʷ/, /ɹ̙ ɹ̙’/ de-emphaticisation in Lower St’át’imcets, and the lack of emphatic /ɹ̙ ɹ̙’/ in Upper St’át’imcets. However, the corpus and data for the St’át’imcets acoustic study will first be described. For the study's procedural details, see §2.3.1.1.

corpus and speakers for the St'át'imcets data

This chapter reports on data from 35 tokens of St'át'imcets consonants and 169 tokens of St'át'imcets vowels, which were recorded in 37 carrier forms. The carrier forms were all real St'át'imcets words; they are listed in Appendix VI. Real words were used to ensure tokens that resulted from the regular phonology and phonetics of the language. They were tape-recorded from two literate, adult male native speakers: LC, a 52-year-old speaker of the Lower dialect, and LN, a 45-year-old speaker of the Upper dialect. Two tokens of each of the 37 forms were elicited from each speaker. The data from LC and LN were analysed separately, since formant frequencies of their vowel tokens were very different. (This is evident from the vowel graphs to be presented in §3.4 and §3.5.

Articulatory data, as discussed in §1.4.2, indicate that emphatic consonants are produced with two secondary postvelar articulations: uvularisation and pharyngealisation. Acoustic data which support the assumption that St'át'imcets emphatics are produced with these articulations will now be presented.

Table 3:4 reports F_1 and F_2 of two tokens each of St'át'imcets non-emphatic /k/, emphatic /k̙/, non-emphatic /l/, emphatic /l̙/, and, for LC, the Lower St'át'imcets speaker, non-emphatic {ɹ'} (= de-emphaticised /ɹ̙'/), and emphatic /ɹ̙'/. The carrier forms are identified in the table.

Table 3:4

F_1 and F_2 of tokens of St'at'imcets /k/, /k̙/, /l/, /l̙/, {ɹ'} (= de-emphaticised /ɹ̙'/), and /ɹ̙'/

		Speaker: LC		Speaker: LN	
carrier form	token	F_1	F_2	F_1	F_2
{keɰʷæʔtu} (fem. name)	[k]1	471	1059	475	1374
	[k]2	465	1142	460	1388
	mean F	468	1101	468	1381
{k̙əɬ-ən} 'to put something away, to bury something (tr.)'	[k̙]1	670	990	649	1284
	[k̙]2	651	985	695	1304
	mean F	661	988	672	1294
	|difference| mean F	193	113	204	87
{tʃi-tʃ-l-uʃæʔ} 'fresh fruit'	[l]1	--	--	285	1583
	[l]2	--	--	319	1454
	mean F			302	1519
{k̙ʌl̙-ɰʷɪl̙'x} 'to get spoiled, to break down' (leftmost {l̙})	[l̙]1	--	--	507	1003
	[l̙]2	--	--	524	972
	mean F			516	988
	|difference| mean F			214	531
{xniɹ'-ɑɹ̙'} 'gooseberry bush'	[ɹ']1	355	1356	--	--
	[ɹ']2	420	1336	--	--
	mean F				
{xniɹ'-ɑɹ̙'} 'gooseberry bush'	[ɹ̙']1	586	1179	--	--
	[ɹ̙']2	557	1154	--	--
	mean F	634	1169		
	|difference| mean F	246	177		

In Table 3:4, the mean F values show that for both speakers, F_1 for /k̙/ is medium, almost high. For both speakers, F_2 for /k̙/ is low. (Descriptions of formant frequencies as 'high', 'medium', or 'low' are in reference to the values in Table 1:5.) Based on Table 1:11 in §1.4.3, a medium or high F_1 and low or medium F_2 are expected for a segment that is produced with primary uvular articulation, and pharyngealisation. As the data on /k̙/ in Table 3:4 match these expectations, they can be interpreted as support for the assumption that St'at'imcets /k̙/ is produced with those articulations.

In the table, the absolute values of the difference between mean F show that the tokens of /k̙/ have a higher F_1 and lower F_2 than the tokens of /k/, for both speakers. This is consistent with the general F_1 rise, F_2 drop effects expected for postvelar articulation, as seen from Table 1:8. It supports an assumption that St'at'imcets /k̙/ has postvelar articulation (assumed here to be primary uvular and secondary pharyngeal) that /k/ lacks.

Note that the findings from Table 3:4 do not bear on the issue of the identity of St'át'imcets /k̙/ as velar emphatic vs. primary uvular, as velar emphatics and primary uvulars assumed to be produced with the same articulation. Given this, St'at'imcets /k̙/ [q] is here identified as an emphatic solely on the basis of the phonological evidence presented in §3.2.1.5.4.

In Table 3:4, the absolute values of mean F for /l̙/ and /l/ (reported for LN) show that F_1 for /l̙/ has a medium rise and F_2 has a large drop, compared to F_1 and F_2 for /l/. (Descriptions of formant frequency changes are in reference to the values in Table 1:10.) The absolute values of mean F for {ɹ̙'} and {ɹ'} (reported for speaker LC) show that F_1 for {ɹ̙'} has a medium rise, compared with F_1 for {ɹ'}; F_2 for {ɹ̙'} has a drop which is almost medium, compared with F_2 for {ɹ'}. In §1.4.3, a medium or large rise for F_1 and and large drop for F_2 were predicted for segments that are produced with secondary uvular and pharyngeal articulation. The data on /l̙/ and {ɹ̙'} in Table 3:4 almost match those expectations, and thus provide some support the assumption that the tokens of /l̙/ and Lower dialect /ɹ̙'/ were produced with those articulations. This, in turn, supports the phonological claim that they are emphatics.

Acoustic effects which are generally consistent with those in Table 3:4 have been reported in previous studies of Salish (in which these consonants are described as 'retracted'): Bessell and Czaykowska-Higgins (1991) and Bessell (1992) observe a raised F_1 and lowered F_2 for vowels in the context of Nxa'amxcin coronal emphatics, which they interpret as indicating the same effects for the coronal emphatics; Thompson (1994) reports a lowered F_2 for Lower St'át'imcets {ɹ̙(')}.

In Table 3:4, the tokens of Lower dialect {ɹ'} and {ɹ̙'}are from the carrier form /xnIɹ̙'-Æɹ̙/ {xniɹ'-ɑɹ̙} in which {ɹ'} occurs immediately following /I/. The lack of an F_1 rise and an F_2 drop for the tokens of {ɹ'} supports the assumption that they were not produced with uvularisation and pharyngealisation. This supports the phonological claim that Lower dialect /ɹ̙'/ de-emphaticises in the context of an immediately preceding /I/.

Figure 3:1 presents a wideband spectrogram showing the bursts of one token each of St'át'imcets /k/ and /k̙/. The figure caption identifies the carrier forms and reports the frequency of each burst.

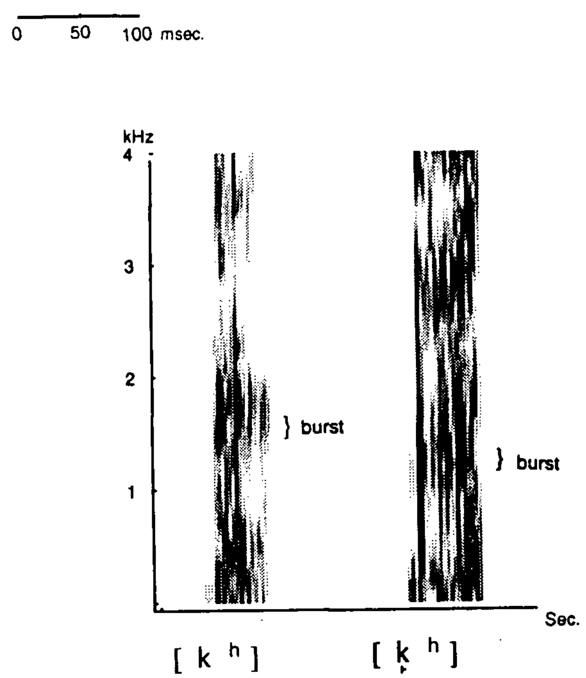


Figure 3:1 Wideband spectrogram of bursts of St'at'imcets [k] and [k̙]. (The token of [k] occurred in {kəɰʷæʔtu} (fem. name); the token of [k̙] occurred in {k̙əɬ-ən} 'to put something away, to bury something (tr.)'.
Burst of [k] = 1514 Hz.
Burst of [k̙] = 1210 Hz.

Figure 3:1 shows a downward shift of 300 Hz in the burst of [k̙] compared to the burst of [k]. This is consistent with the finding of previous studies, e.g., Al-Ani (1970), of a lower concentration of burst energy for emphatic plosives. See Figure 2:35 for Palestinian Arabic data showing the same acoustic effect.

The raised F_1 and lowered F_2 for /l̙/ are seen in the spectrogram in Figure 3:2. The carrier forms are identified in the figure caption. Figure 3:3 presents a spectrogram of a token of Lower dialect /xnI̙ɹ’-Æɹ̙ʔ/ {xniɹ’-ɑɹ̙’}, showing the same effects for {ɹ̙’}, and the lack of those effects for de-emphaticised {ɹ’}. In Figure 3:3, arrows draw attention to the first and second formants of each dental approximant.

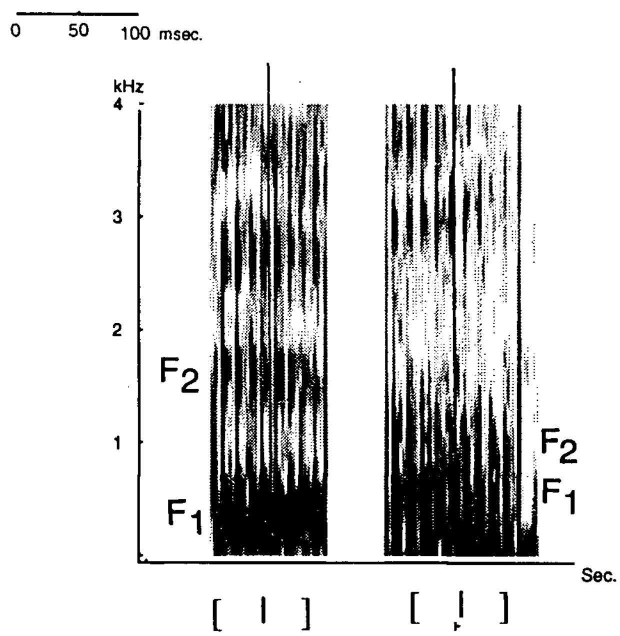


Figure 3:2 Wideband spectrogram of St’át’imcets [l] and [l̙]. The token of [l] occurred in {tʃi-tʃ-l-usæʔ} ‘fresh fruit’; the token of [l̙] occurred as the leftmost [l̙] in {k̙ʌl̙-ɰʷɪl̙’x} ‘to get spoiled, to break down’. (Formants measured at the points indicated by the vertical lines.)

[l]: $F_1 = 285$ Hz; $F_2 = 1583$ Hz.

[l̙]: $F_1 = 507$ Hz; $F_2 = 970$ Hz.

Figure 3:3 presents a spectrogram of a token of Lower dialect /xnIɹ̙'-Æɹ̙'/ {xniɹ'-ɑɹ̙'}, showing the raised F_1 and lowered F_2 for {ɹ̙'}, and the lack of those effects for de-emphaticised {ɹ'}. Arrows draw attention to the first and second formants of each {ɹ'}.

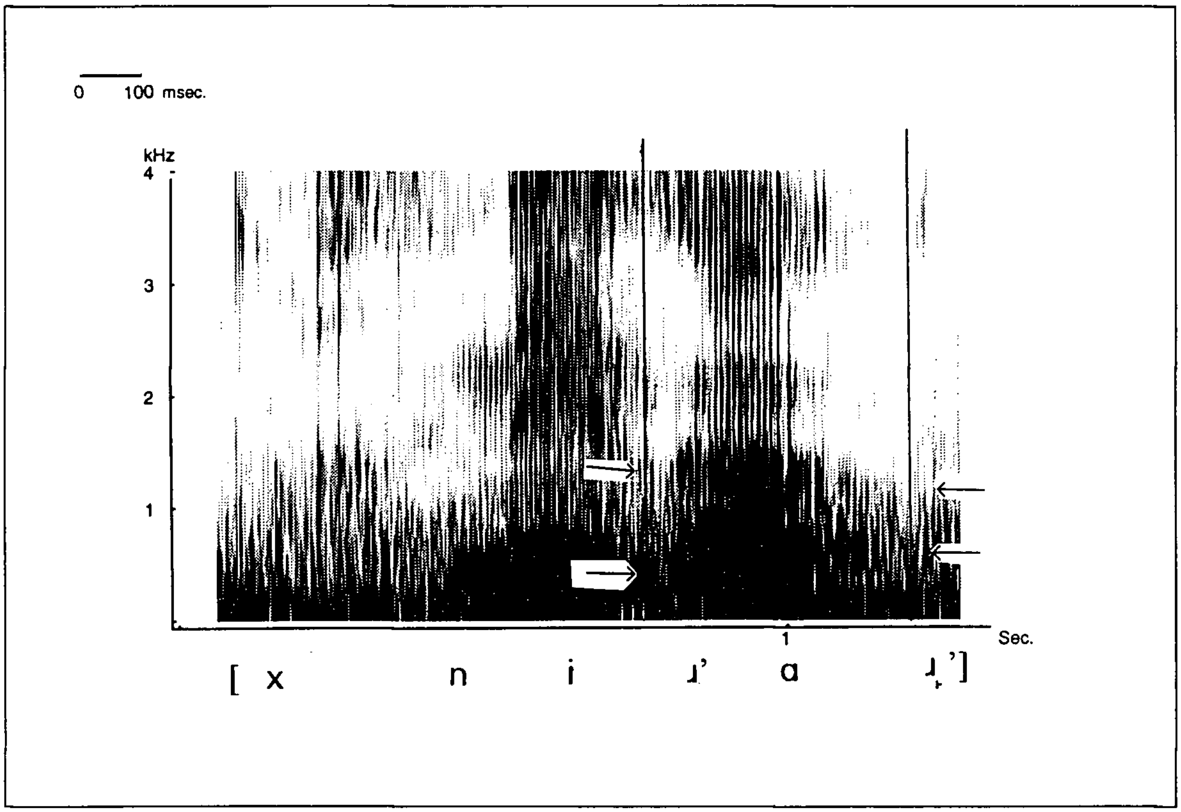


Figure 3:3 Wideband Spectrogram of a token of Lower St'át'imcets {xniɹ'-ɑɹ̙'} 'gooseberry bush'. (Formants measured at the points indicated by the vertical lines.)
[ɹ']: F_1 = 388 Hz; F_2 = 1291 Hz.
[ɹ̙']: F_1 = 586 Hz; F_2 = 1163 Hz.

In sum, the data in Table 3:4 and Figures 3:1 - 3:3 support the assumption that St'át'imcets /k̙/ is produced with uvular articulation and pharyngealisation, and that /l̙/ and Lower dialect {ɹ̙'} are produced with uvularisation and pharyngealisation. As noted earlier, this finding for /ḳ/ supports either of two phonological claims, *viz.*, that it is velar emphatic /ḳ/ or that it is primary uvular /q/, as a /q/ is assumed to be produced with the same articulation as /ḳ/. The present identification of St'at'imcets /ḳ/ [q] as an emphatic is based solely on the phonological evidence presented in §3.2.1.5.4. The finding with respect to /ḷ/ and Lower dialect {ɹ̣'} supports the phonological claim that those segments are emphatics. The data also support the assumption that Lower dialect /ɹ̣'/ is not produced with emphatic articulation in the context of an immediately preceding /I/. This supports the phonological claim that Lower dialect /ɹ̣'/ de-emphaticises in that context.

Figure 3:4 presents a wideband spectrogram of one token of Upper dialect /xnIɹ'-Æɹ'/ {xniɹ'-æɹ'}. Arrows point out the first and second formants of each [ɹ']. The spectrogram shows that F_1 of the [ɹ'] on the right has a medium rise. However, F_2 of the two [ɹ']s is almost the same. The raised F_1 of the [ɹ'] on the right is here interpreted as a coarticulatory effect from the preceding [ɑ]. Thus interpreted, the data in Figure 3:4 support the assumption that neither token was produced with uvularisation and pharyngealisation. This, in turn, supports the phonological claim that Upper dialect /ɹ(')/ is not an emphatic.

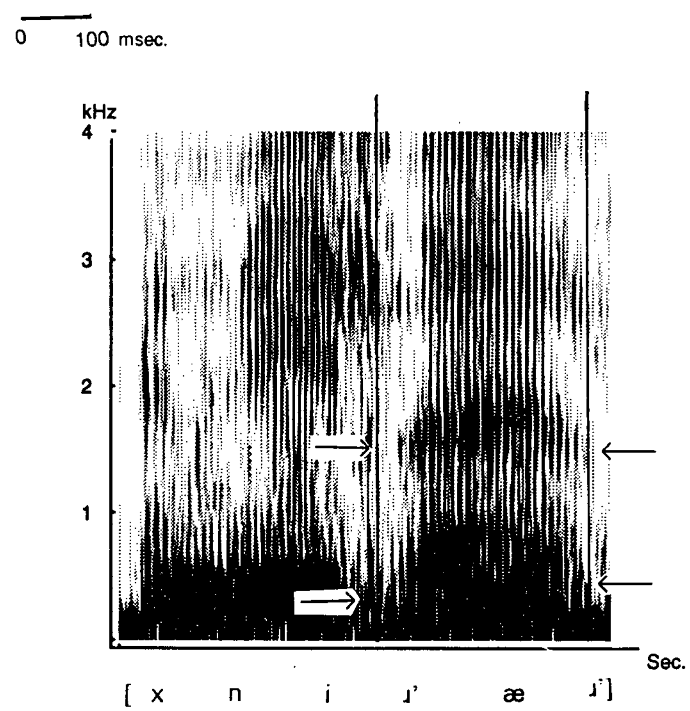


Figure 3:4 Wideband Spectrogram of a token of Upper St'át'imcets {xniɹ'-æɹ'} 'gooseberry bush'.

[ɹ'] on the Left: F_1 = 285 Hz; F_2 = 1576 Hz.

[ɹ'] on the Right: F_1 = 463 Hz, F_2 = 1544 Hz.

3.2.2. Vocalic Inventory

Consistent with van Eijk (1985),[12] the St'át'imcets underlying vocalic inventory is analysed as seen in (26). It has two degrees of height, no underlying length, and no underlying low front vs. low back distinction.

[12]The underlying status of the vowel transcribed by van Eijk (1985, 1987) with a schwa symbol has been a point of contention, and will be discussed in §3.2.2.2.

3.2.2. Vocalic Inventory

(26) The St'át'imcets Underlying Vocalic Inventory

	FRONT		BACK
HIGH	I		U
LOW		Æ	

The surface vocalic inventory is analysed as seen below:

(27) The St'át'imcets Surface Vocalic Inventory

	FRONT				CENTRAL				BACK			
	NON-RTR		RTR		NON-RTR		RTR		NON-RTR		RTR	
	NON-RD	RD	NON-RD	RD	NON-RD	RD	NON-RD	RD	NON-RD	RD	NON-RD	RD
HIGH	i		ɪ							u		ʊ
MID					ɘ	ɵ	ɜ	ɞ			ʌ	ɔ
LOW	æ		a								ɑ	

A major way in which the surface inventory differs from the underlyingly inventory is in containing six mid vowels, which are either non-rd or rd. The surface inventory has a low front vs. low back distinction: in low front position, there is non-rtr {æ} and rtr {a}; in low back position there is a single, rtr vowel, {ɑ}.

All surface vowels, except the non-high back vowels, occur in non-rtr/rtr pairs: {i} vs. {ɪ}, {æ} vs. {a}, {ɘ} vs. {ɜ}, {ɵ} vs. {ɞ}, and {u} vs. {ʊ}. In mid back and low back positions, only rtr {ʌ ɔ} and rtr {ɑ} occur. The reason for this will be discussed in §3.5.

This chapter will argue that rtr {ɪ a ɜ ɞ ʊ} comprise a set of pharyngealised vowels which are phonologically distinct from the non-high back rtr vowels {ʌ ɔ ɑ}.

Back {ʌ ɔ ɑ} will be identified as uvularised vowels. Acoustic findings which support the distinct pharyngealised vs. uvularised sets will be presented in §3.4 and §3.5.

The discussion that follows first summarises the previous analysis of the St'át'imcets surface vowels. It then presents the bases for the analysis in (27).

3.2.2.1. Previous Analyses of the St'át'imcets Surface Vocalic System

Van Eijk's (1985) analysis of the surface vocalic system is seen in (28).

(28) Van Eijk's (1985) Analysis of the St'át'imcets Surface Vocalic System

	FRONT		BACK
HIGH	i ị		u ụ
MID		ə ə̣	
LOW		a ạ	

Van Eijk claims that the surface inventory contains pairs of non-retracted vs. retracted vowels: {i} vs. {ị}, {ə} vs. {ə̣}, {a} vs. {ạ}, and {u} vs. {ụ}. He thus claims that {ị ụ} and {ə̣ ạ} comprise a single set of 'retracted' vowels. Under his analysis, the retracted set occurs immediately preceding a uvular, a Lower dialect dental approximant, and in a retracted root. Previous theoretical accounts, Remnant (1990) and Bessell (1992), have assumed this analysis, claiming that the retracted vowels in retracted roots are the effect of a floating retraction feature. In §3.2.1.2, arguments were presented which refute a retracted root analysis for the majority of roots previously assumed to involve a floating retraction feature.

Van Eijk (1985:14) documents the variant {ɔ} for /U/ in the context of an immediately following /ʁ ʁ' ʁʷ ʁ'ʷ/. Remnant (1990:17,130) observes that /I/ occurs as {ɛ} in that context.

Van Eijk (1985:13-14) describes vowels immediately preceding one of /ʁ ʁ' ʁʷ ʁ'ʷ/ as phonetically pharyngealised, although he does not note this effect for /I/. Remnant refers to such vowels as 'epiglottalised'. This issue will be addressed in §3.2.2.4. Data which provide preliminary acoustic documentation of the effect just referred to will be presented.

Finally, van Eik (1985:37) describes a reduction of root vowels in some forms. Because vowel reduction is not observed in the present corpus, this will be discussed no further here.

3.2.2.2. The Epenthetic Vowel

This section addresses the vowel which van Eijk (1985) transcribes as 'ə̕' or 'ə̣'. Following van Eijk (1985), Matthewson (1994), Roberts and Shaw (1994), and Shaw (1996b), this vowel is analysed here as epenthetic. Departing from previous studies, it is analysed as having six surface variants: {ɘ}, {ɵ}, {ɜ}, {ɞ}, {ʌ}, and {ɔ}. The discussion that follows first presents evidence for its epenthetic status. It then argues for its six surface variants.

The vowel under discussion is observed immediately preceding non-initial consonants (both obstruents and resonants) in a consonant cluster. This is illustrated by the data in (29).

(29) a. IPA /RED, ʃx/	{ ʃəx-ʃəx }	'partly crazy'
NA /RED, sx/	{ səx-səx }	
b. IPA /mxÆɹ̙/	{ məxɑɹ̙ }	'huckleberry' (Lower dialect)
NA /mxÆz/	{ məxạ ẓ }	
c. IPA /RED, k̙l̙/	{ k̙ʌ-k̙ʌl̙ }	'good for nothing, useless (persons, horses, etc.)'
NA /qḷ /	{ qə̣-qəḷ }	
d. IPA /ʔÆtʃ'x̙-n/	{ ʔætʃ'x̙-ən }	'to see something, someone (tr.)'
NA /ʔac'x̌-n/	{ ʔac'x̌-ən }	
e. IPA /RED, tɰ^{w}t/	{ təw-əɰ^w-ɰ'^{w}ət }	'(young) boy'
NA /RED, twt/	{ təw-əw-w'ət }	

It is not observed if the non-initial consonant in such a cluster is syllabifiable as a syllable onset. This is illustrated by the data in (30) in which periods clarify the syllabification of the grammatical surface forms.

(30)

a. IPA /RED, ʃx/	{ ʃəx.-ʃəx }	(*{ ʃəx-əʃəx })	'partly
NA /RED, sx/	{ səx.-səx }	(*{ səx-əsəx })	crazy'
b. IPA /ʔÆtʃ'x̙-n/	{ ʔætʃ'.x̙-ən }	(*{ ʔætʃ'ʌx̙-ən })	'to see some-
NA /ʔac'x̌-n/	{ ʔac'.x̌-ən }	(*{ ʔac'ə̣x̌-ən })	thing, some-
			one (tr.)'
c. IPA /RED, k̙l̙-nUx^{w}-mIn/	{ k̙ʌ̙l.-k̙ʌl.-nux^{w}.-min }	(*{ k̙ʌ̙l-ʌk̙ʌ̙l-ənux^{w}-əmin })	
NA /RED, ql̩̣-nUx^{w}-mIn/	{ qə̣l̩̣.-qə̣l̩̣.-nux^{w}.-min }	(*{ qə̣l̩̣-ə̣qə̣l̩̣-ənux^{w}-əmin })	
		'to be unfriendly to someone (tr.)'	

The generalisation from (29) and (30) is that the occurrrence of this vowel is predictable. For previous discussion of its predictability, see van Eijk (1985) and Matthewson (1994). Based on its predictability, following van Eijk (1985), Matthewson (1994), Roberts and Shaw (1994), and Shaw (1996b), it is here analysed as epenthetic.[13] See Czaykowska-Higgins (1993), Kinkade (1993, to appear), and Urbanczyk (1996b) for discussion of the epenthetic vowel in other Salish languages.

The present corpus indicates that St'át'imcets speakers differ in their phonological tolerance of consonant clusters and that this difference might be dialectal: the epenthetic vowel is not observed for LC, a Lower dialect speaker, in forms where it is observed for LN, an Upper dialect speaker. This is seen from comparison of the data in (31) with those in (32). For a theoretical account of the difference illustrated by (31) and (32), see Shaw (1996b).

[13]As underlying forms contain only unpredictable phonological elements (see §1.7.1 for discussion), the predictability of this vowel is evidence for the underlying status of the consonant clusters in data such those in as (28) and (29).

3.2.2. Vocalic Inventory

(31) Lower St'át'imcets Forms

a.	IPA /RED, ʁItʃ-k̙ʃ/	{ ʁi-ʁ'-tʃ̙-k̙ʃ }	'small rainbow trout'
	NA /RED, ʕIc-qs/	{ ʕi-ʕ'-c̣-qs }	
b.	IPA /tʃ'k̙ʷʔIk̙ʷ/	{ tʃ'k̙ʷʔɪk̙ʷ }	'salmon stretcher'
	NA /c'qʷʔIqʷ/	{ c'qʷʔịqʷ }	
c.	IPA /tʃ̙k̙ʷ-ÆnÆʔ/	{ tʃ̙k̙ʷ-ænæʔ }	'lynx
	NA /cqʷ-ÆnÆʔ/	{ c̣qʷ-anaʔ }	

(32) Upper St'át'imcets Forms

a.	IPA /RED, ʁItʃ-k̙ʃ/	{ ʁi-ʁ'-tʃ-ʌk̙s }	'small rainbow trout'
	NA /RED, ʕIc-qs/	{ ʕi-ʕ'-c-ə̣qs }	
b.	IPA /tʃ'k̙ʷʔIk̙ʷ/	{ tʃ'ɔk̙ʷʔɪk̙ʷ }	'salmon stretcher
	NA /c'qʷʔIqʷ/	{ c'ə̣qʷʔịqʷ }	
c.	IPA /tʃ̙k̙ʷ-ÆnÆʔ/	{ tʃɔk̙ʷ-ænæʔ }	'lynx'
	NA /cqʷ-ÆnÆʔ/	{ cə̣qʷ-anaʔ }	

More fieldwork is necessary to determine whether this difference is dialectal or idiolectal; van Eijk (1985:30-31) assumes the latter.

Van Eijk (1985:12) describes several different qualities for the epenthetic vowel, which he transcribes as '[ʊ ɪ ə ʌ ɔ̂]', where '^' denotes what he refers to as a 'pharyngealisation' effect. Matthewson (1994:5) assumes the various qualities are determined by phonetic coarticulation. This chapter will make a different claim, *viz.*, that much of the variation is phonological; this claim is reflected in the surface inventory in (27). It will be argued that three harmonies, rounding harmony, pharyngealisation harmony, and uvularisation harmony, give rise to six surface variants of the epenthetic vowel. This will be supported by acoustic data to be presented in §3.4 and §3.5.

The rounding harmony, and the surface variants of the epenthetic vowel which result from it, will be discussed below. St'át'imcets pharyngealisation harmony and uvularisation harmony, and their effects on the epenthetic vowel, will be addressed in §3.2.2.5 and §3.2.2.6. They will be examined in greater detail in §3.4 and §3.5.

The epenthetic vowel surfaces as rounded {ɵ}, {ɵ}, or {ɔ} under adjacency to a rounded consonant. This is illustrated by (33). See also (29c) and (32b-c).

(33) a. IPA /t͡ɬ'xʷ-xÆl/	{t͡ɬ'ɵxʷ-xæl}	'to hit (as a bush to make
NA /RED, ƛ'xʷ-xÆl/	{ƛ'əxʷ-xal}	the berries fall off)'
b. IPA /lʁʷ-n/	{lɵʁʷ-ən}	'to hide something (intr.,
NA /RED, lʕʷ-n/	{ləʕʷ-ən}	tr.)'
c. IPA /ʃ-tx̙ʷ/	{ʃ-tɔx̙ʷ}	'really, very much'; 'to be
NA /s-tx̌ʷ/	{s-tə̣x̌ʷ}	in the way'
d. IPA /ʔx̙ʷʔUn/	{ʔɔx̙ʷʔun}	'to cough'
NA /ʔx̌ʷʔUn/	{ʔə̣x̌ʷʔun}	

It does not surface rounded under adjacency to a non-rounded consonant. This is illustrated by (34), also by (29a-d) and (32a).

(34) a. IPA /pUn-ɬp/	{ pun-ɬəp}	'Rocky Mountain
NA /pUnɬp/	{ punɬəp}	Juniper'
b. IPA /tʃʁ-n/	{ tʃɜʁ-n}	'to rip, tear something
NA /cʕ-n/	{ cəʕ-ən}	(tr.)'
c. IPA /GLOT, mʁ/	{ mɜ-'-ʁ}	'(breaking) daylight'
NA /GLOT, mʕ/	{ mə-'-ʕ}	
d. IPA /mk̝'/	{ mʌk̝'}	'to get stuffed, to eat too
NA /mq'/	{ mə̣q'}	much'

This rounding is here considered phonological, rather than phonetic, for two reasons. First, when rounded, the epenthetic vowel is perceptually fully round, as opposed to rounded for only part of its duration. That is, when rounded, it is perceptually not a non-rd - rd diphthong or rd - non-rd diphthong (with the rounded portion occurring adjacent to a rounded postvelar), e.g., [ɜo̯] or [ɵɜ̯], respectively, where ' ̯ ' identifies the second half of the diphthong. Second, acoustic data to be presented §3.4 indicate that tokens of the rounded variants have and maintain a rounded target. This supports ascribing phonological status to the rounding, in a manner to be explained in that section.

A final discussion concerns the distinction between St'át'imcets' epenthetic vowel and its purely phonetic vowel. This distinction is made by Matthewson (1994) and Shaw (1996b) who label the latter 'excrescent', consistent with the suggestions of Kinkade (to appear) with respect to Salish vowels in general. The excrescent vowel is seen in the phonetic forms in (35). In this data set, periods mark the syllable breaks in the surface forms. The qualities of the excrescent vowel mirror those of the epenthetic vowel. (The vowel [ə] in the IPA transcription in (35c) is the lowered counterpart of [ɵ]. Phonetic lowering of St'át'imcets vowels will be discussed in §3.2.2.3.)

(35)

a. IPA /RED, tʃIl-UʃÆʔ/	{ tʃi-tʃ.-l-u.ʃæʔ}	[tʃitʃəluʃæʔ]	'fresh fruit'
NA /RED, cIl-UsÆʔ/	{ ci-c.-l-u.saʔ}	[cicəlusaʔ]	
b. IPA /RED, tɰʷt/	{ tɵ.wɵ-ɰʷ.-ɰ'ʷɵt}	[tɵwɵɰʷɵɰ'ʷɵt]	'(young) boy'
NA /RED, twt/	{ tə.w-əw.-w'ət}	[təwəwəw'ət]	
c. IPA /RED, ʁl/	{ ʁɵl.-ʁɵl}	[ʁɵlɜʁɵl]	'strong,
NA /RED, ʕl/	{ ʕəl.-ʕəl}	[ʕələʕəl]	healthy,
			vigorous'

In (35), the vowel observed in each phonetic form but not in the respective surface form occurs between a coda consonant and an onset consonant, where the onset consonant is a resonant. This environment has been identified for excrescent vowels in Nxa'amxcin Salish by Willett and Czaykowska-Higgins (1995). The St'át'imcets exscrescent vowel is audible but does not serve as the nucleus of any phonological syllable: the consonants which flank it are perceptually coda and onset of distinct syllables. Given this, it is here concluded, with Matthewson (1994:5): "the appearance of [the excrescent] vowel is independent of syllable structure."

The present corpus indicates that data such as those in (35) occur with or without the exscrescent vowel. That is, the occurrence of the exscrescent vowel is optional. This has been observed by Matthewson (1994:5), who found: "the optionality of the vowel was manifested in a single elicitation session, between different utterances of the same word; sometimes it was present, sometimes absent." The phonetic forms in (35) record productions in which it occurred for a St'át'imcets consultant on a particular occasion.

The optionality of this vowel and its independence from syllable structure requirements are here considered evidence for its phonetic status. Based on this, following Matthewson (1994) and Shaw (1996b), it is analysed as an excrescent/enunciative/anatyptic vowel, that is, a vowel which occurs only in the phonetics and serves as a transitional element. See Willett and Czaykowska-Higgins (1995) and Kinkade (to appear) for further discussion of Salish excrescent vowels.

3.2.2.3. Phonetic Mid Height

Mid height is observed for the high vowels that are adjacent to a postvelar. Mid height for high vowels in the context of postvelars is observed also in Palestinian Arabic; see §2.2.2.4. The effect in St'át'imcets is illustrated by (36). In (36), the lowering is seen in the transcriptions of the phonetic forms, which are presented only in IPA. The form in (36f), in which no lowering is observed for the non-postvelar-adjacent /I/, demonstrates the adjacency requirement.

(36) a. IPA /k̘'IɬIl/	{k̘'iɬil}	[k̘'ei̯ ɬil]	'to run'
NA /q'IɬIl/	{q'iɬil}		
b. IPA /kʷl̘-Iʔ/	{kʷl̘-iʔ}	[k̘ʷl̘ei̯ ʔ]	'green, yellow'
NA /qʷḷ-Iʔ/	{qʷḷ-iʔ}		
c. IPA /ʁIʃ/	{ʁiʃ}	[ʁei̯ ʃ]	'to shrink'
NA /ʕIs/	{ʕis}		
d. IPA /k̘ʷUʔ/	{k̘ʷuʔ}	[k̘ʷoʔ]	'water'
NA /qʷUʔ/	{qʷuʔ}		
e. IPA /ʁʷUj't /	{ʁʷuj't}	[ʁʷoj't]	'sleep'
NA /ʕʷUy't/	{ʕʷuy't}		
f. IPA /ʁIʃ-In'/	{ʁiʃ-in'}	[ʁei̯ ʃin']	'to shrink something (tr.)'
NA /ʕIs-In'/	{ʕis-in'}		
g. IPA /mIx̘Æɬ/	{mɪx̘æɬ}	[mɛx̘æɬ]	'black bear'
NA /mIx̌Æɬ/	{mix̣̌aɬ}		
h. IPA /tʃIk̘-In'/	{tʃɪk̘ -in'}	[tʃɛk̘ei̯ n']	'to stab someone (tr.)'
NA /cIq-In'/	{ciq̣-in'}		

The mid height is not observed under adjacency to non-postvelars. This is illustrated by (37). The form in (37h) contains an underlying postvelar, /ɹ̘/. In §3.2.1.5.5, it was argued that Lower dialect /ɹ̘/ de-emphaticises in the context of an immediately preceding /I/. The lack of phonetic lowering in (37h) suggests that Lower /ɹ̘/ might de-emphaticise also in the context of /U/, as claimed in its transcription, below.

(37)

a. IPA /tUp-Un'/ NA /tUp-Un'/	{tup-un'} {tup-un'}	[tupun'] [tupun']	'to punch someone, hit someone with the fist (intr., tr.)'
b. IPA /ʃItʃt/ NA /sItst/	{ʃitʃt} {sitst}	[ʃitʃt] [sitst]	'night'
c. IPA /tʃIxʷ/ NA /cIxʷ/	{tʃixʷ} {cixʷ}	[tʃixʷ] [cixʷ]	'to arrive (over there), to reach (over there)'
d. IPA /RED, n-kʷUtʃÆ/ NA /RED, n-kʷUcÆ/	{n-kʷu-kʷtʃæ} {n-kʷu-kʷca}	[nkʷukʷtʃæ] [nkʷukʷca]	'downstream area'
e. IPA /kItʃ-In'/ NA /kIc-In'/	{kitʃ-in'} {kic-in'}	[kitʃin'] [kicin']	'to lay something down (intr., tr.)'
f. IPA /t͡ɬ'ÆmIn/ NA /ƛ'ÆmIn/	{t͡ɬ'æmin} {ƛ'amin}	[t͡ɬ'æmin] [ƛ'amin]	'wool, fur' (Upper dialect)
g. IPA /ʃ-p'Iʔ-l'ɰʷÆʃ/ NA /s-p'Iʔ-l'wÆs/	{ʃ-p'iʔ-əl'ɰʷæʃ} {s-p'iʔ-əl'wÆs}	[ʃp'iʔəl'ɰʷæʃ] [sp'iʔəl'wÆs]	'squeezed in the middle'
h. IPA /ɹUh-n/ NA /ẓuh-n/	{ɹuh-ən} {zuh-ən}	[ɹuhən] [zuhən]	'to warn someone, tell someone to be careful (intr., tr.)'

The mid height observed in (36) is analysed as an effect due to the adjacent postvelar. The exclusion of /h ʔ/ from the triggering class for this lowering, seen from (37g,h), supports the present claim that St'á'timcets laryngeals are not gutturals (and thus not postvelars). That is, unlike Palestinian laryngeals, they lack articulation, under the definition of 'articulation' assumed in this thesis (see §1.3.3.1). This claim was made in §3.2.1.4; it will be supported by acoustic data to be presented in §3.4 and §3.5.

The lowering illustrated by (36) is here considered phonetic for reasons parallel to those discussed with respect to Palestinian high vowel lowering in §2.2.2.4. First, in several forms it is impressionistically gradient: e.g., in (36a-c,h), the lowered vowel is perceptually a short diphthong from mid [e] to high [i]; this indicates the lowering to be non-discrete. Second, to my knowledge, there is no evidence that the lowered height is phonologically visible. Under the phonetics/phonology distinction drawn in §1.7.1, non-discreteness and phonological invisibility characterise phonetic sound properties and do not characterise phonological sound properties. On this basis, the lowered height is assigned phonetic status.

An alternative analysis of the lowered height in (36) is possible, *viz.*, that the mid height results from [LOW] harmony triggered by an adjacent postvelar. The form in (36b) will serve to illustrate the claims this would entail: under a [LOW] analysis, it would be transcribed as:

(38) /tʃIk̙-In'/ { tʃɛk̙-ɛn' } [tʃɛk̙ei̯n'] 'to stab someone (tr.)'

A [LOW] analysis would observe that the post-emphatic /I/ in (38) is [ei̯], that is, that it is gradiently less low than the pre-emphatic /I/, which is [ɛ]. To account for this, the alternative analysis would claim: (i) when under [LOW] harmony, /I/ surfaces as { ɛ } (ii) both /I/s in /tʃIk̙-In'/ harmonise, yielding the surface form: { tʃɛk̙-ɛn' }; (iii) assuming a phonetic mid-to-high continuum starting at [ɛ] and ending at [i], the lesser degree of phonetic lowering for the post-emphatic /I/ is a phonetic effect resulting from the fact that anticipatory phonetic coarticulation is stronger than perseveratory phonetic coarticulation.

This analysis rejected on two grounds. First, it assumes that St'át'imcets postvelars are specified for [LOW], on which basis they trigger [LOW] harmony on an adjacent vowel. Given the ample evidence that postvelars are specified for [RTR], as reviewed in §2.3, as provided in §2.4, and as will be further provided in §3.4, their additional specification for [LOW] is undesirable on economy grounds. That is, as the range of data involving postvelars can be accounted for assuming their specification for [RTR] without additional specification for [LOW], positing their specification for [LOW] is an unnecessary and therefore undesirable representational enrichment.

Second, under the alternative analysis, the absence of phonetic [ɪ̯] in (38) remains a mystery. That is, why is the phonetic form in (38) not [tʃɛk̟eɪ̯n']? The claim that the lowness of a post-trigger vowel is gradiently interpreted in the phonetics along a mid-to-high continuum starting at [ɛ] and ending at [i] predicts that [ɪ̯] might be observed for some tokens this word. However, it is not. The robust generalisation from the corpus of this study is that phonetic tokens of the post-trigger vowel in words such as /tʃIk̟-In'/ are exclusively non-rtr for their duration. Note that this implies that [ei̯] and [eɪ̯] are in principle distinct diphthongs. It also implies that lowness (along some abstract height dimension) and rtr-ness (along some abstract non-rtr vs. rtr dimension) are, or can be, perceptually distinct. The second implication is not based on a new claim. The perceptual distinctness of lowness vs. rtr-ness is implicit, e.g., in the IPA vowel chart: in that chart,

[e], which is lower than [i] and [ɪ], occupies a position distinct from [ɛ], which is also lower than [i] and [ɪ] and in addition, under the present analysis, is rtr. That degree of lowness and degree of rtr-ness are represented distinctly in the chart implies that lowness and rtr-ness are perceptually distinct.

By contrast, the absence of [ɪ̭] in (38) is accounted for under the proposed analysis. The proposed analysis, to be detailed in §3.4.1, is that the harmony observed in a word like /tʃIk̙-In'/ is [RTR] harmony, whereby harmonising vowels surface rtr. In St'át'imcets, [RTR] harmony only affects a vowel which immediately precedes a postvelar. The fact that the post-trigger vowel never receives specification for [RTR] predicts its complete non-rtr colouring in the phonetic form.

A final note concerns the epenthetic vowel. The present database indicates that its surface variant {ɘ} is phonetically lowered to [ə] when immediately following a postvelar. Forms illustrating this are presented in (39). The lowering is documented in the phonetic forms, which are presented only in the IPA; (39c) was seen earlier in (35c). Acoustic data consistent with this analysis will be presented in §3.4.

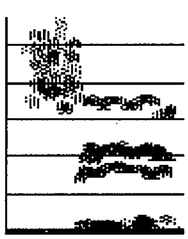
(39) a. IPA /k̙ɬn/	{k̙ɘɬ-ɘn}	[k̙ əɬɘn]	(*[k̙ɘɬɘn])	'to put something
NA /qɬ-n/	{ qəɬ-ən}			away, to bury something'
b. IPA /ʁtʃ-n/	{ ʁɘtʃ-ɘn}	[ʁ ətʃɘn]	(*[ʁɘtʃɘn])	'to stab someone
NA /ʕc-n/	{ ʕəc-ən}			(tr.)'
c. IPA /RED, ʁl/	{ ʁəl-ʁɘl}	[ʁəlɜʁɘl]	(*[ʁɘlɜʁɘl])	'strong, healthy,
NA /RED, ʕl/	{ ʕəl-ʕəl}			vigorous'

3.2.2.4. Phonetic Epiglottalisation

Van Eijk (1985:13-14) claims that /ʁ ʁ' ʁʷ ʁ'ʷ/ have a phonetic pharyngealisation effect on an immediately preceding epenthetic vowel, /Æ/, or /U/. He denotes a pharyngealised epenthetic vowel and /Æ/ both as '[â]', a pharyngealised /U/ as '[ɔ̂]'. He does not mention this effect for /I/.

Following Remnant (1990), the effect referred to by van Eijk is interpreted here as epiglottalisation, that is, as a superimposition of epiglottal constriction from the following uvular resonant. Acoustic data which provide preliminary support for this interpretation will be presented below.

An outstanding issue is whether or not the epiglottalisation has any role in the phonology. Remnant (1990) assumes it does, but does not discuss the bases of her assumption. With van Eijk (1985), it is assumed here to be phonetic, pending the findings of further phonological and phonetic investigation.



3.2.2.4.1. Acoustic Support

Ladefoged and Maddieson (1996:307) report a lowered F_3 for epiglottalised vowels, based on the data of Catford (in preparation) from Caucasian languages such as

Tsakhur and Udi. This section presents data on St'át'imcets vowels which occur immediately preceding one of /ʁ ʁ' ʁʷ ʁ'ʷ/. Given Ladefoged and Maddieson's observation, the St'at'imcets vowels were investigated for a possible F_3 effect in that context.

Table 3:5 reports the F_1, F_2, and F_3 of tokens of /I/ and the epenthetic vowel which did not occur immediately preceding one of /ʁ ʁ' ʁʷ ʁ'ʷ/, and tokens which did. (Although van Eijk 1985 does not mention an epiglottalisation effect for /I/, /I/ was analysed just in case an effect might be found.) The carrier forms are identified in the table. The forms {ɬɪ-'-ʁ'} 'to scatter' in I.A and {pɜ-'-ʁ'} 'pale, faded' in II.B each contain a glottalised vowel. Phonetically, they each contain a broken vowel; that is, for each form, the glottalised vowel is implemented as two consecutive phonetic tokens of the vowel separated by a glottal stop. (No tokens of /Æ/ or /U/ immediately preceding one of /ʁ ʁ' ʁʷ ʁ'ʷ/ were analysed, due to lack of data.)

Table 3:5

F_1, F_2, and F_3 of tokens of St'át'imcets vowels not immediately preceding /ʁ(')(ʷ)/ vs. immediately preceding /ʁ(')(ʷ)/

I. /I/		Speaker: LC		
carrier form	token	F_1	F_2	F_3
A. not immediately preceding /ʁ(')(ʷ)/				
{t͡ɬ'ɪk̘} 'to arrive here'	[ɪ]1	559	1545	2247
	[ɪ]2	578	1565	2267
{tʃ'k̘ʷʔɪk̘ʷ} 'salmon stretcher'	[ɪ]3	510	1614	2152
	[ɪ]4	593	1736	2229
	mean F	563	1615	2224
B. immediately preceding /ʁ(')(ʷ)/				
{ɬɪ-'-ʁ'} [ɬɪʔɪʁ'] 'to scatter'	[ɪ]5	612	1417	1986
(rightmost phonetic token)	[ɪ]6	617	1412	1940
	mean F	615	1415	1963
	|difference| mean F	52	200	261

II. The Epenthetic Vowel		Speaker: LC		
carrier form	token	F_1	F_2	F_3
A. not immediately preceding /ʁ(')(ʷ)/				
{pɜ-'-ʁ'} [pɜʔɜʁ'] 'pale, faded'	[ɜ]1	615	1434	2110
(leftmost phonetic token)	[ɜ]2	675	1473	2085
{ ʁəl-ʁəl} [ʁəlʁəl] 'strong, healthy, vigorous' (leftmost vowel)	[ə]3	613	1475	2152
	mean F	616	1461	2116
B. immediately preceding /ʁ(')(ʷ)/				
{ tʃɜʁ-ən} 'to rip, tear	[ɜ]4	600	1430	1937
(leftmost vowel)	[ɜ]5	600	1398	1988
	mean F	600	1414	1963
	|difference| mean F	16	47	153

Table 3:5 shows that, for the tokens analysed, F_3 is lower for the tokens of /I/ and the epenthetic vowel which occurred immediately preceding one of /ʁ ʁ' ʁʷ ʁ'ʷ/ (sections I.B and II.B) than it is for tokens which did not occur in that context (sections I.A and II.A). That is, the tokens analysed have a lowered F_3. This matches the effect shown by tokens of epiglottalised vowels in Tsakhur and Udi, as discussed by Ladefoged and Maddieson (1996).

Based on the data in Ladefoged and Maddieson (1996:306-310) and Esling (1996, 1997), epiglottalisation is here assumed to be a secondary articulation which produces a constriction in the very low pharynx, in the region of the epiglottis. Under the appropriate articulation-to-acoustic assumptions (left unexplored here), the data in Table 3:5 are considered potential preliminary support for the assumption that the tokens of /I/ and the epenthetic vowel which occurred immediately preceding a uvular resonant may have been produced with epiglottal constriction (and that those which did not occur in that context were not). This lends potential support to the possibility of St'at'imcets being epiglottalised immediately preceding one of those consonants.

Figure 3:5 presents a wideband spectrogram showing two tokens of /I/, one immediately preceding [k̟], the other immediately preceding [ʁ']. F_3 of each [ɪ] is reported in the caption. The spectrogram shows the lowered F_3 for the [ɪ] immediately preceding [ʁ'].

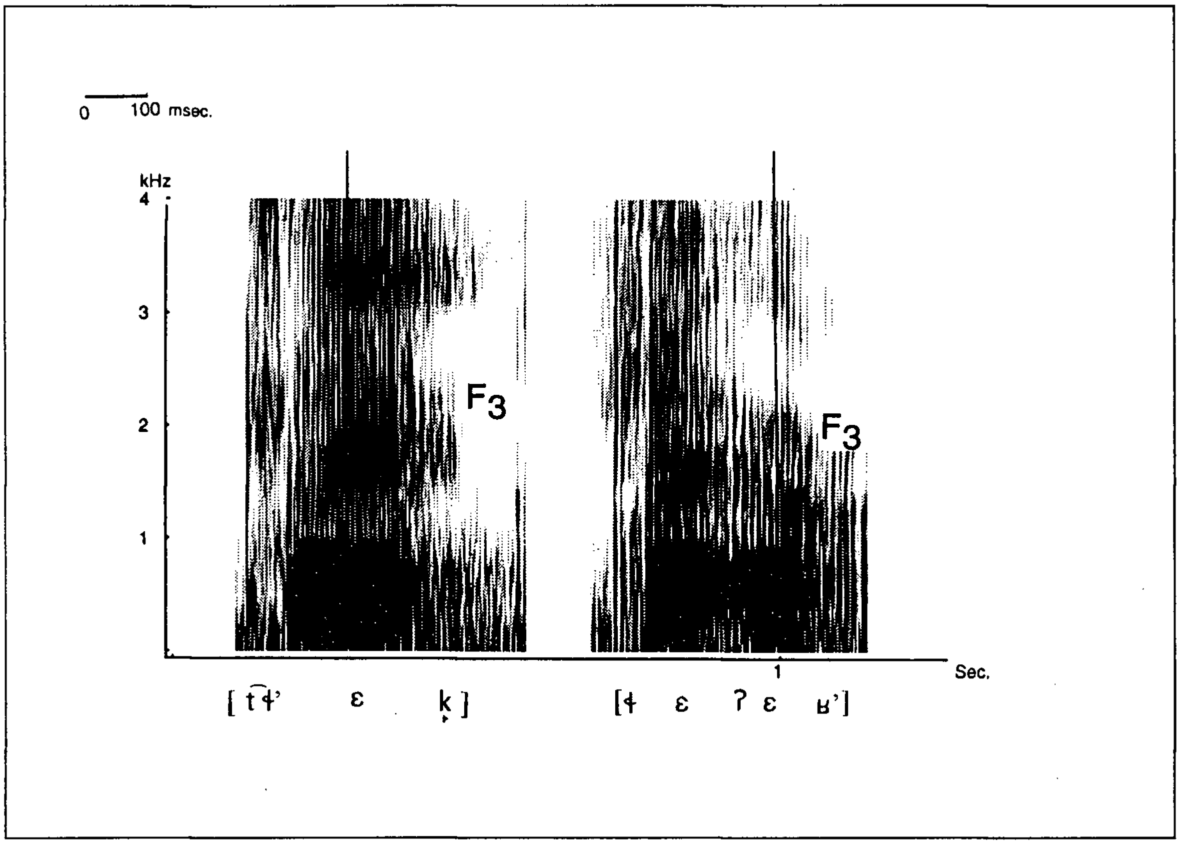


Figure 3:5 Wideband spectrogram showing a lowered F_3 for St'át'imcets /I/ immediately preceding a uvular resonant. The token on the left is [ɪ] in {t͡ɬ'ɪk̟} 'to arrive (here)'. The token on the right is a token of the rightmost [ɪ] in {ɬɪ-'-ʁ'} [ɬɪʔɪʁ'] 'to scatter (e.g., people leaving from a gathering)'. (Formants measured at the points indicated by the vertical lines.)

F_3 of [ɪ] on the left = 2267 Hz.

F_3 of [ɪ] on the right =1986 Hz.

Figure 3:6 shows the lowered F_3 of a token of the epenthetic vowel immediately preceding a uvular resonant.

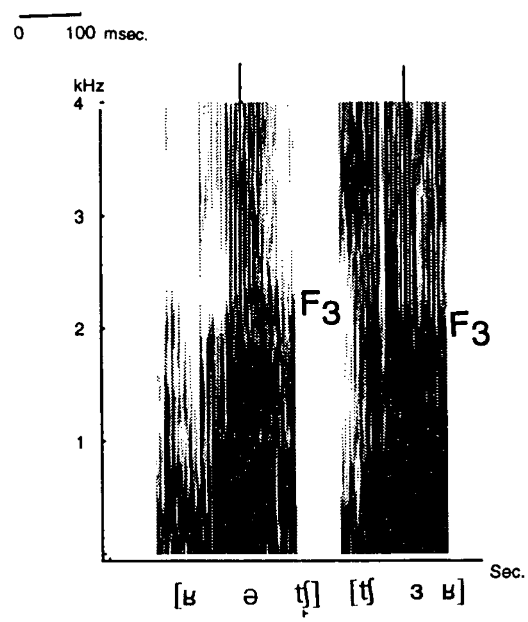


Figure 3:6 Wideband spectrogram showing a lowered F_3 for the St'át'imcets epenthetic vowel immediately preceding a uvular resonant. The token on the left is a token of epenthetic {ə} in {ʁətʃ̠-k̠in-upʔ-æm} 'to lead horses by tying them to the tail of the horse in front'. The token on the right is a token of epenthetic {ɜ} in {tʃɜʁ-ən} 'to rip, tear something (tr.)'. (Formants measured at the points indicated by the vertical lines.)

F_3 of [ə] = 2152 Hz.

F_3 of [ɜ] = 1988 Hz.

3.2.2.5. Pharyngealised Vowels

Rtr {ɪ a ɜ ɵ ʊ} occur immediately preceding a postvelar. This is illustrated by the data in (40). (I know of no forms showing this in which {ɪ a ɜ ɵ ʊ} arise as a result of morphological alternation. That is, the generalisation just stated is based solely on distributional evidence.)

(40) a. IPA /ʃ-ʧUʁʷ/	{ʃ-ʧʊʁʷ}	'stripe'
NA /s-cUʕʷ/	{s-cụʕʷ}	
b. IPA /mIx̟Æɬ/	{mɪx̟æɬ}	'black bear'
NA /mIx̌Æɬ/	{mịx̌aɬ}	
c. IPA /ʧIk̟-In'/	{ʧɪk̟ -in'}	'to stab someone (tr.)'
NA /cIq-In'/	{cịq-in'}	
d. IPA /ʧʁ-n/	{ʧɜʁ-ən}	'to rip, tear something (tr.)'
NA /cʕ-n/	{cəʕ-ən}	
e. IPA /lʁʷ-n/	{lɵʁʷ-ən}	'to hide something (intr., tr.)'
NA /lʕʷ-n/	{ləʕʷ-ən}	
f. IPA /RED, mÆʁ/	{mɜʁ-maʁ}	'light, bright'
NA /RED, mÆʕ/	{məʕ-maʕ}	

In §3.4, it will be argued that {ɪ}, {a}, and {ʊ} are underlying /I/, /Æ/, and /U/, respectively, and that {ɜ ɵ} are the epenthetic vowel, under pharyngealisation harmony with the postvelar. As illustrated by (40e), rounded {ɵ} occurs where the epenthetic vowel undergoes both pharyngealisation harmony and rounding harmony.

3.2.2.6. Uvularised Non-high Vowels

The backed vowels {ʌ ɔ ɑ} occur immediately preceding an emphatic. This is illustrated by the forms in (41). (I know of no forms showing this in which {ʌ ɔ ɑ} arise as a result of morphological alternation. The generalisation with respect to { ʌ ɔ ɑ } is also based solely on distributional evidence.)

(41)	a. IPA /k̙l̙/	{ k̙ʌl̙ }	'bad; old, worthless'
	NA /qḷ/	{ qə̣ḷ }	
	b. IPA /ʃ-tχ̙ʷ/	{ ʃ-tɔχ̙ʷ }	'really, very much'; 'to be in the way'
	NA /s-tx̌ʷ/	{ s-tə̣x̌ʷ }	
	c. IPA /ʔÆl̙ʃ̙-m/	{ ʔɑl̙ʃ̙-əm }	'sick, ill'
	NA /ʔÆḷṣ-m/	{ ʔạḷṣ-əm }	
	d. IPA /mxÆɹ̙/	{ məxɑɹ̙ }	'huckleberry' (Lower dialect)
	NA /mxÆẓ/	{ məxạẓ }	
	d. IPA /mÆk̙Æʔ/	{ mɑk̙æʔ }	'snow'
	NA /mÆqÆʔ/	{ mạqaʔ }	

In §3.5 it will be argued that { ʌ ɔ } and { ɑ } are the epenthetic vowel and /Æ/, respectively, under uvularisation harmony with the emphatic. It will be further argued in §3.5.3 that the high vowels /I U/ do not undergo uvularisation harmony. As illustrated by (41b), rounded { ɔ } occurs where the uvularised epenthetic vowel also undergoes rounding harmony.

3.2.2.7. Summary

The distribution of the St’át’imcets surface vowels is summarised in (42). In the table, a shaded cell means that the particular underlying vowel does not undergo the rounding, pharyngealisation, or uvularisation harmony. Fuller justification for the claims in (42) will be presented in the remainder of this chapter.

(42)

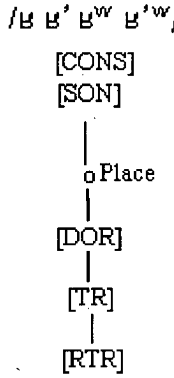
	Surface Correspondents					
	NON-RD	RD	NON-RD PHARYNGEAL-ISED	RD PHARYNGEAL-GEALISED	NON-RD UVULARISED	RD UVULARISED
/I/	i		ɪ			
/Æ/	æ		a		ɑ	
(epenthetic vowel)	ɘ	ɵ	ɜ	ɞ	ʌ	ɔ
/U/		u		ʊ		

3.3. Preliminary Issues

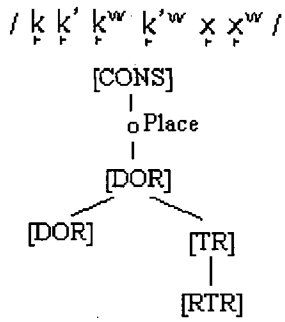
3.3.1. Underlying Pharyngealisation, Underlying Uvularisation

The representations of the St’át’imcets gutturals and emphatics, as proposed in §3.2.1.5.4, are seen in (43) and (44), respectively. Additional specifications which are assumed are: [SON] for /ɹ̘ ɹ̘’ l̘ l̘ ’/, [LAT] for /l̘ l̘’/, [CG] for /k̘’ k̘’ʷ ɹ̘’ l̘’ ʁ’ ʁ’ʷ/, [STRID] for /t̘ʃ/, and secondary-[LAB] for /k̘ʷ k̘’ʷ x̘ʷ ʁʷ ʁ’ʷ/.

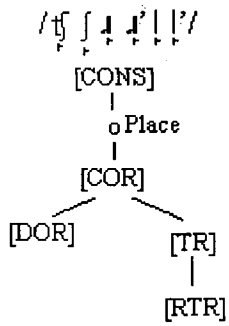
(43) The Representation of St'át'imcets Gutturals
a. uvulars



(44) The Representations of St'át'imcets Emphatics
a. dorsal emphatics



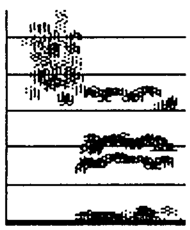
b. coronal emphatics



The gutturals /ʁ ʁ' ʁʷ ʁ'ʷ/ bear primary-[DOR] and secondary-[RTR]. Under the present representational assumptions, this defines them as primary uvulars. The emphatics /tʃ̙ ʃ̙ ɹ̙ ɹ̙' l̙ l̙' k̙ k̙' k̙ʷ k̙'ʷ x̙ x̙ʷ/ bear secondary-[DOR] and secondary-[RTR], which defines them as uvularised. The claim that uvular gutturals and emphatics are defined in this manner is based on the arguments presented in §2.3.1.

By the representations in (42) - (43), I claim that St'át'imcets gutturals and emphatics are underlyingly pharyngealised. Phonological evidence for this will be presented in §3.4.1: it will be shown that both classes of segments trigger St'át'imcets pharyngealisation harmony. The representations also claim that the uvular component of the gutturals vs. emphatics differ in that it is primary for the former, secondary for the latter. Phonological evidence for this will be presented in §3.5.1: it will be shown that the emphatics trigger St'át'imcets uvularisation harmony but the gutturals do not.

Acoustic support for the secondary-[DOR] and secondary-[RTR] specifications of the emphatics was presented in §3.2.1.5.7. Acoustic data reported in that section are consistent with the assumption that St'át'imcets emphatics are produced with the postvelar articulations of emphatics: pharyngealisation, assumed here to result from specification for secondary-[RTR], and uvularisation, assumed here to result from specification for secondary-[DOR]. Acoustic support for the primary-[DOR] and secondary-[RTR] specifications of the gutturals will be presented next.



3.3.1.1. Acoustic Support

Table 3:6 reports the F_1 and F_2 of two tokens each of palatal /j'/ and the uvular guttural /ʁʷ/. As /j'/ is non-postvelar, it serves as a useful contrast for /ʁʷ/.

Table 3:6

F_1 and F_2 of tokens of St'át'imcets /j'/ and /ʁʷ/

carrier form	token	F_1	F_2
{ʁʷuj't}	[j']1	296	2157
'to sleep'	[j']2	321	2002
{ʁʷuj't}	[ʁʷ]1	574	1000
'to sleep'	[ʁʷ]2	543	1000

Table 3:6 shows that for /ʁʷ/, F_1 is medium and F_2 is low. Constrastingly, for /j'/, F_1 is low, F_2 is high. Based on the investigation of §1.4.3, a medium or high F_1 and a low or medium F_2 is expected for a primary uvular such as /ʁʷ/, which is presumed to be produced with primary uvular and secondary pharyngeal articulation. The data in Table 3:6 match these expectations. They thus support the assumption that the [ʁʷ]s were produced with those gestures. This, in turn, supports the primary-[DOR] and secondary-[RTR] specifications proposed for St'át'icmets gutturals in (47). (As a lowered F_2 is also expected for segments produced with lip rounding, the F_2 effect observed for each [ʁʷ] is also consistent with their rounded production.)

The medium F_1 and low F_2 for /ʁʷ/ are seen in the spectrogram in Figure 3:7, which shows tokens [ʁʷ]1 and [j']1 from Table 3:6.

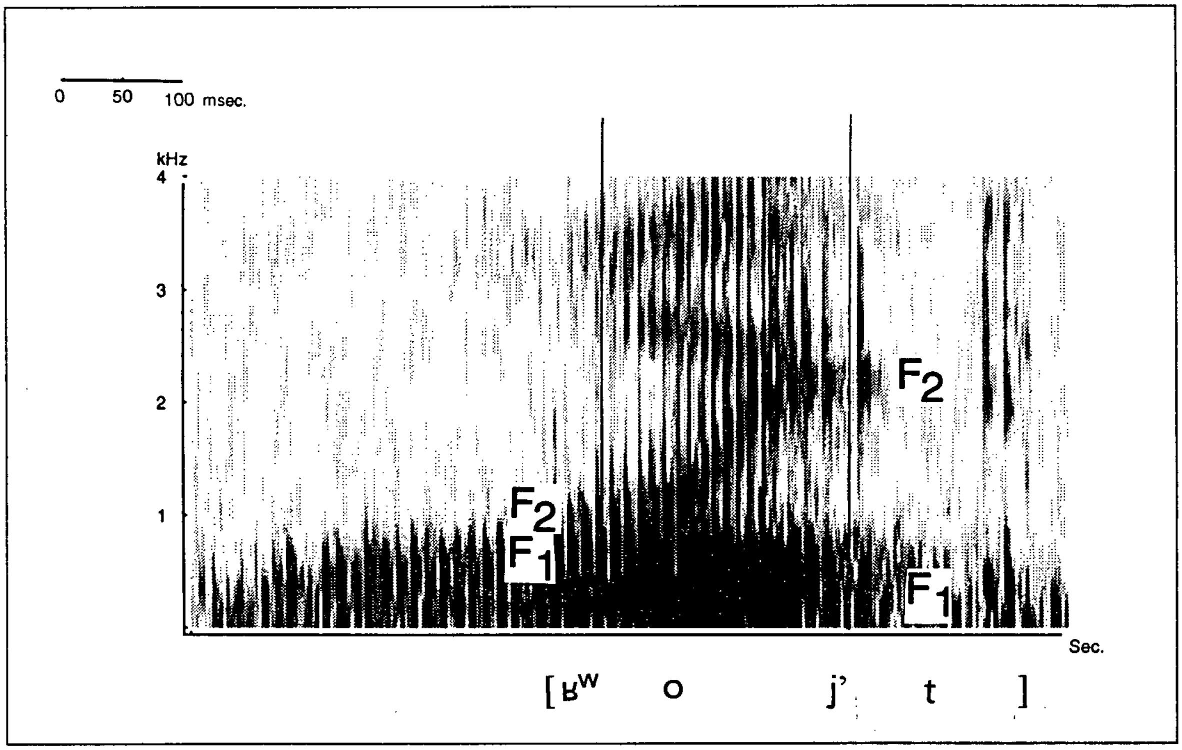


Figure 3:7 Wideband spectrogram of a token of {ʁʷuj’t} ‘to sleep’. (Formants measured at the points indicated by the vertical lines.)

[ʁʷ]: F_1 = 574 Hz; F_2 = 1000 Hz.

[j’]: F_1 = 296 Hz; F_2 = 2157 Hz.

3.3.2. The Derivation of the St’át’imcets Underlying Postvelar Inventory

The derivation of the St’át’imcets’ underlying postvelar inventory is assumed to be governed by the same conditions holding in Palestinian, *viz.*, ‘*Prim, Prim, ‘Prim-RTR/*Sec-RTR, Sec-RTR/DOR, and ‘FRONT/*Sec-DOR ∧ Sec-RTR; see §2.3.2 for further discussion.

Note that St’át’imcets has two underlying post-alveolar emphatics: /tʃ ʃ/. Further note that the St’át’imcets post-alveolar /tʃ/ undergoes uvularisation harmony. This was illustrated in (17); it will be shown in detail in §3.5.1. St'át'imcets post-alveolars thus contrast with Palestinian post-alveolars: Palestinian has no underlying post-alveolar emphatics and the Palestinian post-alveolars, /ʃ tʃ ʤ/, do not undergo uvularisation harmony; see §2.3.2 and §2.5.1 for discussion.

This crosslinguistic difference is here assumed to have a featural basis, *viz.*, that St'át'imcets post-alveolars bear [COR], as seen in (44), whereas Palestinian post-alveolars bear [DOR]/[FRONT]. (For the proposed representation of Palestinian post-alveolars, see (135) in §2.5.4.) Because FRONT/*Sec-DOR ∧ Sec-RTR prohibits specification for secondary-[DOR] and secondary-[RTR] only for segments bearing [FRONT], St'át'imcets post-alveolars can be emphatic, but Palestinian post-alveolars cannot. The fact that St'át'imcets post-alveolars are apical, as observed in §3.2.1, whereas Palestinian post-alveolars are laminal is considered support for this assumption.

3.4. St'át'imcets Pharyngealisation Harmony

3.4.1. Pharyngealisation Under Adjacency to a Postvelar

3.4.1.1. Analysis

St'át'imcets pharyngealisation harmony is triggered by postvelars and affects only one vowel in the word. Consider first the forms in (45), which show that /I/, /Æ/, /U/, and the epenthetic vowel surface non-rtr in forms that do not contain a postvelar. (These data also show that, unlike Palestinian, a closed syllable does not trigger pharyngealisation of vowels in St'át'imcets; see §2.3.3.1 for discussion of Palestinian closed-syllable pharyngealisation.)

(45) a. IPA /kItʃ-In'/	{kitʃ-in'}	'to lay something down (intr.,
NA /kIc-In'/	{kic-in'}	tr.)'
b. IPA /tʃUtʃIn/	{tʃutʃin}	'mouth'
NA /cUcIn/	{cucin}	
c. IPA /ʃItʃt/	{ʃitʃt}	'night'
NA /cUcIn/	{sitst}	
d. IPA /pUn-ɬp/	{pun-ɬəp}	'Rocky Mountain Juniper'
NA /pUn-ɬp/	{pun-ɬəp}	
e. IPA /t͡ɬ'l-Il'x/	{t͡ɬ'əl-il'x}	'to keep still, to sit still without
NA /ƛ'l-Il'x/	{ƛ'əl-il'x}	moving'
f. IPA /mUlx/	{mulx}	'stick' (N)
NA /mUlx/	{mulx}	
g. IPA /RED, n-kʷUtʃÆ/	{n-kʷu-kʷ-tʃæ}	'downstream area'
NA /RED, n-kʷUcÆ/	{n-kʷu-kʷ-ca}	
h. IPA /RED, ʃx/	{ʃəx-ʃəx}	'partly crazy'
NA /RED, sx/	{səx-səx}	
i. IPA /RED, tɰʷt/	{təɰʷə-ɰʷ-ɰ'ʷət}	'(young) boy'
NA /RED, twt/	{təw-əw-w'ət}	
j. IPA /t͡ɬ'xʷ-xÆl/	{t͡ɬ'əxʷ-xæl}	'to hit (as a bush to make
NA /ƛ'xʷ-xÆl/	{ƛ'əxʷ-xal}	the berries fall off)'

k. IPA /ʃ-p'Iʔ-l'ɰ^wÆʃ/	{ ʃ-p'iʔ-əl'ɰ^wæʃ}		'squeezed in the middle'
NA /s-p'Iʔ-l'wÆs/	{ s-p'iʔ-əl'was}		
l. IPA /RED, ʔUʃÆʔ/	{ ʔu-ʔ-ʃæʔ}		'egg'
NA /RED, ʔUsÆʔ/	{ ʔu-ʔ-saʔ}		

The data in (46) show that vowels surface rtr immediately preceding a guttural. (An Optimality tableau for (46a) will be presented in §3.4.2.) This effect has been observed by previous studies: van Eijk (1985:14) notes the occurrence of /U/ as [ɔ] immediately preceding one of /ʁ ʁ' ʁʷ ʁ'ʷ/; Remnant (1990:17,113) notes the occurrence of /I/ as [ɛ] in the same context. However, it has not previously been incorporated into an analysis which considers the full range of St'át'imcets postvelar harmony. (The mid height documented by van Eijk and Remnant is analysed here as phonetic; see §3.2.2.3 for further discussion. In (46), no ungrammatical NA forms are provided for words for which NA transcription would not encode the relevant rtr vs. non-rtr distinction(s).)

(46)

a. IPA /tIʁ'ʷ-In'/	{ tɪʁ'ʷ-in'}	(*{ tiʁ'ʷ-in'})	'to untie something, to turn
NA /tIʕ'ʷ-In'/	{ ti̗ʕ'ʷ-in'}	(*{ tiʕ'ʷ-in'})	an animal loose (tr.)'
b. IPA /RED, ʃIʁʷ/	{ ʃɵʁʷ-ʃɪʁʷ}	(*{ ʃɵʁʷ-ʃiʁʷ})	'loose (objects, also ways
NA /RED, sIʕʷ/	{ səʕʷ-si̗ʕʷ}	(*{ səʕʷ-siʕʷ})	of behaviour)'
c. IPA /ʃ-tʃUʁʷ/	{ ʃ-tʃʊʁʷ}	(*{ ʃ-tʃuʁʷ})	'stripe'
NA /s-cUʕʷ/	{ s-cu̗ʕʷ}	(*{ s-cuʕʷ})	
d. IPA /tʃʁ-n/	{ tʃɜʁ-ən}	(*{ tʃəʁ-ən})	'to rip, tear something
NA /cʕ-n/	{ cəʕ-ən}		(tr.)'

e. IPA /GLOT, mʁ/	{ mɜ-ʼ-ʁ }	(*{ mə-ʼ-ʁ })	'(breaking) daylight'
NA /GLOT, mʕ/	{ mə-ʼ-ʕ }		
f. IPA /lʁʷ-n/	{ ləʁʷ-ən }	(*{ leʁʷ-en })	'to hide something (intr., tr.)'
NA /lʕʷ-n/	{ ləʕʷ-ən }		
g. IPA /RED, mÆʁ/	{ mɜʁ-maʁ }	(*{ meʁ-mæʁ })	'light, bright'
NA /RED, mÆʕ/	{ məʕ-maʕ }		
h. IPA /RED, lÆʁʼʷ/	{ ləʁʷ-laʁʼʷ }	(*{ leʁʷ-læʁʼʷ })	'room, spaces in between things'
NA /RED, lÆʕʷ/	{ ləʕʷ-laʕʼʷ }		

The forms in (47) show that vowels surface rtr immediately preceding an emphatic.

(47)

a. IPA /mIx̙Æɬ/	{ mɪx̙æɬ }	(*{ mix̙æɬ })	'black bear'
NA /mIx̌Æɬ/	{ mịx̌aɬ }	(*{ mix̌aɬ })	
b. IPA /t͡ɬʼIk̙/	{ t͡ɬʼɪk̙ }	(*{ t͡ɬʼik̙ })	'to arrive (here)'
NA /ƛʼIq/	{ ƛʼịq }	(*{ ƛʼiq })	
c. IPA /t͡ʃIk̙-Inʼ/	{ t͡ʃɪk̙ -inʼ }	(*{ t͡ʃik̙ -inʼ })	'to stab someone (tr.)'
NA /cIq-Inʼ/	{ cịq-inʼ }	(*{ ciq-inʼ })	
d. IPA /ʔUx̙ʷ-xÆl/	{ ʔʊx̙ʷ-xæl }	(*{ ʔux̙ʷ-xæl })	'to smoothen something (wood) by shaving it (intr.)'
NA /ʔUx̌ʷ-xÆl/	{ ʔụx̌ʷ-xal }	(*{ ʔux̌ʷ-xal })	
e. IPA /n-ɬUk̙ʷ-xIt/	{ n-ɬʊk̙ʷ-xit }	(*{ n-ɬuk̙ʷ-xit })	'to serve food to someone (tr.)'
NA /n-ɬUqʷ-xIt/	{ n-ɬụqʷ-xit }	(*{ n-ɬuqʷ-xit })	

f. IPA /kʷUʃ̙U/	{kʷʊʃ̙u}	(*{kʷuʃ̙u})	'pig' (borrowing
NA /kʷUṣU/	{kʷụṣu}	(*{kʷuṣu})	from Chinook
			Jargon)
g. IPA /GLOT, kIx̙/	{kɪ-'-x̙}	(*{ki-'-x̙})	'cranky (child), fussing
NA /GLOT, kIx̌/	{kị-'-x̌}	(*{ki-'-x̌})	(because it wants
			attention or is sick)'
h. IPA /GLOT, ʔUx̙ʷ-UʃÆʔ/	{ʔʊ-'-x̙ʷ-uʃæʔ}	(*{ʔu-'-x̙ʷ-uʃæʔ})	'to peel fruit
NA /GLOT, ʔUx̌ʷ-UsÆʔ/	{ʔụ-'-x̌ʷ-usaʔ}	(*{ʔu-'-x̌ʷ-usaʔ})	(intr., tr.)'

The data in (47) involve only high vowels. When immediately preceding an emphatic, the epenthetic vowel surfaces as rtr back {ʌ} or {ɔ} and /Æ/ surfaces as rtr back {ɑ}. Data which show this will be presented in §3.5.1. Back {ʌ ɔ ɑ} will be analysed as arising through uvularisation harmony with the following emphatic. Because the epenthetic vowel and /Æ/ undergo that distinct harmony immediately preceding an emphatic, forms in which they occur in that context will not be examined further until §3.5.

The data in (48) show that vowels immediately following a postvelar surface non-rtr. (A tableau for (48d) will be presented in §3.4.2.)

(48)

a. IPA /tIʁ'ʷ-In'/	{ tɪʁ'ʷ-in' }	(*{ tɪʁ'ʷ-ɪn' })	'to untie something,
NA /tIʕ'ʷ-In'/	{ tịʕ'ʷ-in' }	(*{ tịʕ'ʷ-ịn' })	to turn an animal loose (tr.)'
b. IPA /tʃIk̟-In'/	{ tʃɪk̟-in' }	(*{ tʃɪk̟-ɪn' })	'to stab someone
NA /cIq-In'/	{ cịq-in' }	(*{ cịq-ịn' })	(tr.)'
c. IPA /k̟'IɬIl/	{ k̟'iɬil }	(*{ k̟'ɪɬil })	'to run'
NA /q'Iɬ-Il/	{ q'iɬ-il }	(*{ q'ịɬ-il })	
d. IPA /ʁIʃ/	{ ʁiʃ }	(*{ ʁɪʃ })	'to shrink'
NA /ʕIs/	{ ʕis }	(*{ ʕịs })	
e. IPA /k̟ʷUʔ/	{ k̟ʷuʔ }	(*{ k̟ʷʊʔ })	'water'
NA /qʷUʔ/	{ qʷuʔ }	(*{ qʷụʔ })	
f. IPA /kʷl̟-It /	{ kʷl̟-it }	(*{ kʷl̟-ɪt })	'brass'
NA /kʷḷ-It/	{ kʷḷ-it }	(*{ kʷḷ-ịt })	
g. IPA /x̟ʷUl-ÆkÆʔ/	{ x̟ʷul-ækæʔ }	(*{ x̟ʷʊl-ækæʔ })	'finger'
NA /x̌ʷUl-ÆkÆʔ/	{ x̌ʷul-akaʔ }	(*{ x̌ʷụl-akaʔ })	

The generalisations from (45) - (48) are that St'át'imcets vowels surface rtr when immediately preceding a postvelar; in any other context, they surface non-rtr. The rtr effect is analysed as pharyngealisation harmony triggered by the immediately following postvelar.

The forms in (49) show that vowels do not surface rtr immediately preceding a laryngeal. (Lower dialect /ɹ̟/ is analysed as surface non-emphatic in (49c); see §3.2.2.3 for relevant discussion.)

(49)

a. IPA /ʃ-p'Iʔ-l'ɰ̟ʷÆʃ/	{ ʃ-p'iʔ-əl'ɰ̟ʷæʃ }	(*{ ʃ-p'ɪ̣ʔ-əl'ɰ̟ʷæʃ })	'squeezed in
NA /s-p'Iʔ-l'wÆs/	{ s-p'iʔ-l'was }	(*{ s-p'ịʔ-əl'was })	the middle'
b. IPA /RED, ʔUʃÆʔ/	{ ʔu-ʔ-ʃæʔ }	(*{ ʔʊ-ʔ-ʃaʔ })	'egg'
NA /RED, ʔUsÆʔ/	{ ʔu-ʔ-saʔ }	(*{ ʔụ-ʔ-saʔ })	
c. IPA /ɹ̟Uh-n/	{ ɹuh-ən }	(*{ ɹʊh-ən })	'to warn some-
NA /ẓUh-n/	{ zɹuh-ən }	(*{ zɹ̣h-ən })	one, to tell someone to be careful (intr., tr.)'

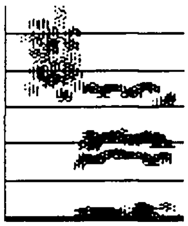
The lack of effect immediately preceding a laryngeal indicates that St'át'imcets laryngeals are not gutturals; that is, that unlike Arabic laryngeals, they lack postvelar articulation. (For discussion of the support for assuming that Arabic laryngeals are tongue root articulated, see §1.3.2.2 and §2.4.1.2.) Further indication comes from the phonetic vowel lowering discussed in §3.2.2.3: St'át'imcets gutturals and emphatics trigger the lowering but the laryngeals do not.

Finally, the forms in (50) - (51) show that St'át'imcets pharyngealisation harmony does not extend beyond the word. This shows that the word is the harmony domain. These data are phrases which each contain a word-final vowel followed by word-initial postvelar. The word-final vowel does not pharyngealise, as seen. This is so whether the words involved are bound morphemes (that is, clitics, as described by Spencer 1991:14), as in (50), or free morphemes, as in (51). (Clitic word boundaries are marked below by '‿#'.)

(50)

a. IPA /nI ‿# ʁItʃ-mn/	{ni ‿# ʁitʃ-mən}	(*{nɪ ‿# ʁitʃ-mən})	'the tooth
NA /nI ‿# ʕIc-mn/	{ni ‿# ʕic-mən}	(*{nị ‿# ʕic-mən})	(absent, unknown)'
b. IPA /k̟ʷU ‿# k̟'ʷl-Æɹ̟'/	{k̟ʷu ‿# k̟'ʷl-ɑɹ̟'}	(*{k̟ʷʊ ‿# k̟'ʷl-ɑɹ̟'})	'a bunch of
NA /qʷU ‿# q'ʷlÆẓ'/	{qʷu ‿# q'ʷlạẓ'}	(*{qʷụ ‿# q'ʷlạẓ'})	fruit trees'
c. IPA /ʔI ‿# ʁÆpÆʃ/	{ʔi ‿# ʁæpæʃ}	(*{ʔɪ ‿# ʁæpæʃ})	'when evening
NA /ʔI ‿# ʕÆpÆs/	{ʔi ‿# ʕapas}	(*{ʔị ‿# ʕapas})	comes'
d. IPA /k̟'m'p # ɰʷI ‿# x̟ʷʔUtʃIn/	{k̟'əm'p # ɰʷi ‿# x̟ʷʔutʃin} (*{k̟'əm'p # ɰʷɪ ‿# x̟ʷʔutʃin})		'fourteen'
NA /q'm'p # wI ‿# x̌ʷʔUcIn/	{q'əm'p # wi ‿# x̌ʷʔucin} (*{q'əm'p # wị ‿# x̌ʷʔucin})		

(51) IPA /t͡ɬ'U # k̟'tʃ'-p/	{t͡ɬ'u # k̟'ətʃ'-əp}	(*{t͡ɬ'ʊ # k̟'ətʃ'-əp})	'until it got
NA /ƛ'U # q'c'-p/	{ƛ'u # q'əc'-əp}	(*{ƛ'ụ # q'əc'-əp})	tangled up'



3.4.1.2. Acoustic Support

Figures 3:8 - 3:15 present F_1 - F_2 plots for the four St'át'imcets vowels. The tokens plotted in these graphs are all the St'át'imcets vowels analysed for this thesis, except for a handful which are reported instead in a spectrogram or table. The tokens produced by LC, the Lower dialect speaker, and those produced by LN, the Upper dialect speaker, are presented in separate graphs. Figures 3:8 - 3:9 plot the tokens of /I/; Figures 3:10 - 3:11 plot the tokens of /U/; Figures 3:12 - 3:13 plot the tokens of /Æ/; Figures 3:14 - 3:15 plot the tokens of the epenthetic vowel.

IPA symbols identify clusters of tokens which are perceptually non-rtr vs. rtr allophones, per vowel. Ellipses are calculated to enclose 90% of the normally distributed tokens of a given allophone. Each IPA symbol associates with the ellipse closest to it. The caption for each figure reports statistics for each allophone: the number of tokens plotted, their mean F_1, mean F_2, and the standard deviation ('s.d.') of F_1 and F_2. For allophones for which less than six tokens are plotted, ellipses are calculated assuming a s.d. of 40 Hz, based on Lindblom (1962); ellipses calculated in this manner are presented with a dotted line. (Due to lack of data, no tokens of {ʊ} for are plotted for LN and no tokens of {ʌ} are plotted for LC. For the same reason, no tokens of rtr {a} or rtr {ə} are plotted for either speaker.)

3.4.1. Pharyngealisation Under Adjacency to a Postvelar

In this section, observations which bear on the phonological claims of §3.4.1.1 will be made from the data in Figures 3:8 - 3:15. However, the paucity of data for some vowel allophones should be noted; e.g., in several graphs, only two tokens of a particular allophone are plotted. Given this paucity, the observations to be made must await confirmation from a more robust database.

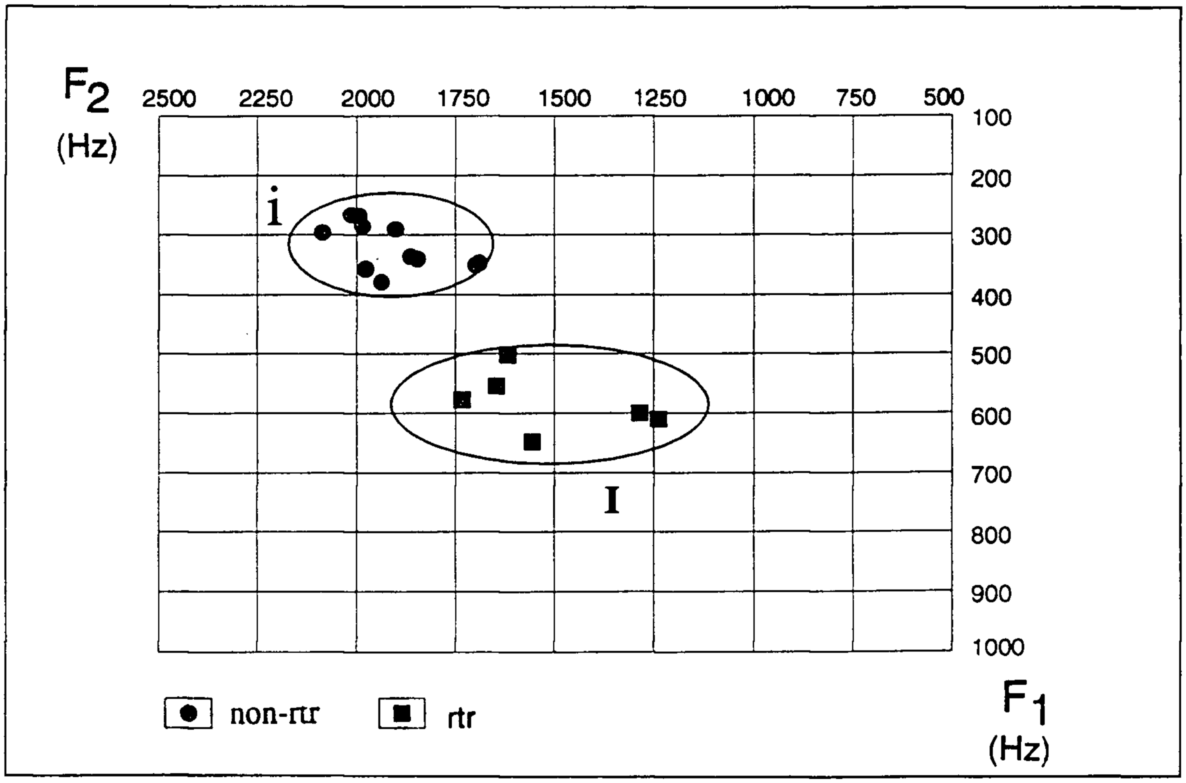


Figure 3:8 F_1 - F_2 plot of tokens of St'át'imcets /I/. Speaker: LC.
[i]: F_1 (mean = 315 Hz; s.d. = 39 Hz); F_2 (mean = 1910 Hz; s.d. = 118 Hz); 12 tokens.
[ɪ]: F_1 (mean = 582 Hz; s.d. = 46 Hz); F_2 (mean = 1514 Hz; s.d. = 186 Hz); 6 tokens.

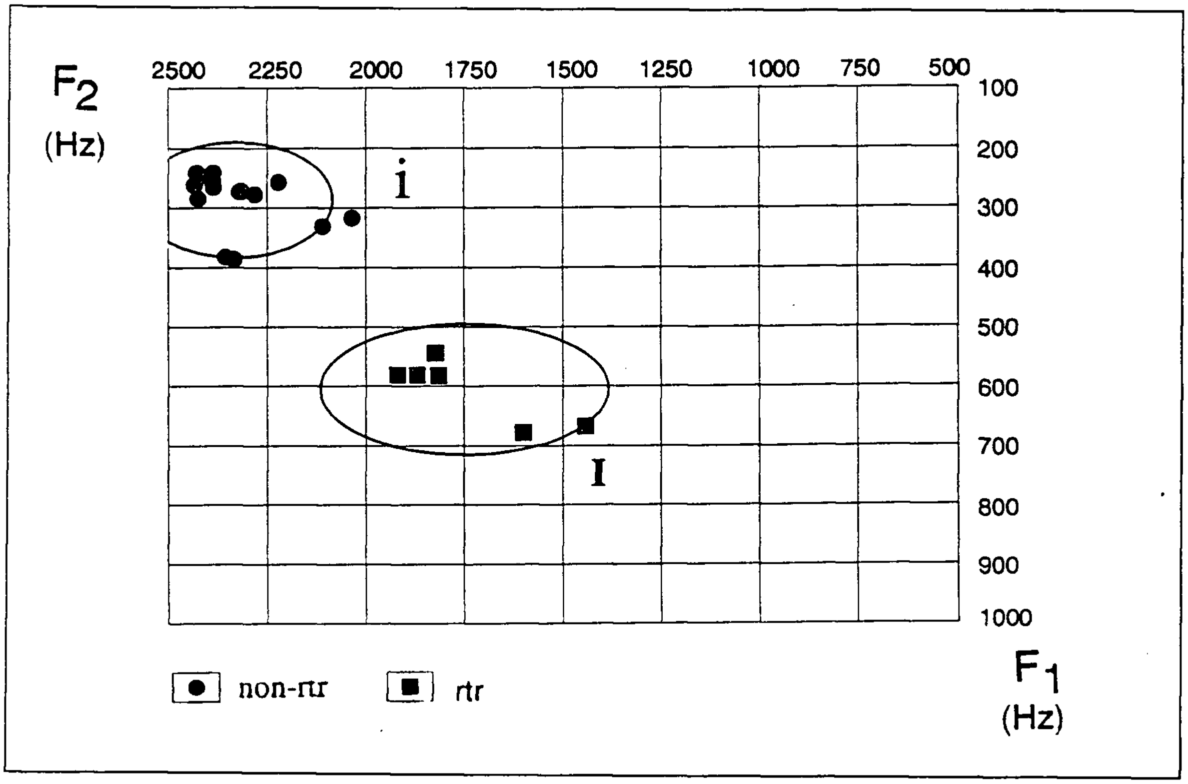


Figure 3:9 F_1 - F_2 plot of tokens of St'át'imcets /I/. Speaker: LN.
[i]: F_1 (mean = 286 Hz; s.d. = 44 Hz); F_2 (mean = 2329 Hz; s.d. = 114 Hz); 16 tokens.
[ɪ]: F_1 (mean = 606 Hz; s.d. = 50 Hz); F_2 (mean = 1744 Hz; s.d. = 168 Hz); 6 tokens.

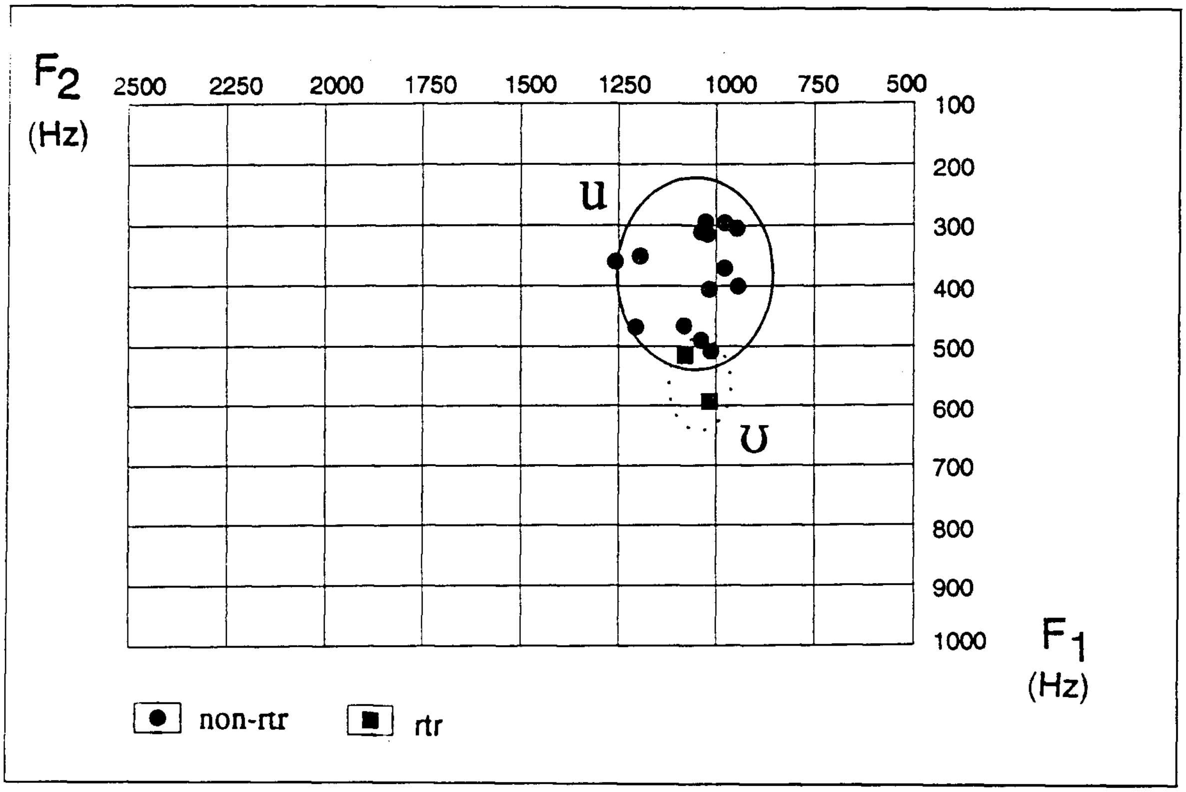


Figure 3:10 F_1 - F_2 plot of tokens of St'át'imcets /U/. Speaker: LC.
[u]: F_1 (mean = 381 Hz; s.d. = 73 Hz); F_2 (mean = 1053 Hz; s.d. = 95 Hz); 14 tokens.
[ʊ]: F_1 (mean = 554 Hz; s.d. = 39 Hz); F_2 (mean = 1048 Hz; s.d. = 32 Hz); 2 tokens.

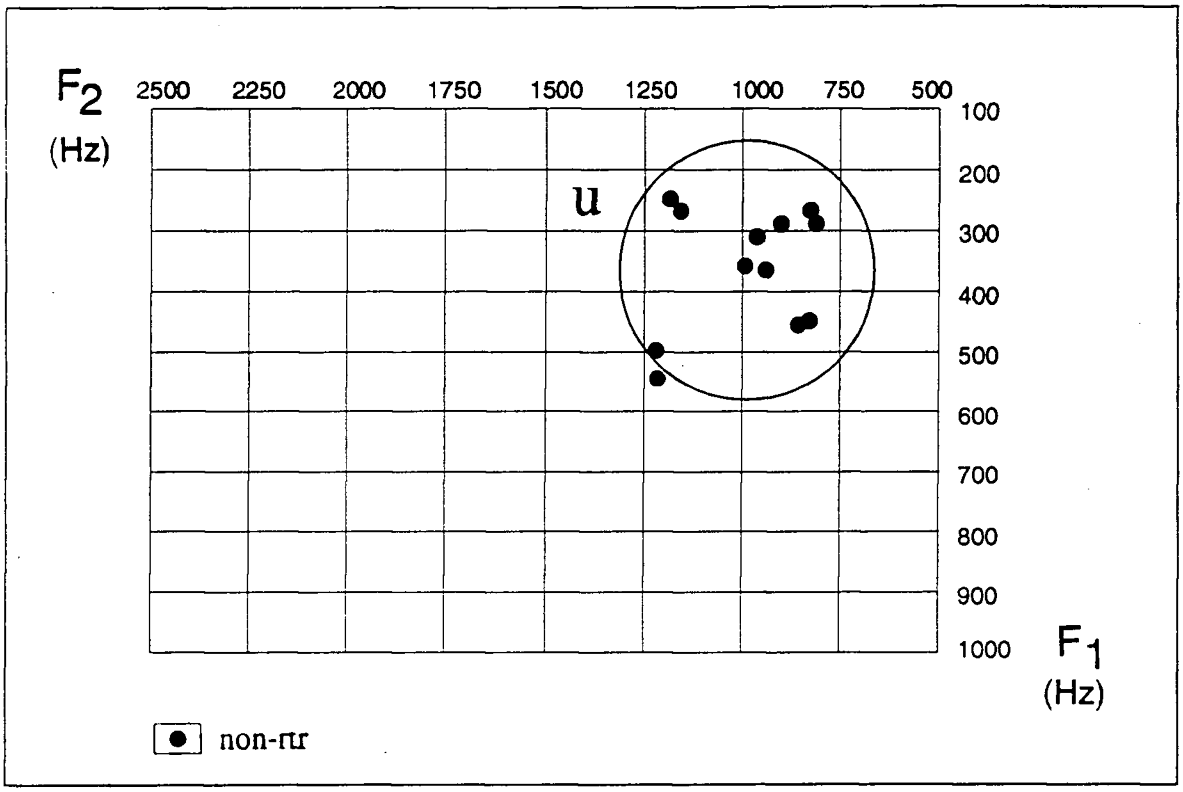


Figure 3:11 F_1 - F_2 plot of tokens of St'át'imcets /U/. Speaker: LN.
[u]: F_1 (mean = 361 Hz; s.d. = 97 Hz); F_2 (mean = 991 Hz; s.d. = 155 Hz); 12 tokens.
[ʊ]: no tokens.

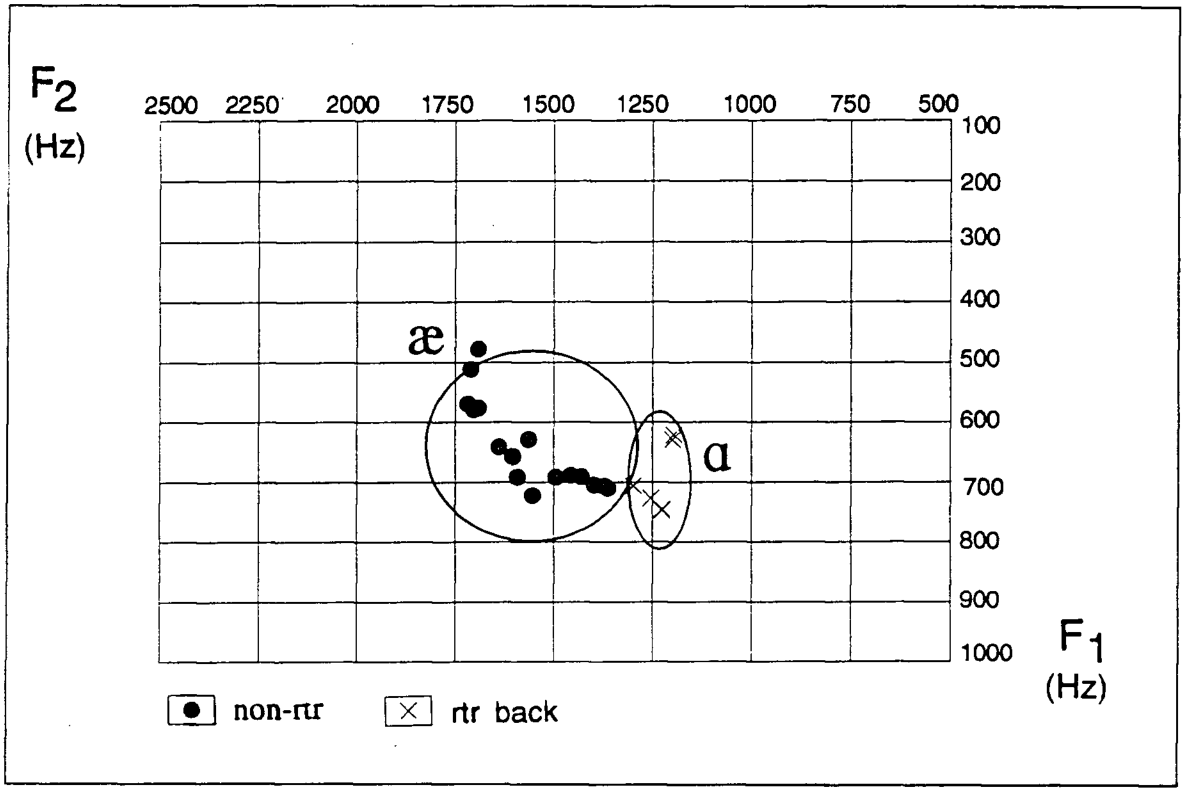


Figure 3:12 F_1 - F_2 plot of tokens of St'át'imcets /Æ/. Speaker: LC.
[æ]:F_1 (mean = 641 Hz; s.d. = 74 Hz); F_2 (mean = 1562 Hz; s.d. = 123 Hz); 16 tokens.
[ɑ]: F_1 (mean = 696 Hz; s.d. = 52 Hz); F_2 (mean = 1234 Hz; s.d. = 35 Hz); 6 tokens.
[a]: no tokens.

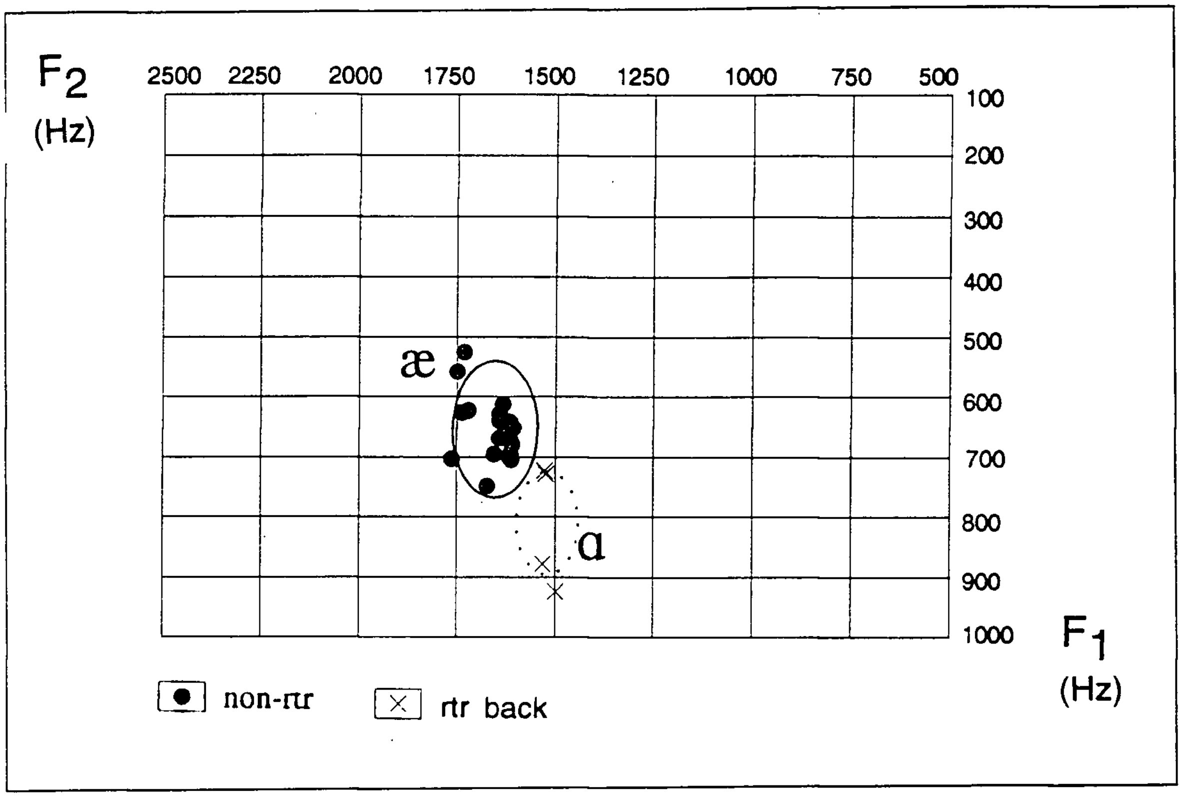


Figure 3:13 F_1 - F_2 plot of tokens of St'át'imcets /Æ/. Speaker: LN.
[æ]:F_1 (mean = 653 Hz; s.d. = 51 Hz); F_2 (mean = 1658 Hz; s.d. = 51 Hz); 20 tokens.
[ɑ]: F_1 (mean = 813 Hz; s.d. = 89 Hz); F_2 (mean = 1521 Hz; s.d. = 13 Hz); 4 tokens.
[a]: no tokens.

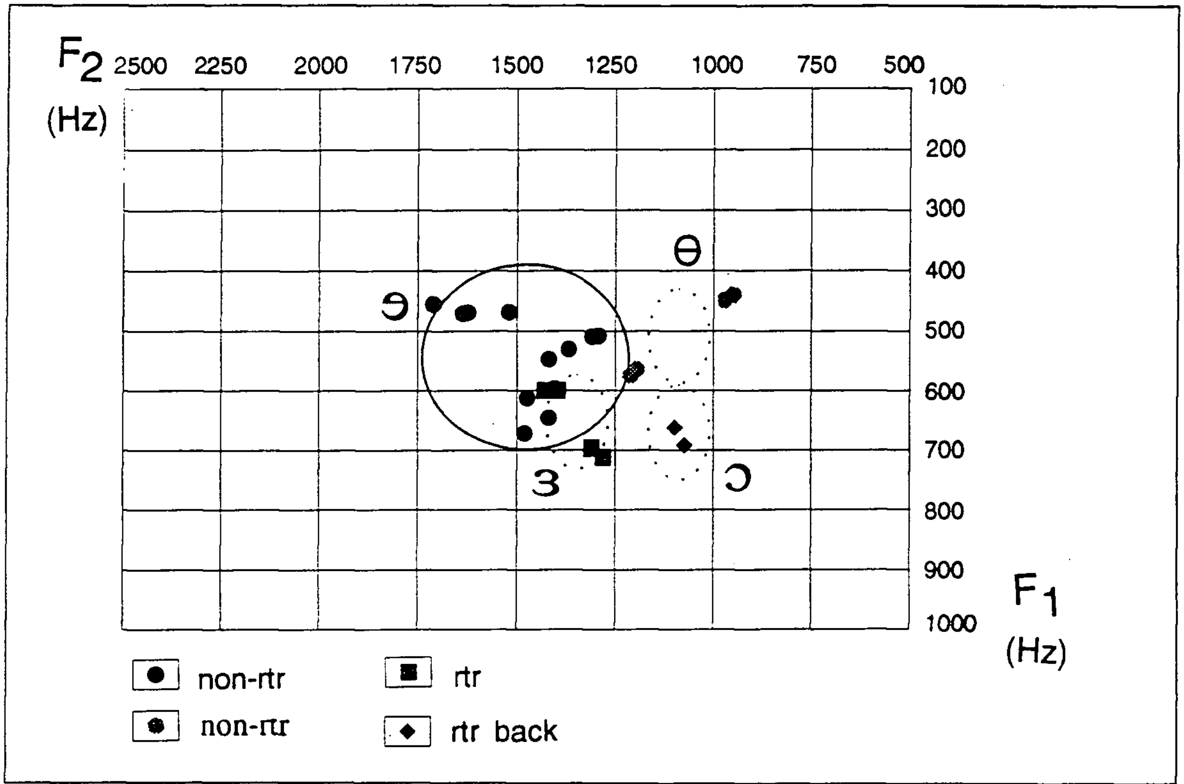


Figure 3:14 F_1 - F_2 plot of tokens of the St'át'imcets epenthetic vowel. Speaker: LC.
[ɘ]: F_1 (mean = 541 Hz; s.d. = 72 Hz); F_2 (mean = 1472; Hz; s.d. = 125 Hz); 12 tokens.
[ɵ]: F_1 (mean = 507 Hz; s.d. = 63 Hz); F_2 (mean = 1083 Hz; s.d. = 123); 4 tokens.
[ɜ]: F_1 (mean = 652 Hz; s.d. = 52 Hz); F_2 (mean = 1355 Hz; s.d. = 61); 4 tokens.
[ɔ]: F_1 (mean = 677 Hz; s.d. = 15 Hz); F_2 (mean = 1087 Hz; s.d. = 12); 2 tokens.
[ʌ]: no tokens.
[ɐ]: no tokens.

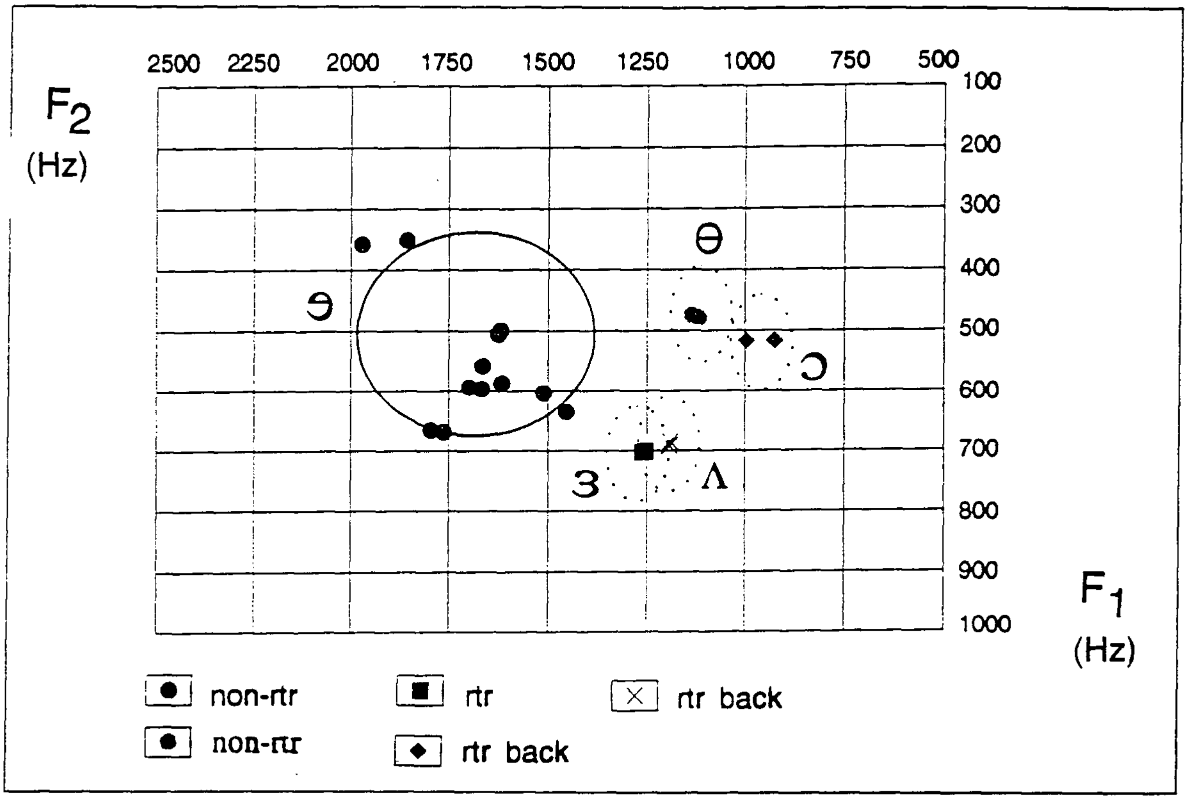


Figure 3:15 F_1 - F_2 plot of tokens of the St'át'imcets epenthetic vowel. Speaker: LN.
[ɘ]: F_1 (mean = 552 Hz; s.d. = 102 Hz); F_2 (mean = 1687; Hz; s.d. = 138 Hz); 12 tokens.
[ɵ]: F_1 (mean = 477 Hz; s.d. = 4 Hz); F_2 (mean = 1114 Hz; s.d. = 10); 2 tokens.
[ɜ]: F_1 (mean = 702 Hz; s.d. = 0 Hz); F_2 (mean = 1273 Hz; s.d. = 2); 2 tokens.
[ɔ]: F_1 (mean = 517 Hz; s.d. = 0 Hz); F_2 (mean = 960 Hz; s.d. = 36); 2 tokens.
[ʌ]: F_1 (mean = 689 Hz; s.d. = 4 Hz); F_2 (mean = 1192 Hz; s.d. = 36); 2 tokens.
[ɐ]: no tokens.

In Figures 3:8 and 3:9, the non-rtr vs. rtr tokens of /I/ fall within distinct regions of the F_1 - F_2 plane. For each speaker, the rtr tokens fall within a higher F_1 and a lower F_2 region than the non-rtr tokens. The same is observed for the non-rtr front vs. rtr back tokens of /Æ/ in Figures 3:12 - 3:13, in which the difference in F_1 is less for speaker LC than for speaker LN.

Figures 3:14 - 3:15 show that the tokens of the epenthetic vowel also fall within distinct regions, which can be described three different ways, corresponding to the three-way distinction that cuts across the surface variants of this vowel, *viz.*, non-rtr vs. rtr, non-back vs. back, non-rd vs. rd. For LC, the non-rtr [ɘ]s fall mostly in a lower F_1 and higher F_2 region than do the rtr [ɜ]s; for LN, all the non-rtr [ɘ]s fall in a lower F_1 and higher F_2 region than the rtr [ɜ ʌ]s. For both speakers, the non-rtr [ɵ]s fall in a lower F_1 region than the rtr [ɔ]s.

The non-back [ɘ ɜ]s fall in a higher F_2 region than the back [ɔ]s or, for LN, back [ʌ]s. For LN, the difference in F_2 between the [ɜ]s and [ʌ]s is slight.

Finally, for both speakers, the non-rd [ɘ ɜ ʌ]s fall in a higher F_2 region than do the rd [ɵ ɔ]s. For LN, the difference in F_2 between the [ʌ]s and [ɵ]s is slight.

Some [ɘ]s in Figures 3:14 - 3:15 occurred immediately following a postvelar. Those [ə]s fall within the lower part of the ellipses for {ɘ} (that is, within the part of the ellipses where F_1 is higher than average); they are more accurately transcribed as '[ə]'. Their lowered position within the ellipses is consistent with the assumption that the epenthetic vowel is phonetically lowered immediately following a postvelar, as discussed in §3.2.2.3. The data in Figure 3:14 are also consistent with a presumed lowering: two of LC's [ɵ]s fall within a lower region than his other two [ɵ]s. The [ɵ]s in the lower region occurred immediately following a rounded postvelar. (See Appendix VI for the relevant carrier forms.)

Figure 3:16 shows a wideband spectrogram of rd [ɔ] and non-rd [ʌ]. F_2 of [ɔ] is about 200 Hz lower than F_2 of [ʌ]. For each vowel, F_2 is steady. This is interpreted as showing that each vowel has reached and maintained its distinct F_2 target.

As discussed in §3.5.1.1., distinct formant targets that are reached and maintained are interpreted as the phonetic implementation of some discrete phonological property. The distinct steady F_2 of [ɔ] vs. [ʌ] in Figure 3:16 are thus expected if rnd [ɔ] and non-rnd [ʌ] are tokens of phonologically distinct vowels: {ɔ}, which is specified for [LAB], and {ʌ}, which is noit specified for [LAB], respectively. The data in Figure 3:16 thus support the claim that the St'at'imcets epenthetic vowel undergoes phonological rounding harmony.

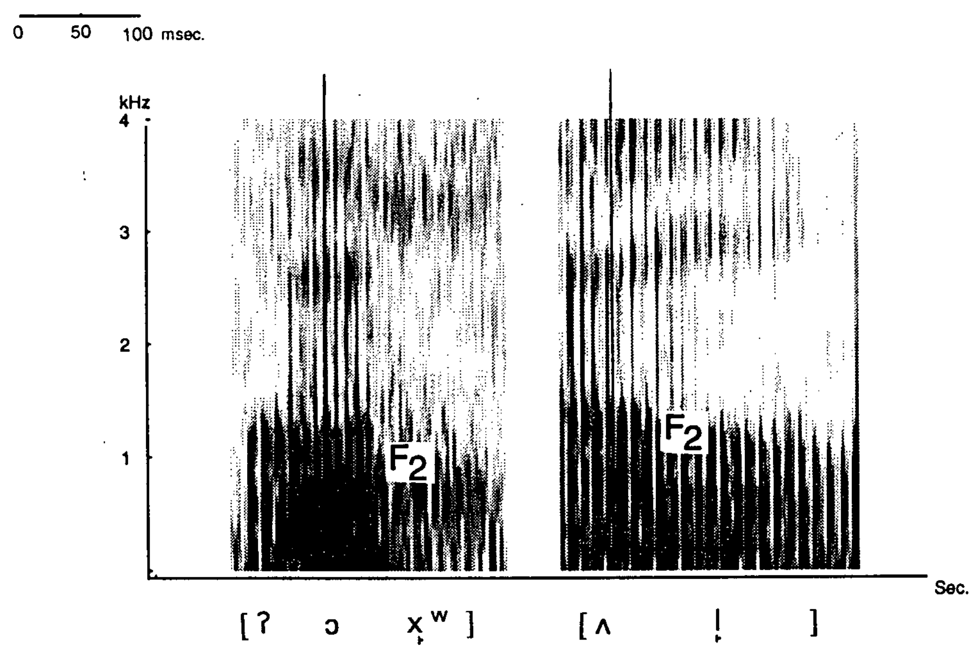


Figure 3:16 Wideband spectrogram of St'át'imcets [ɔ] and [ʌ]. The [ɔ] is a token of epenthetic rd {ɔ} in {ʔɔx̣ʷʔ-un} 'to cough'. The [ʌ] is a token of epenthetic non-rd {ʌ} in {ḳʌḷ-wɪḷ'x} 'to get spoiled (meat, potatoes), to break down (car, wagon)'. (Formants measured at the points indicated by the vertical lines.)
[ɔ]: F_1 = 517 Hz; F_2 = 997 Hz.
[ʌ]: F_1 = 685 Hz; F_2 = 1191 Hz.

3.4.1. Pharyngealisation Under Adjacency to a Postvelar

The subsequent graphs in this section replot the vowel tokens in Figures 3:8 - 3:15 according to the contexts relevant to St'át'imcets pharyngealisation harmony: (i) with no postvelar in the word, (ii) immediately preceding a guttural, (iii) immediately following a guttural, (iv) immediately preceding an emphatic, and (v) immediately following an emphatic. However, no graphs will be given for /Æ/ and the epenthetic vowel in the last two contexts just listed. The data on those vowels in the context of an emphatic will be examined in §3.5.1.1.

Figures 3:17 - 3:24 replot those tokens of /I/, /U/, /Æ/, and the epenthetic vowel which occurred in context (i). The ellipses in the graphs are the same ellipses seen in Figures 3:8 - 3:15.

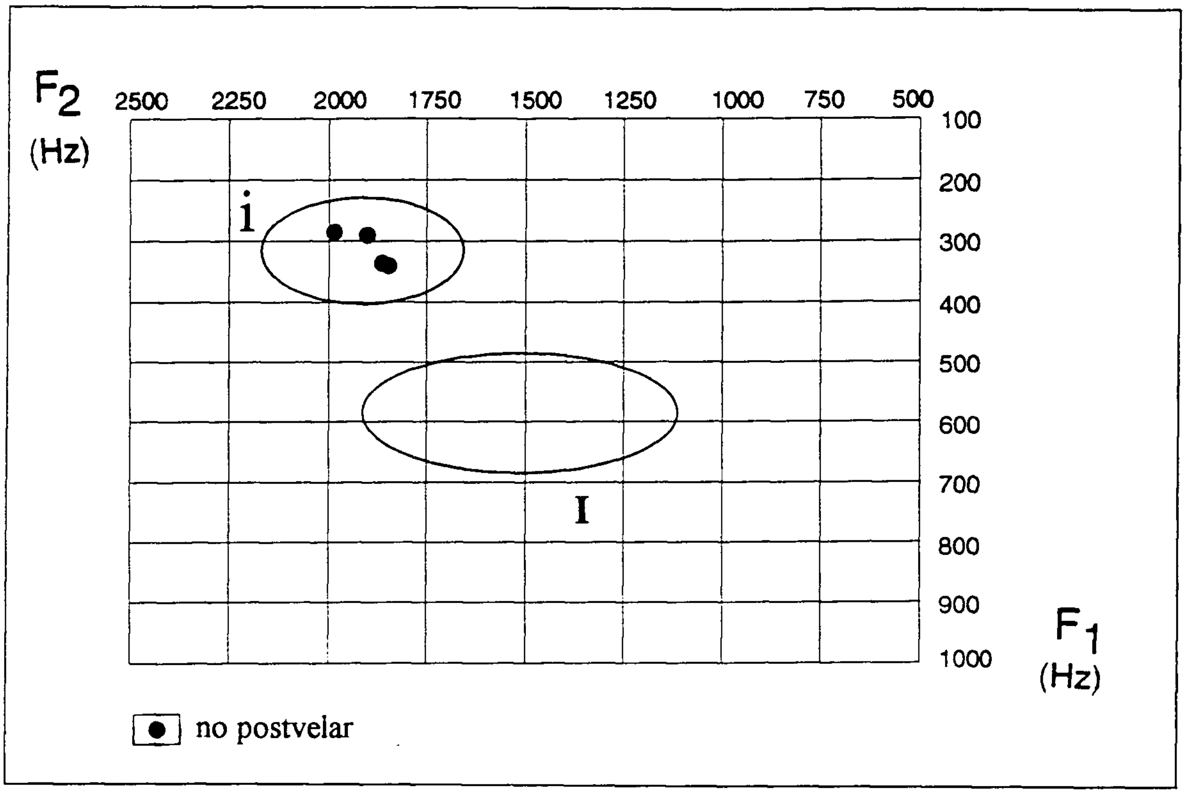


Figure 3:17 F_1 - F_2 plot of St'át'imcets /I/ in the context: (i) with no postvelar in the word. Speaker: LC.

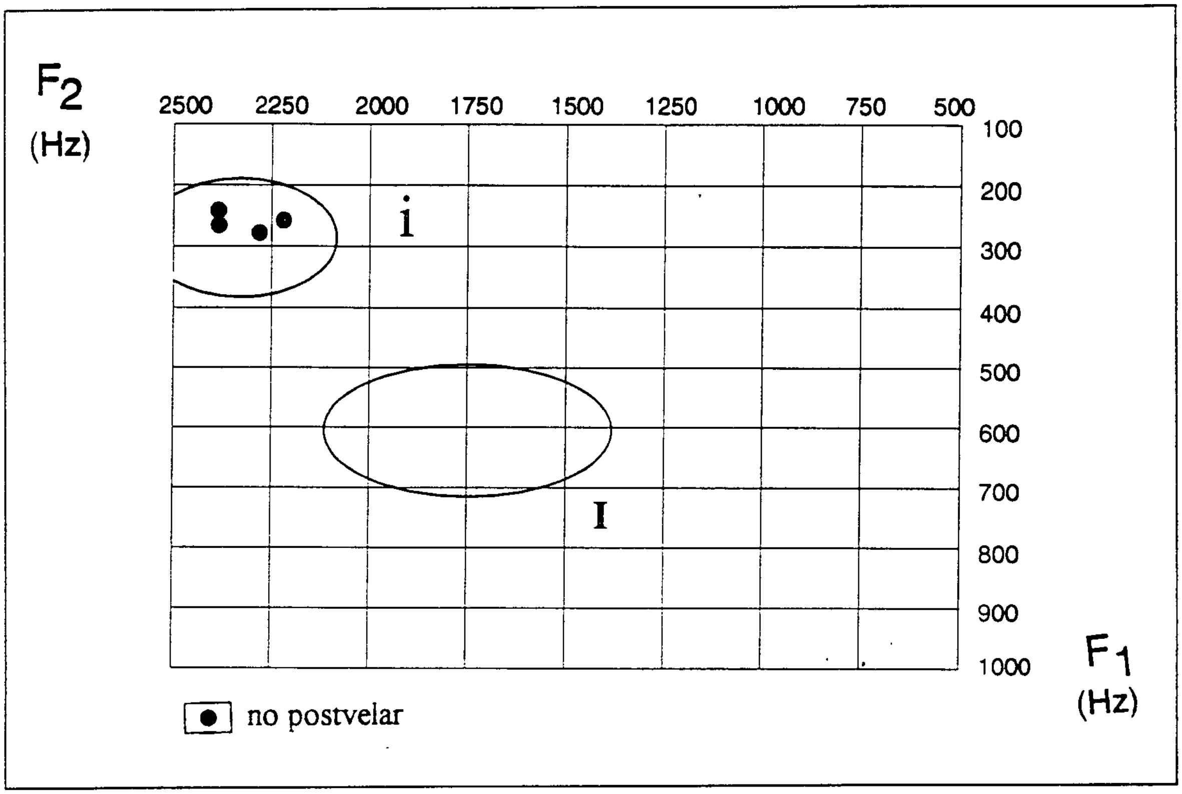


Figure 3:18 F_1 - F_2 plot of St'át'imcets /I/ in the context: (i) with no postvelar in the word. Speaker: LN.

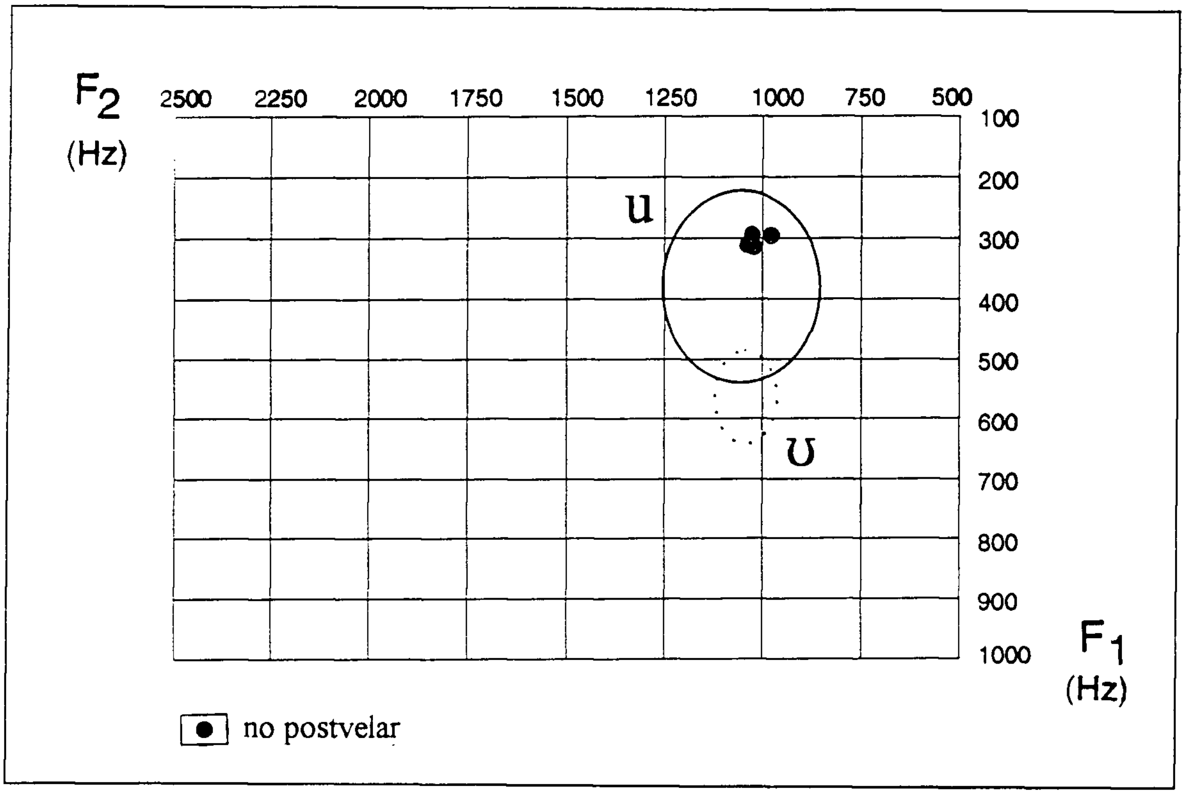


Figure 3:19 F_1 - F_2 plot of St'át'imcets /U/ in the context: (i) with no postvelar in the word. Speaker: LC.

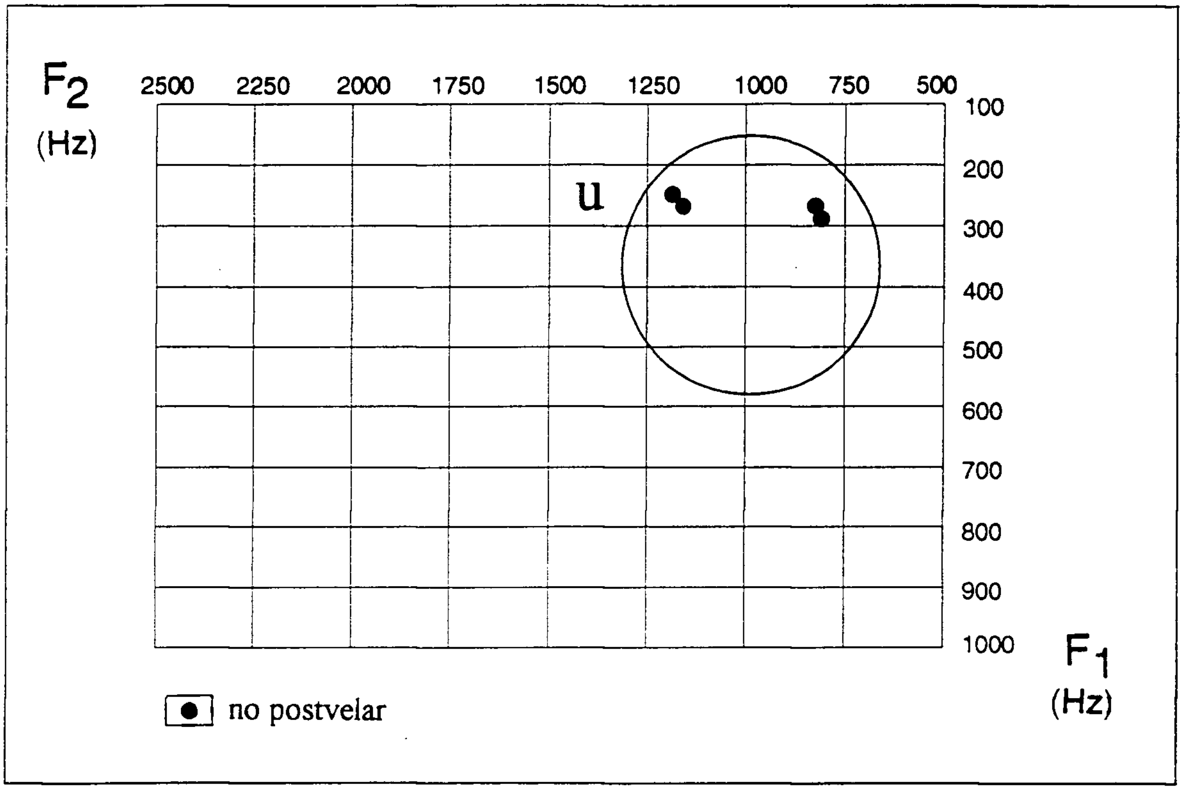


Figure 3:20 F_1 - F_2 plot of St'át'imcets /U/ in the context: (i) with no postvelar in the word. Speaker: LN.

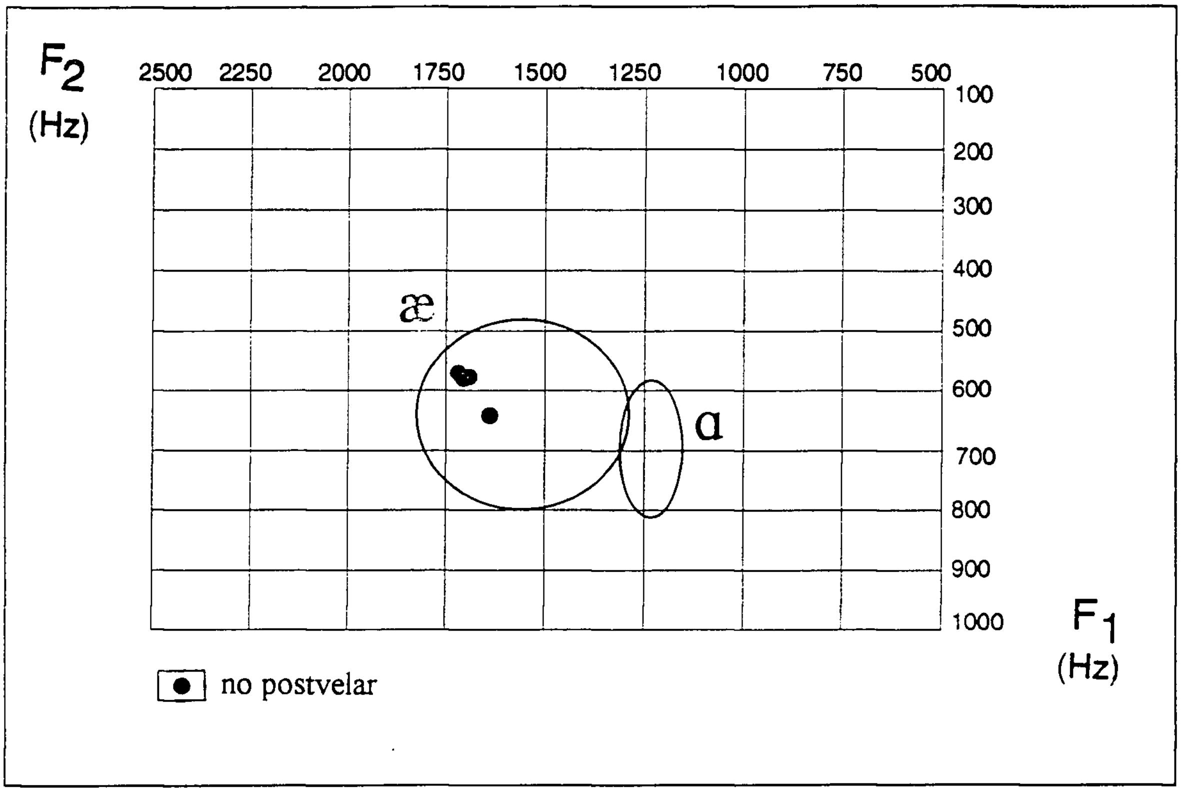


Figure 3:21 F_1 - F_2 plot of St'át'imcets /Æ/ in the context: (i) with no postvelar in the word. Speaker: LC.

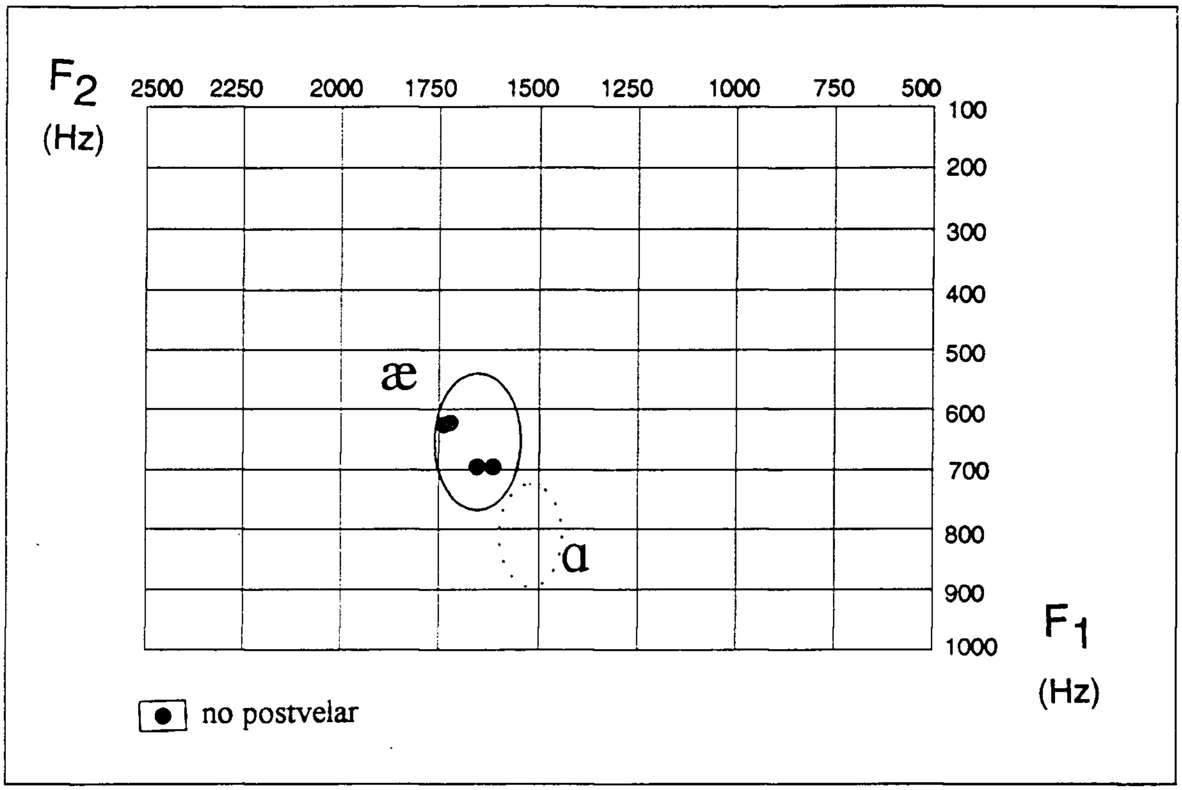


Figure 3:22 F_1 - F_2 plot of St'át'imcets /Æ/ in the context: (i) with no postvelar in the word. Speaker: LN.

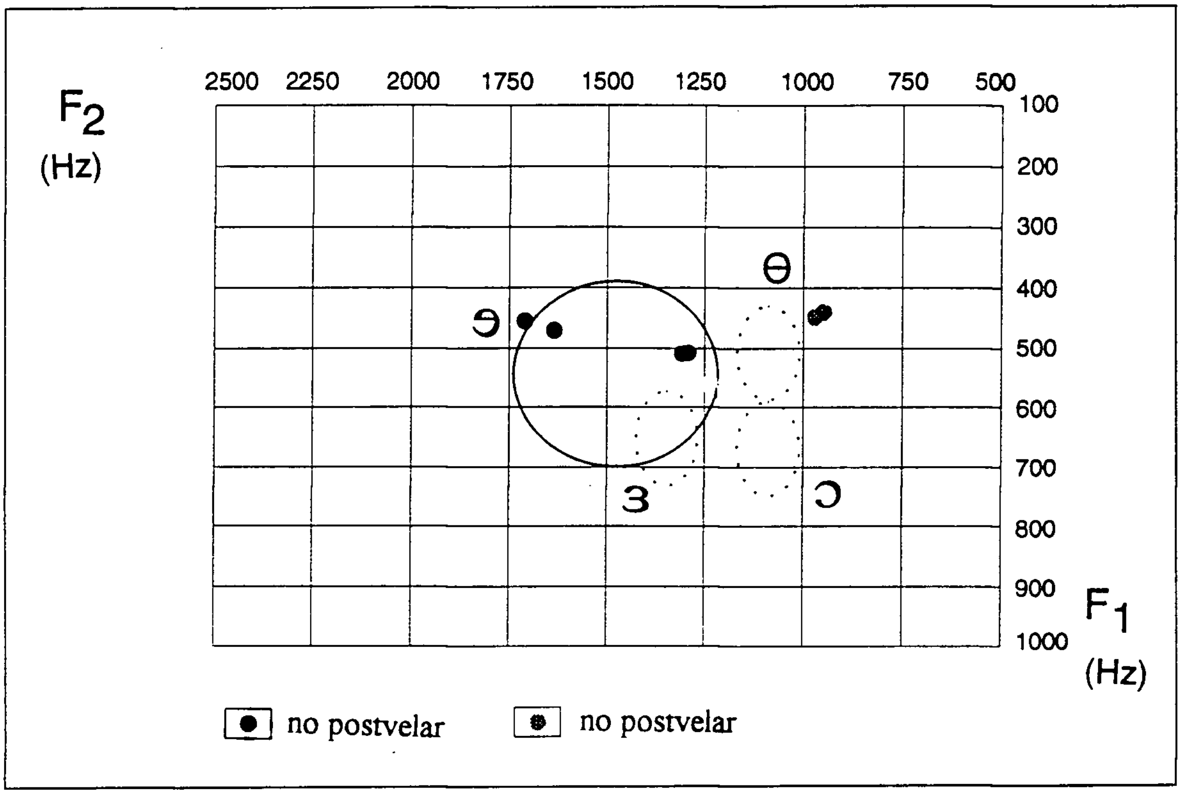


Figure 3:23 F_1 - F_2 plot of the St'át'imcets epenthetic vowel in the context: (i) with no postvelar in the word. Speaker: LC.

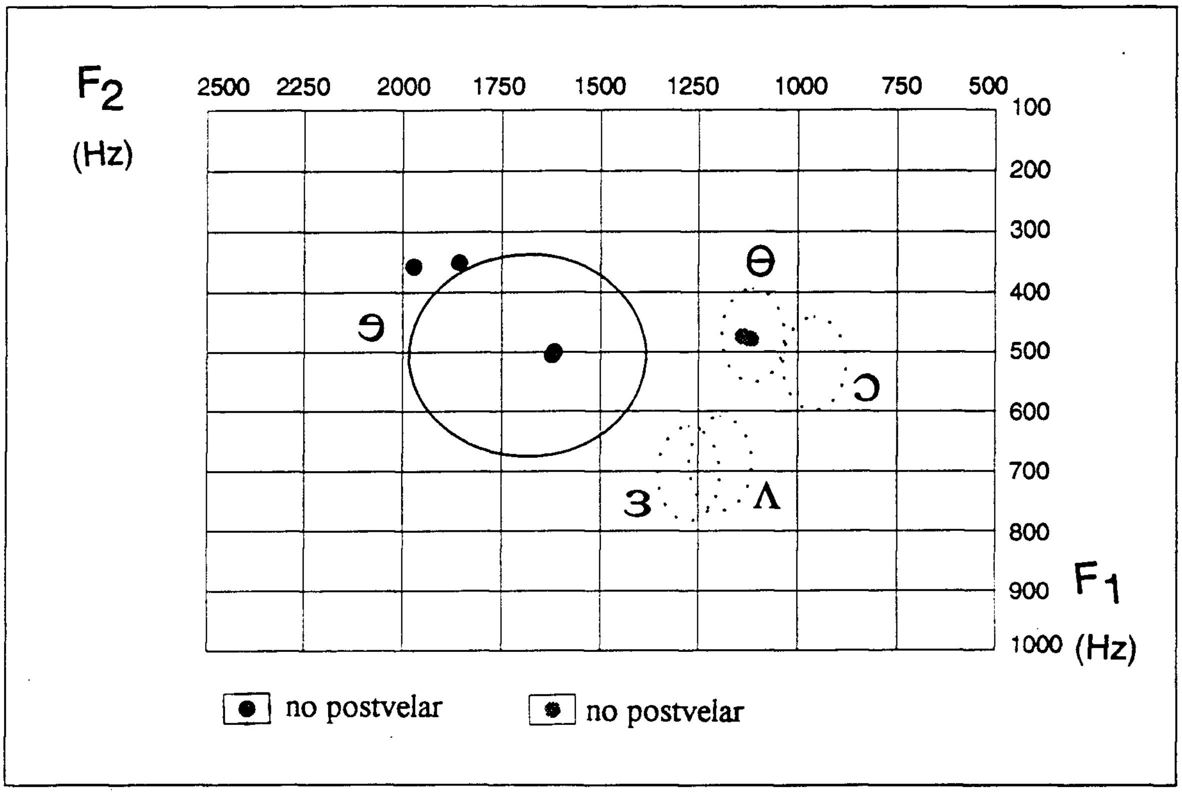


Figure 3:24 F_1 - F_2 plot of the St'át'imcets epenthetic vowel in the context: (i) with no postvelar in the word. Speaker: LN.

The tokens in Figures 3:17 - 3:24 are all non-rtr. That is, they do not have a raised F_1 and lowered F_2, compared to the rtr tokens per vowel seen previously in Figures 3:8 - 3:15. (The empty rtr ellipses in Figures 3:17 - 3:19, 3:21 - 3:24 remind us of the higher F_1 and lower F_2 regions of the rtr tokens in the earlier graphs.) In §1.4.3, based on Table 1:8, the F_1 and F_2 effects expected for a vowel with pharyngealisation articulation were identified as a medium rise and a medium drop, respectively. The tokens in Figures 3:17 - 3:24, which occurred in a word containing no postvelar, do not show those effects. This is consistent with the assumption that they were not produced with pharyngealisation and, in turn, supports the phonological claim that St'át'imcets vowels are not pharyngealised when there is no postvelar in the word.

Figures 3:25 - 3:32 replot the vowel tokens which occurred in context (ii) vs. context (iii), i.e., immediately preceding a guttural vs. immediately following a guttural (but not both). (No tokens of /U/ immediately preceding a guttural are plotted for LN in Figure 3:28, and no tokens of /Æ/ immediately preceding a guttural are plotted for LC and LN in Figures 3:29 - 3:30, due to lack of data.)

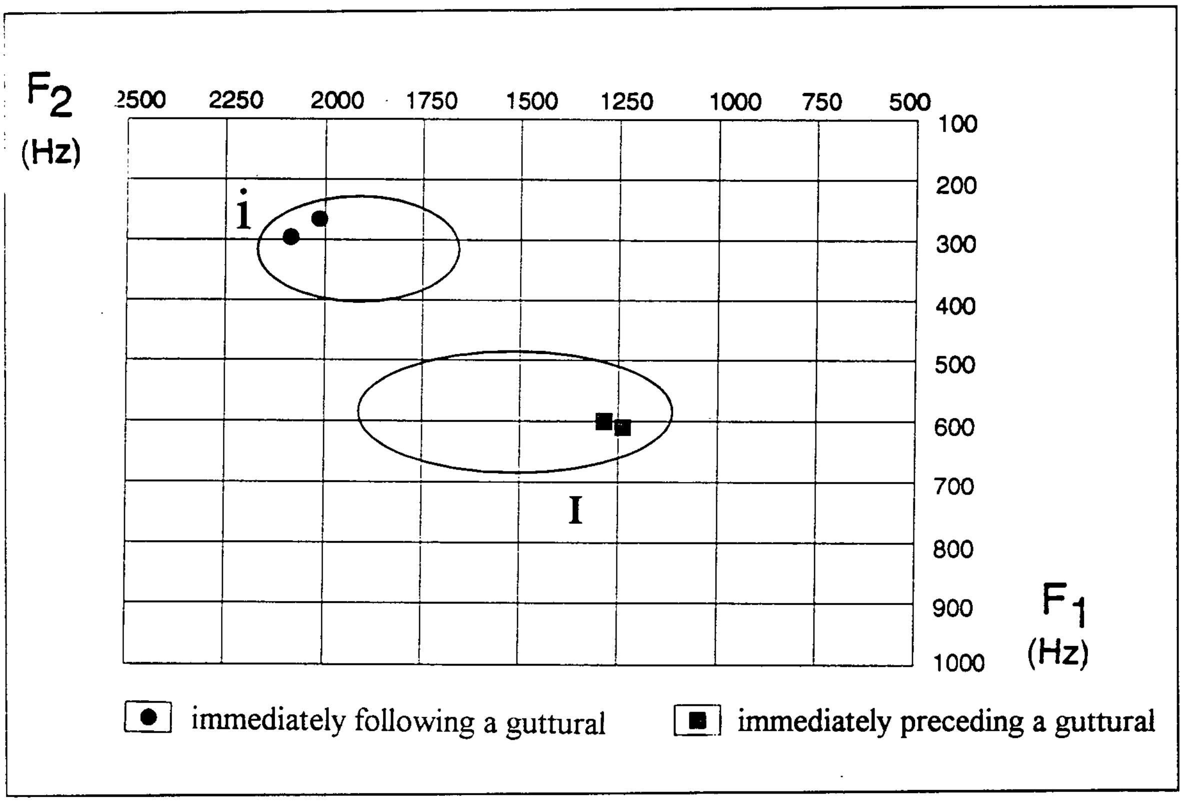


Figure 3:25 F_1 - F_2 plot of tokens of St'át'imcets /I/ in the contexts: (ii) immediately preceding a guttural; (iii) immediately following a guttural. Speaker: LC.

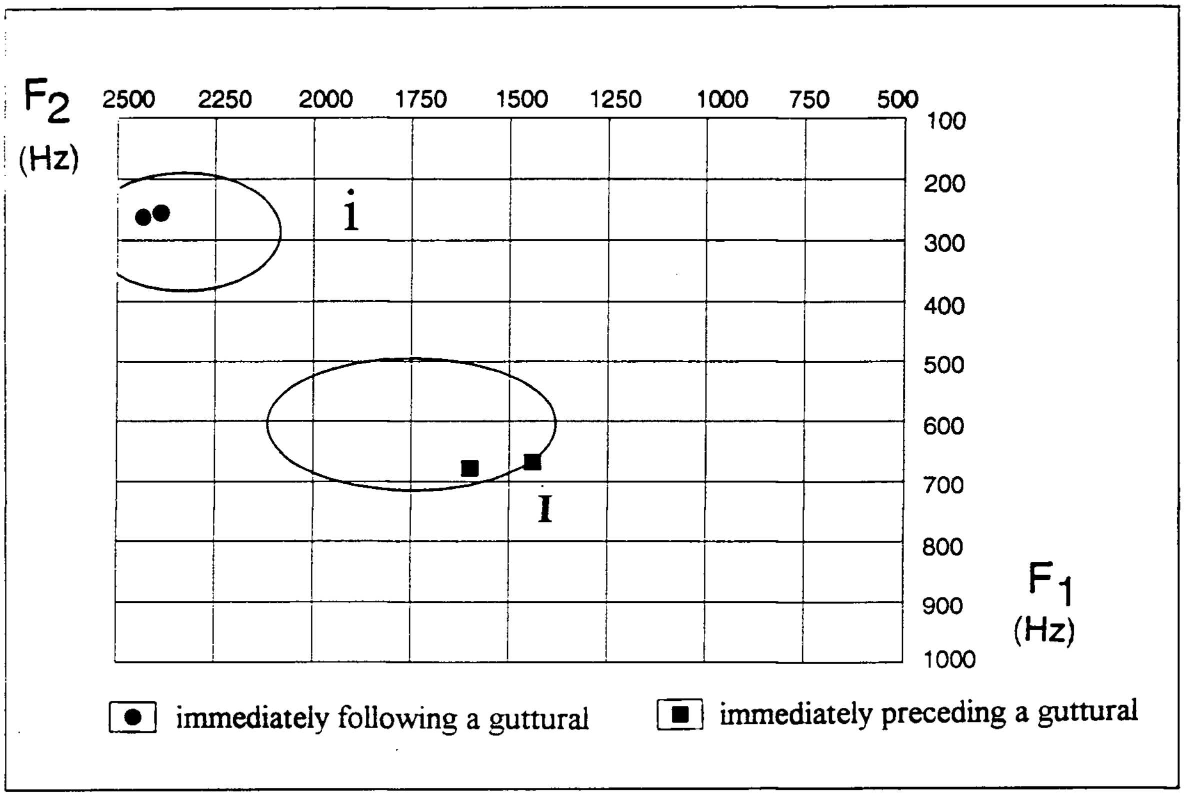


Figure 3:26 F_1 - F_2 plot of tokens of St'át'imcets /I/ in the contexts: (ii) immediately preceding a guttural; (iii) immediately following a guttural. Speaker: LN.

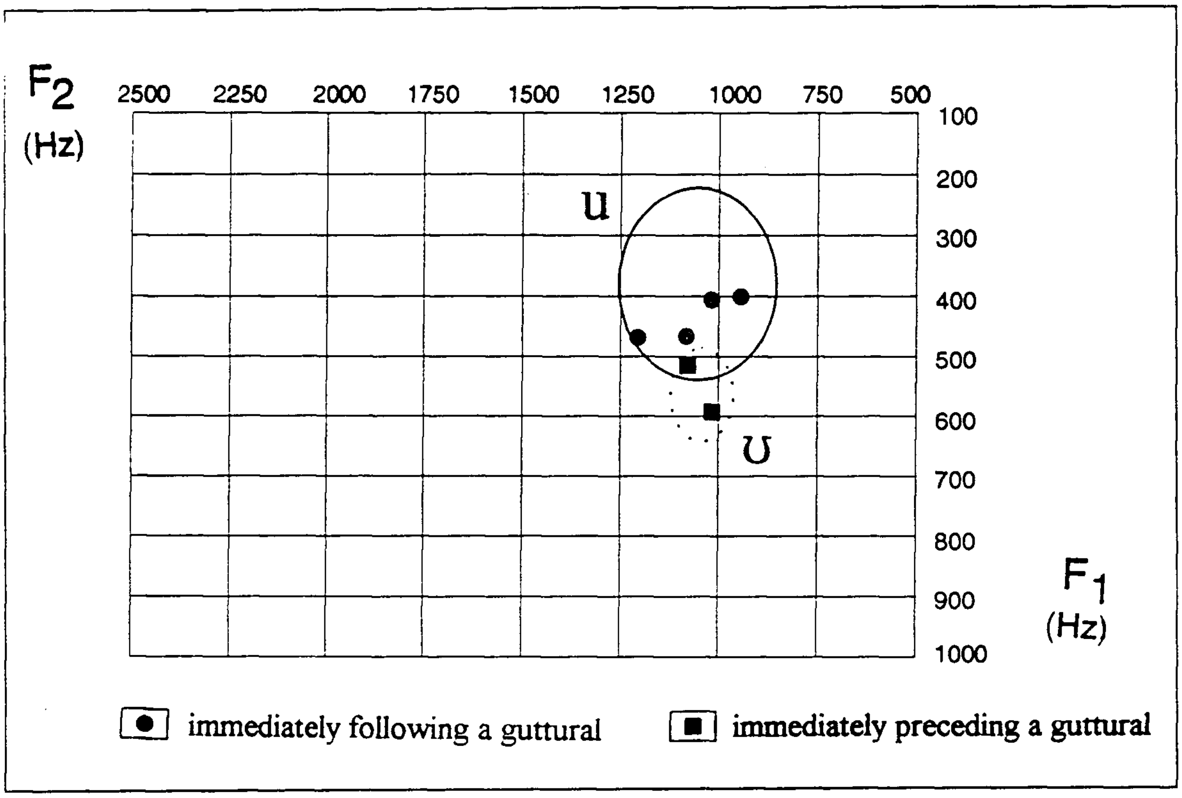


Figure 3:27 F_1 - F_2 plot of tokens of St'át'imcets /U/ in the contexts: (ii) immediately preceding a guttural; (iii) immediately following a guttural. Speaker: LC.

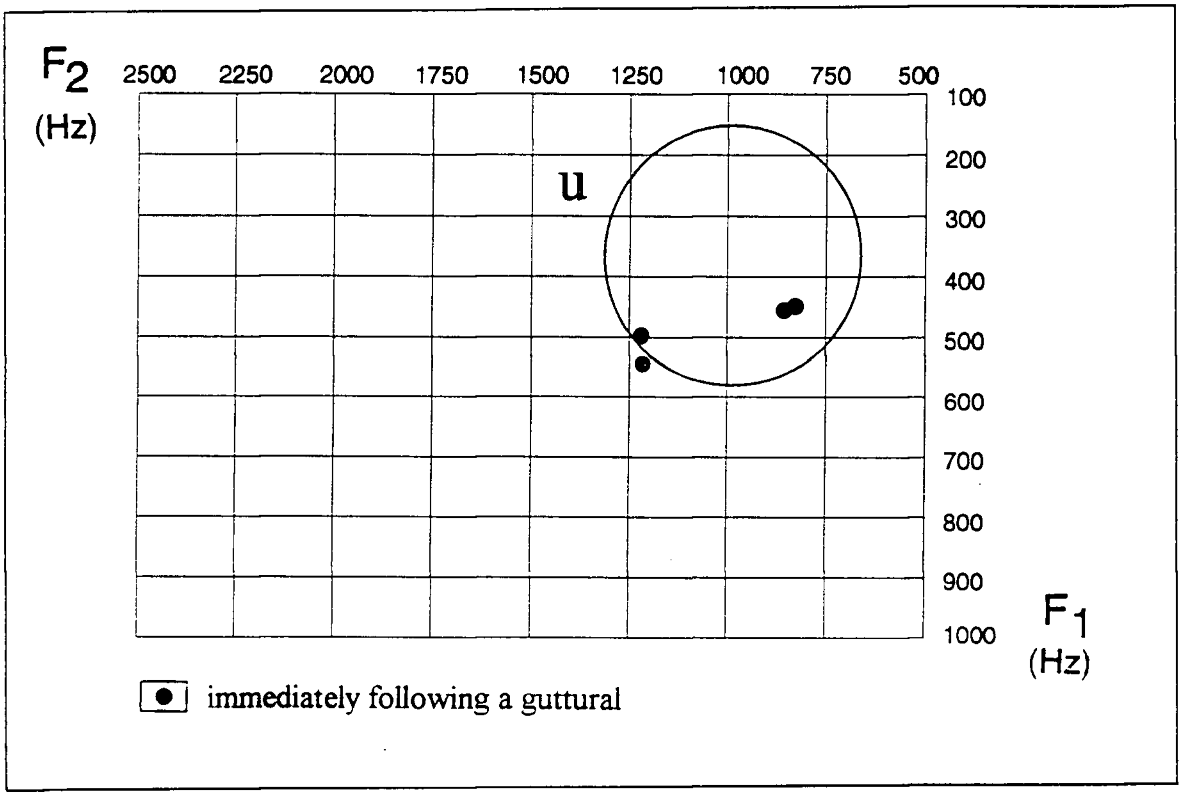


Figure 3:28 F_1 - F_2 plot of tokens of St'át'imcets /U/ in the context: (iii) immediately following a guttural. Speaker: LN.

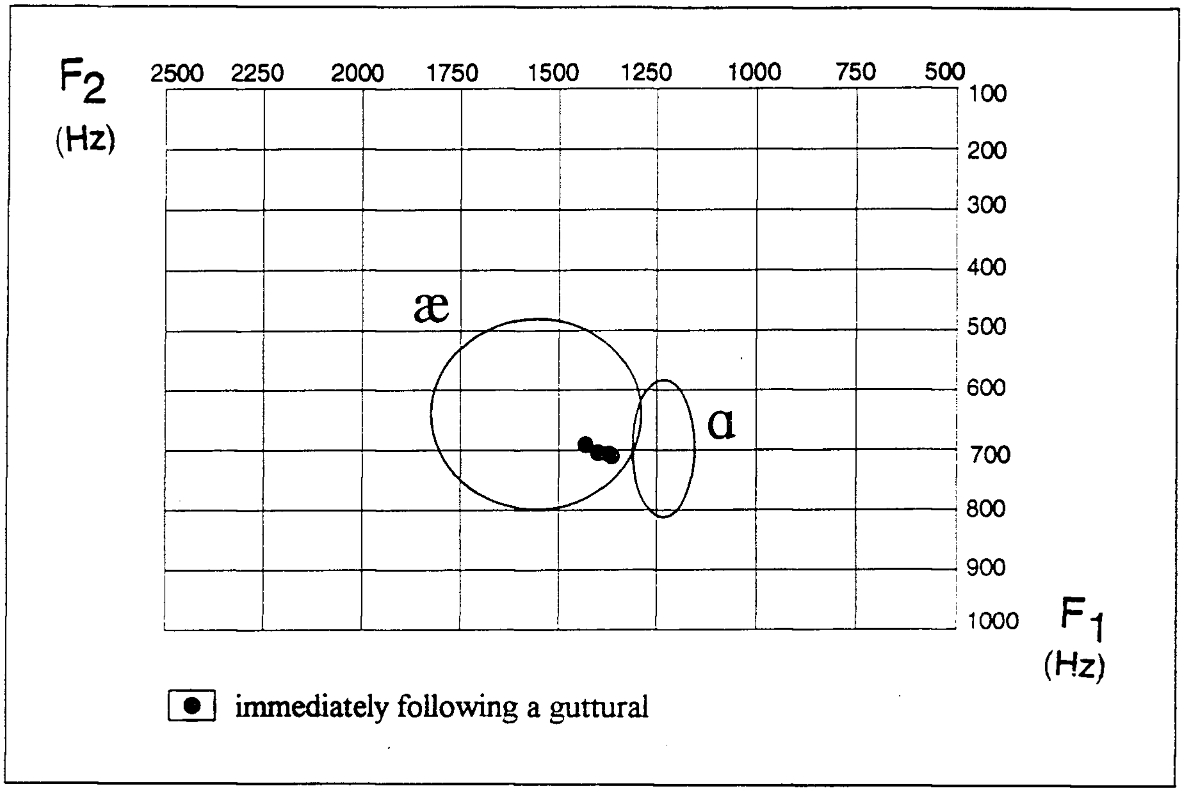


Figure 3:29 F_1 - F_2 plot of tokens of St'át'imcets /Æ/ in the context: (iii) immediately following a guttural. Speaker: LC.

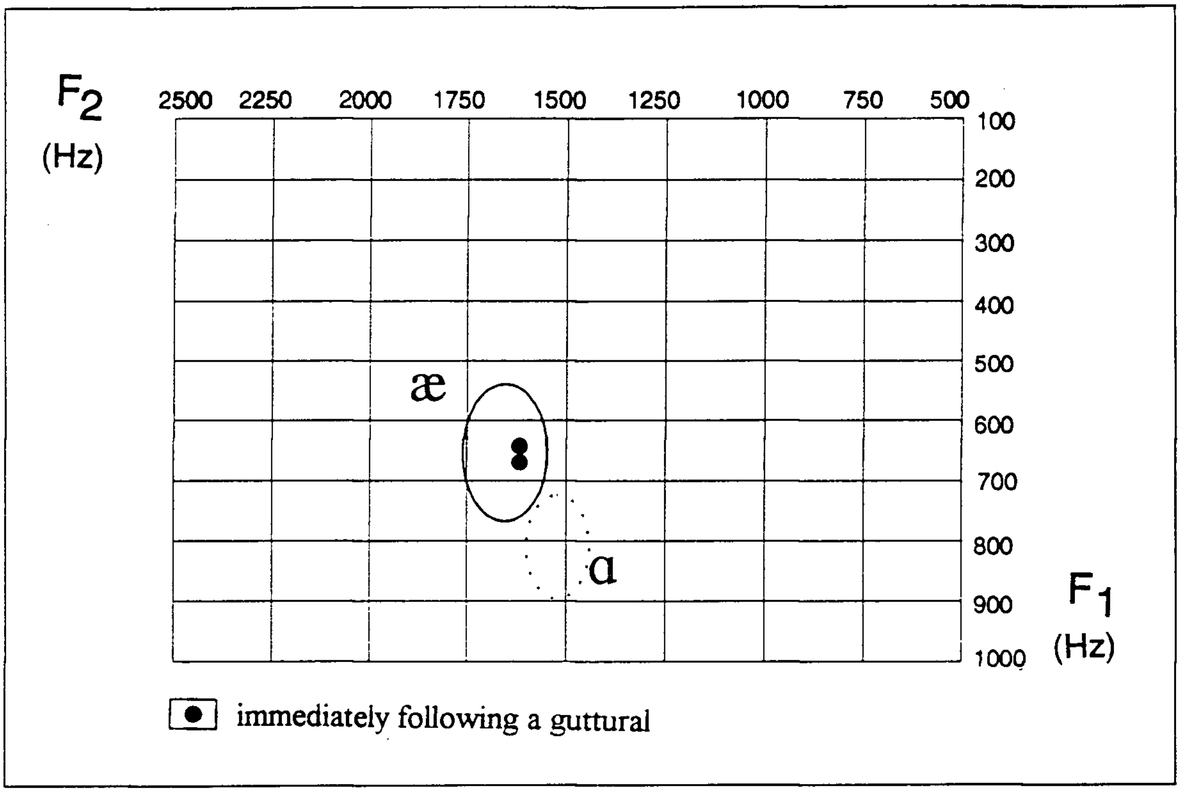


Figure 3:30 F_1 - F_2 plot of tokens of St'át'imcets /Æ/ in the context: (iii) immediately following a guttural. Speaker: LC.

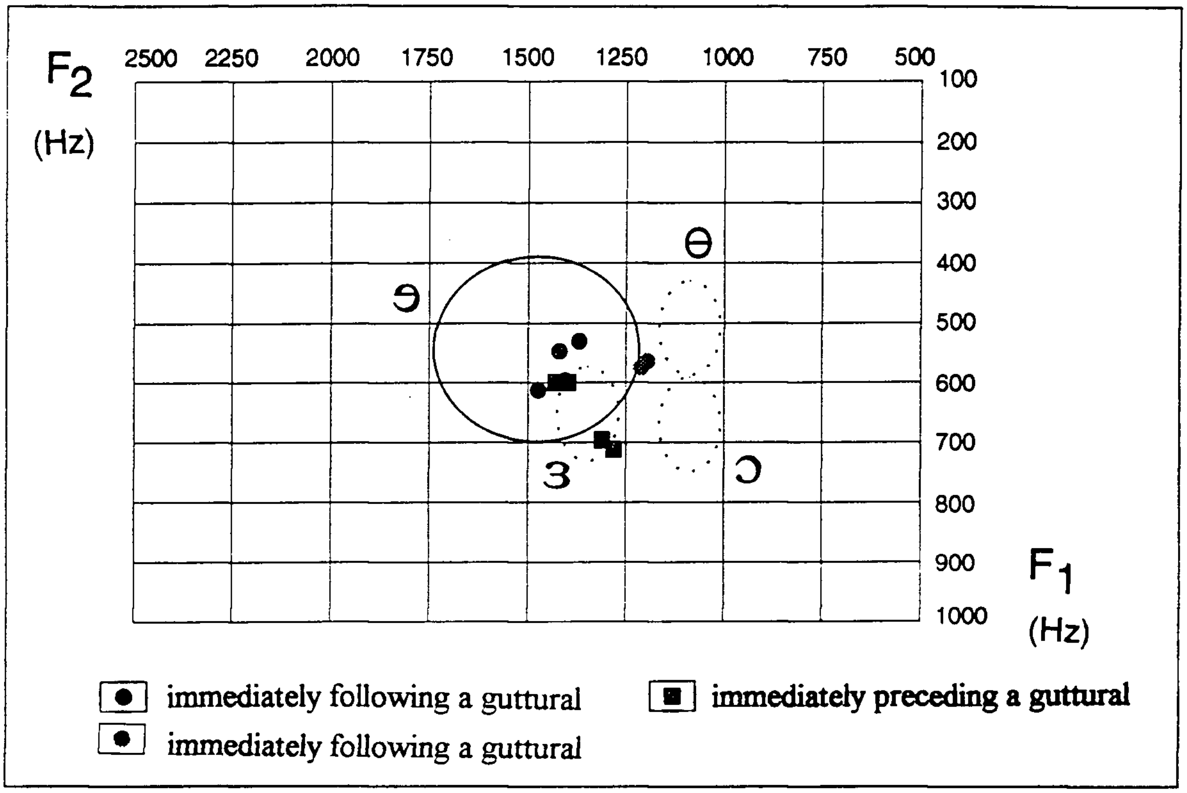


Figure 3:31 F_1 - F_2 plot of tokens of the St'át'imcets epenthetic vowel in the contexts: (ii) immediately preceding a guttural; (iii) immediately following a guttural. Speaker: LC.

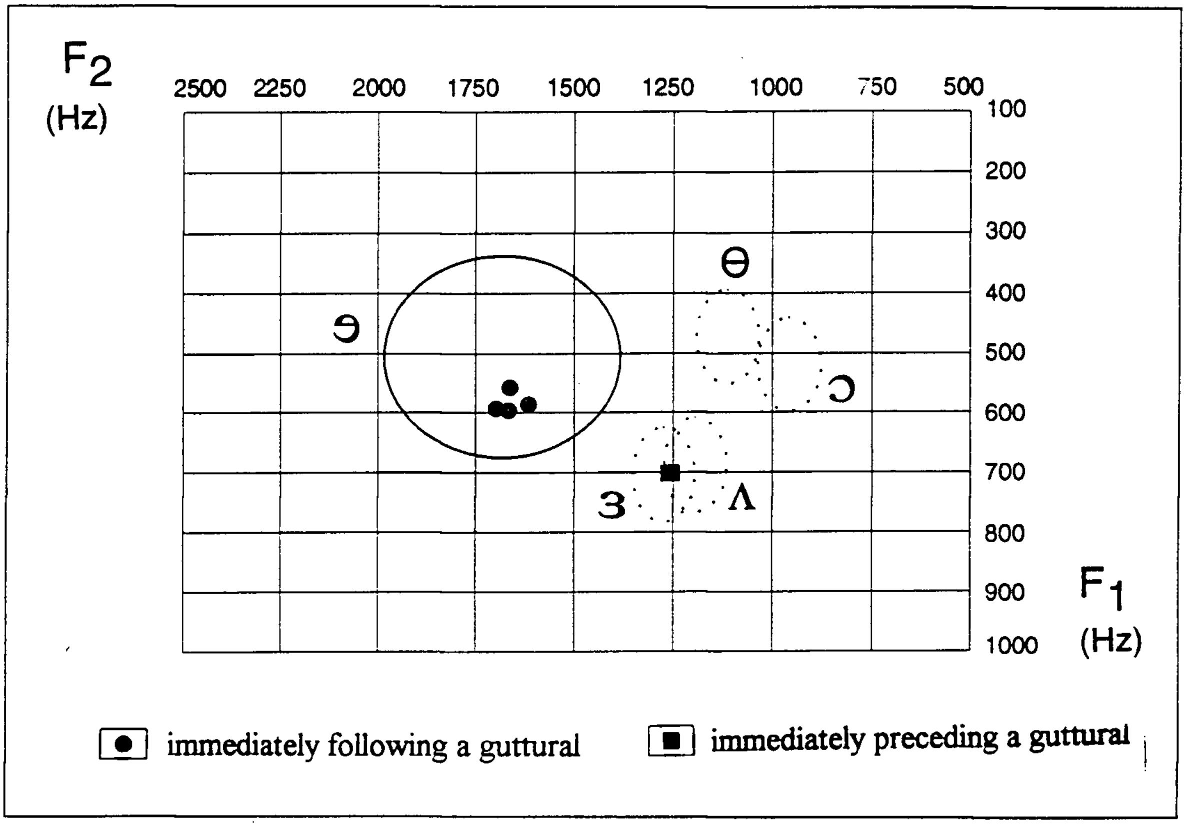


Figure 3:32 F_1 - F_2 plot of tokens of the St'át'imcets epenthetic vowel in the contexts: (ii) immediately preceding a guttural; (iii) immediately following a guttural. Speaker: LN.

In Figures 3:25 - 3:32, the tokens which occurred immediately preceding a guttural are all rtr; those which occurred immediately following a guttural are all non-rtr. That is, the former have a raised F_1 and a lowered F_2; the latter do not.

As discussed above, a medium F_1 rise and medium F_2 drop were identified in §1.4.3 as expected acoustic effects for vowels with pharyngealisation articulation. The F_1 and F_2 means for the rtr tokens in Figures 3:25 - 3:27 and 3:31 - 3:32 were not computed independently from the F_1 and F_2 means of the entire rtr sample per vowel (i.e., the rtr samples in Figures 3:8 - 3:15). Thus, the size of the F_1 rise and F_2 drop of the rtr tokens in Figures 3:25 - 3:27 and 3:31 - 3:32, in reference to the F_1 and F_2 means for the entire non-rtr sample per vowel (the non-rtr samples in Figures 3:8 - 3:15), will not be determined here. However, the F_1 rise for the entire rtr sample ranges from small to large; the F_2 drop ranges from medium to large (tokens of round allophones excepted), based on the F_1 and F_2 means of the non-rtr vs. rtr tokens reported in Figures 3:5 - 3:15. This is considered a rough match with the F_1 and F_2 effects expected for pharyngealised vowels. As the tokens immediately preceding a guttural are rtr, their F_1 rise and F_2 drop as just described is considered support for the assumption that they were produced with pharyngealisation, and that the tokens immediately following a guttural were not. This supports the phonological claims that St'át'imcets vowels pharyngealise immediately preceding a guttural and do not pharyngealise immediately following a guttural.

The graphs in Figures 3:33 - 3:36 replot the tokens of /I/ and /U/ which occurred in context (iv) vs. context (v), ie., immediately preceding an emphatic vs. immediately following an emphatic. (No tokens of /U/ immediately preceding an emphatic are plotted in Figures 3:35 and 3:36, due to lack of data.)

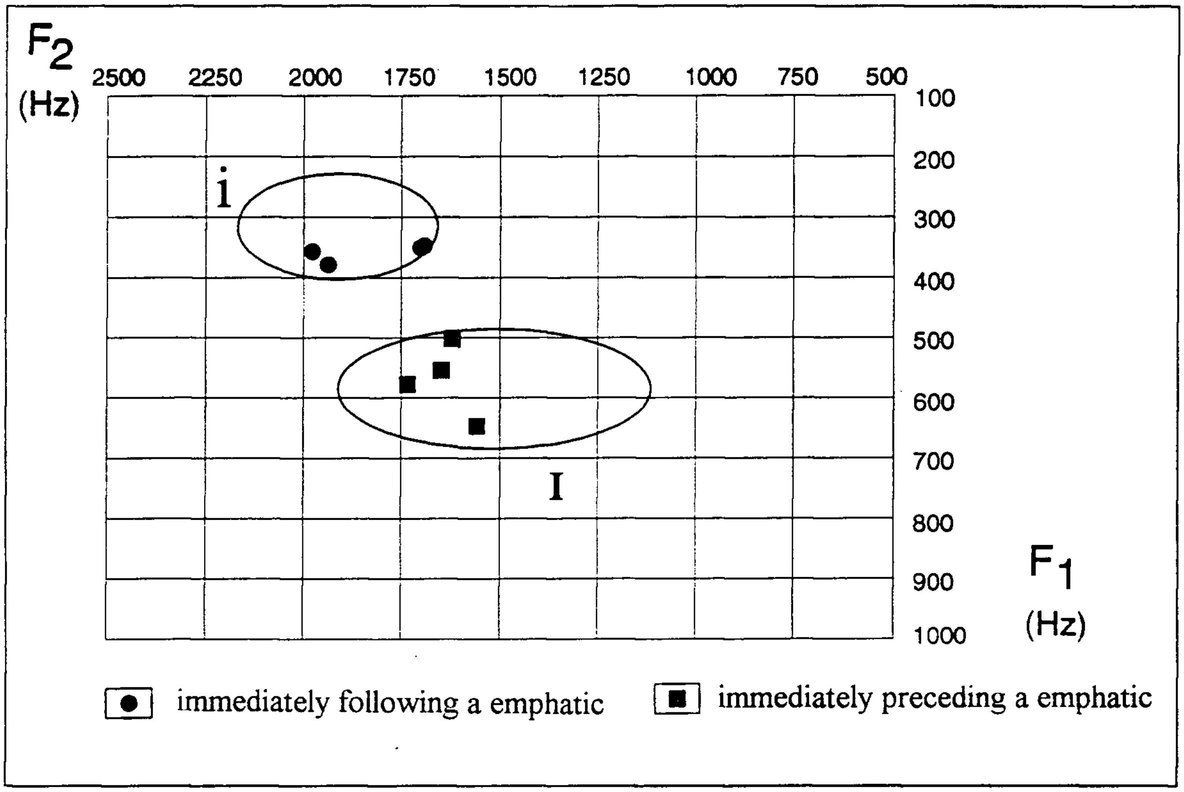


Figure 3:33 F_1 - F_2 plot of tokens of St'át'imcets /I/ in the contexts: (iv) immediately preceding an emphatic; (v) immediately following an emphatic. Speaker: LC.

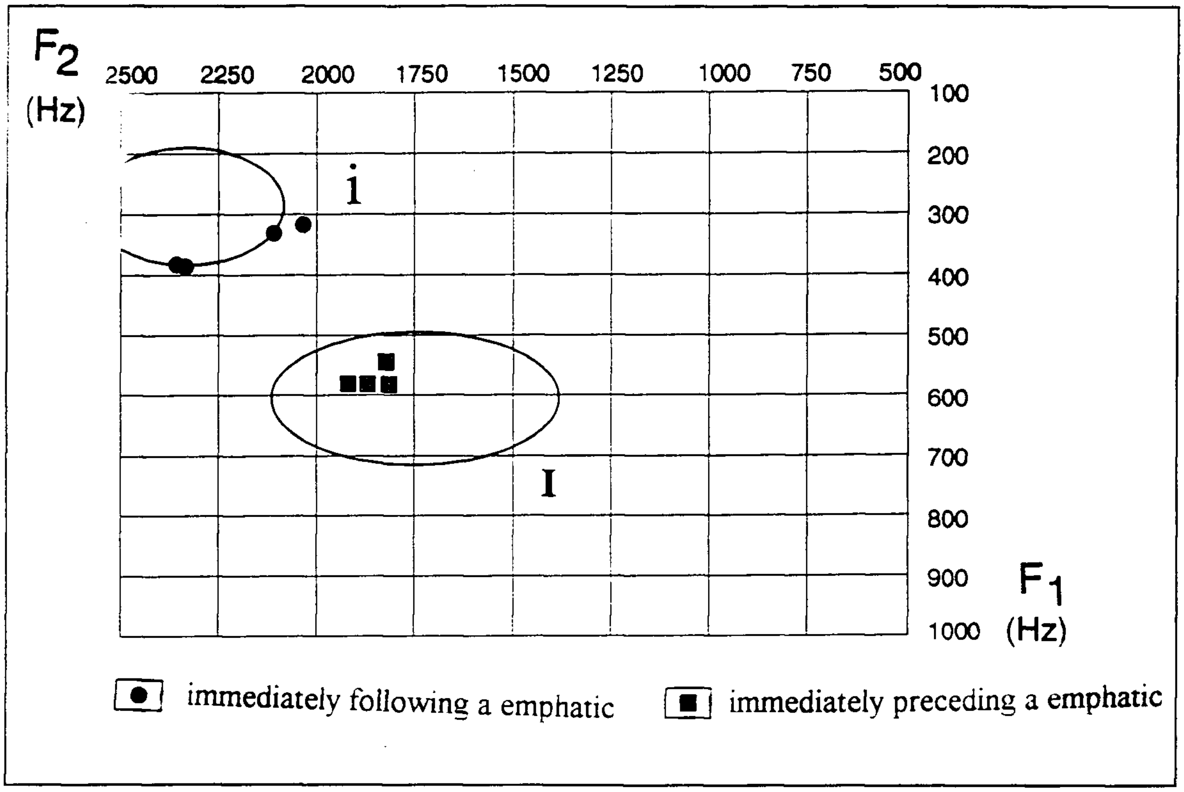


Figure 3:34 F_1 - F_2 plot of tokens of St'át'imcets /I/ in the contexts: (iv) immediately preceding an emphatic; (v) immediately following an emphatic. Speaker: LN.

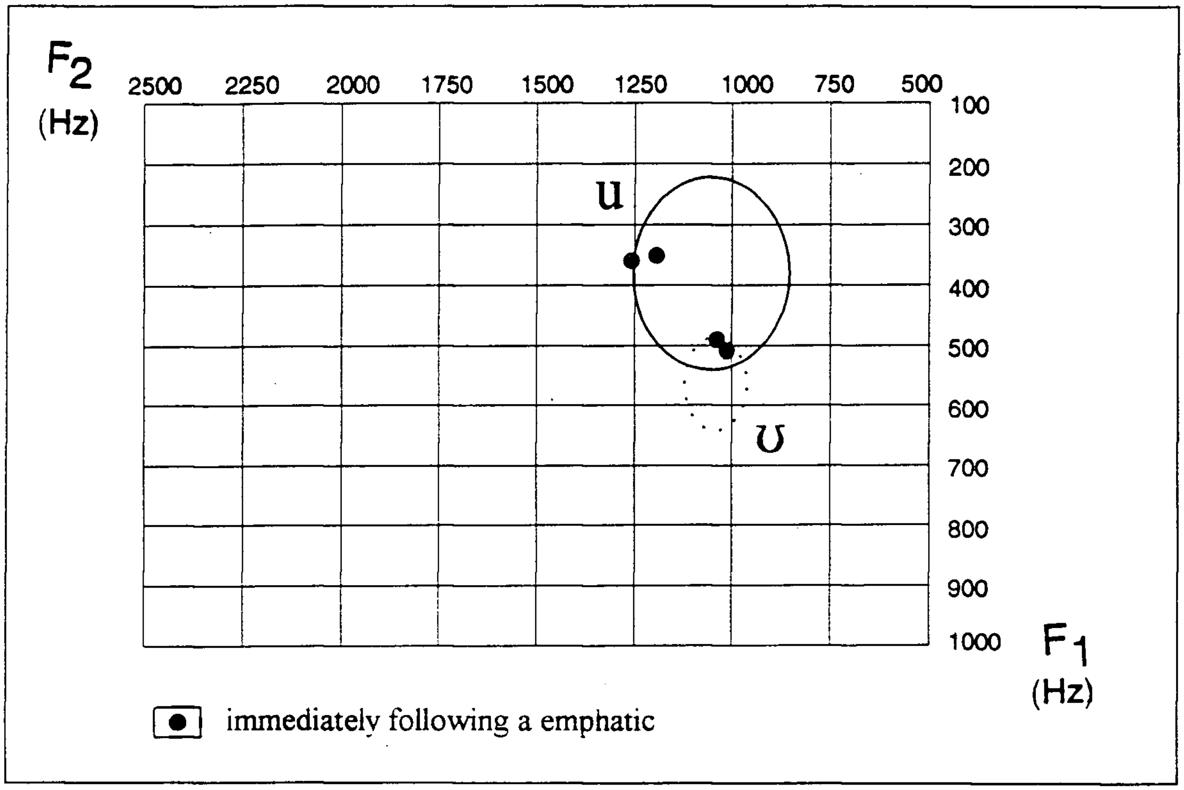


Figure 3:35 F_1 - F_2 plot of tokens of St'át'imcets /U/ in the context: (v) immediately following an emphatic. Speaker: LC.

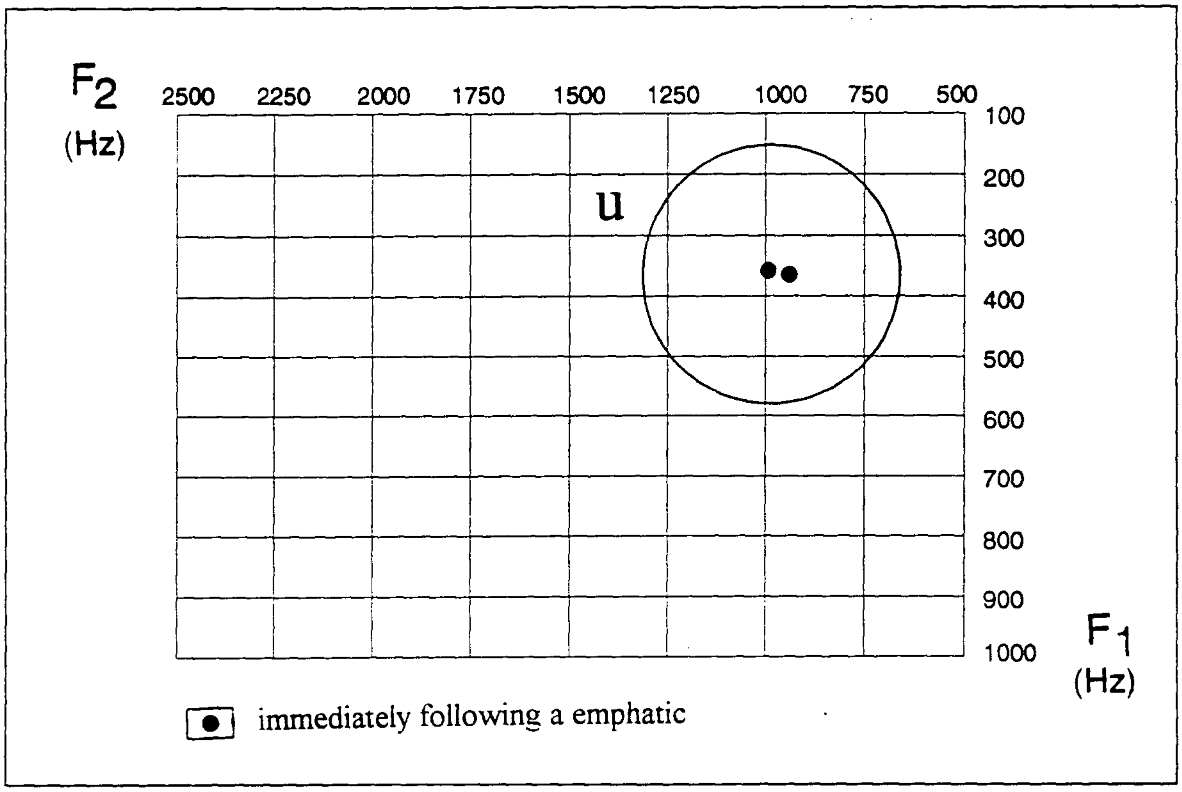


Figure 3:36 F_1 - F_2 plot of tokens of St'át'imcets /U/ in the context: (v) immediately following an emphatic. Speaker: LN.

In Figures 3:33 - 3:34, the tokens which occurred immediately preceding an emphatic are rtr. That is, they have a raised F_1 and a lowered F_2. The tokens which occurred immediately following an emphatic, in Figures 3:33 - 3:36, are non-rtr. That is, they do not show those F_1 and F_2 effects. These observations are consistent with the assumption that the tokens immediately preceding an emphatic were produced with a pharyngealisation articulation which the tokens immediately following an emphatic lacked. This, in turn, supports the phonological claims that St'át'imcets vowels pharyngealise immediately preceding an emphatic, and do not pharyngealise immediately following an emphatic.

Finally, Figures 3:37 - 3:43 replot the tokens which occurred immediately preceding or immediately following a laryngeal. (As an exception, the tokens of /U/ in Figures 3:41 - 3:41 occurred in both contexts, in the carrier form ⟨ ʔu-ʔ-ʃæʔ ⟩ 'egg'.) These data are relevant to the present claim St'át'imcets laryngeals are not gutturals, as will be discussed shortly. (No graph is presented for LN's epenthetic vowel in these contexts, due to lack of data.)

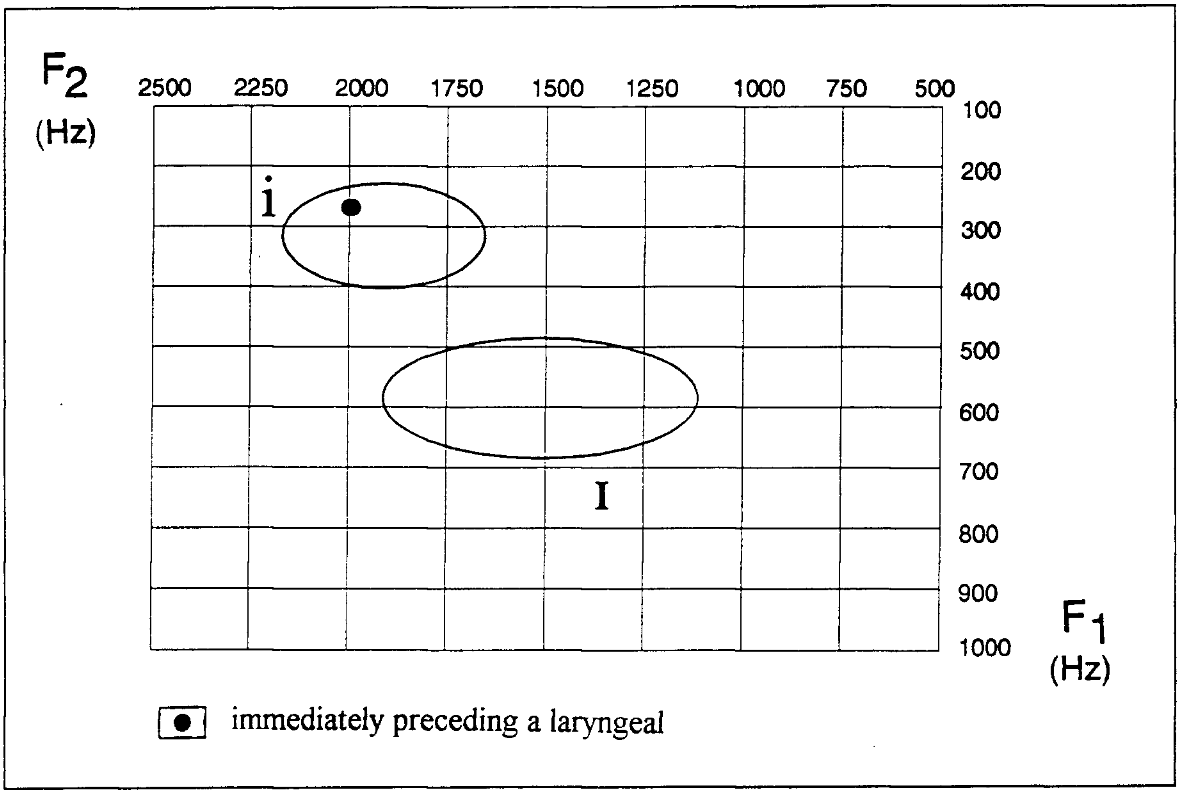


Figure 3:37 F_1 - F_2 plot of tokens of St'át'imcets /I/ in the context: immediately preceding a laryngeal. Speaker: LC.

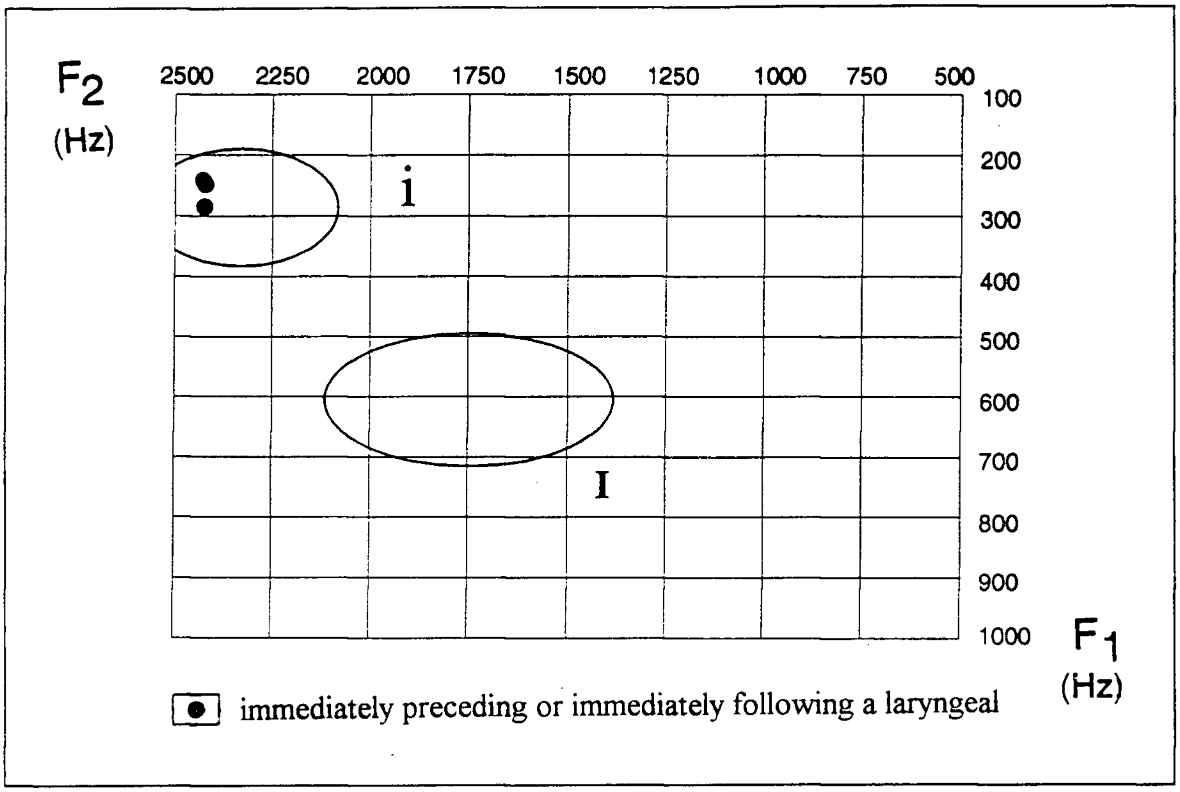


Figure 3:38 F_1 - F_2 plot of tokens of St'át'imcets /I/ in the contexts: immediately preceding a laryngeal or immediately following a laryngeal. Speaker: LN.

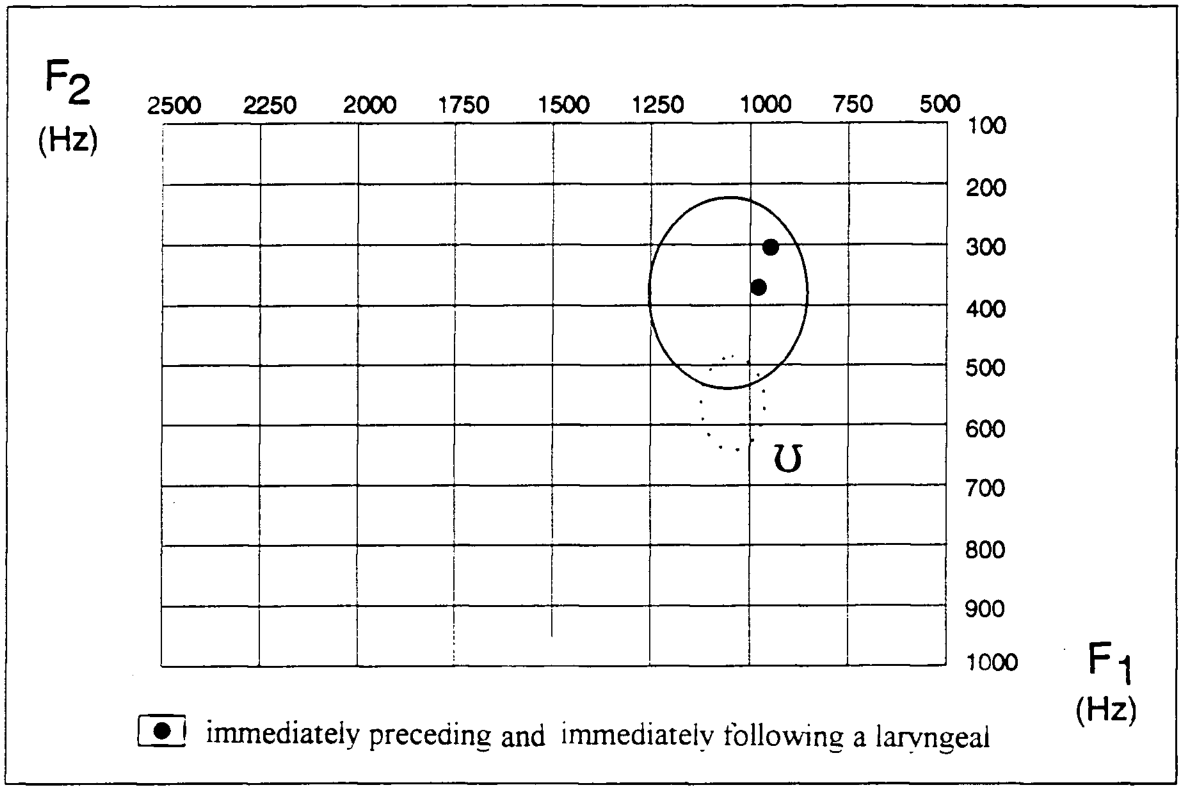


Figure 3:39 F_1 - F_2 plot of tokens of St'át'imcets /U/ in the (simultaneous) contexts: immediately preceding a laryngeal and immediately following a laryngeal. Speaker: LC.

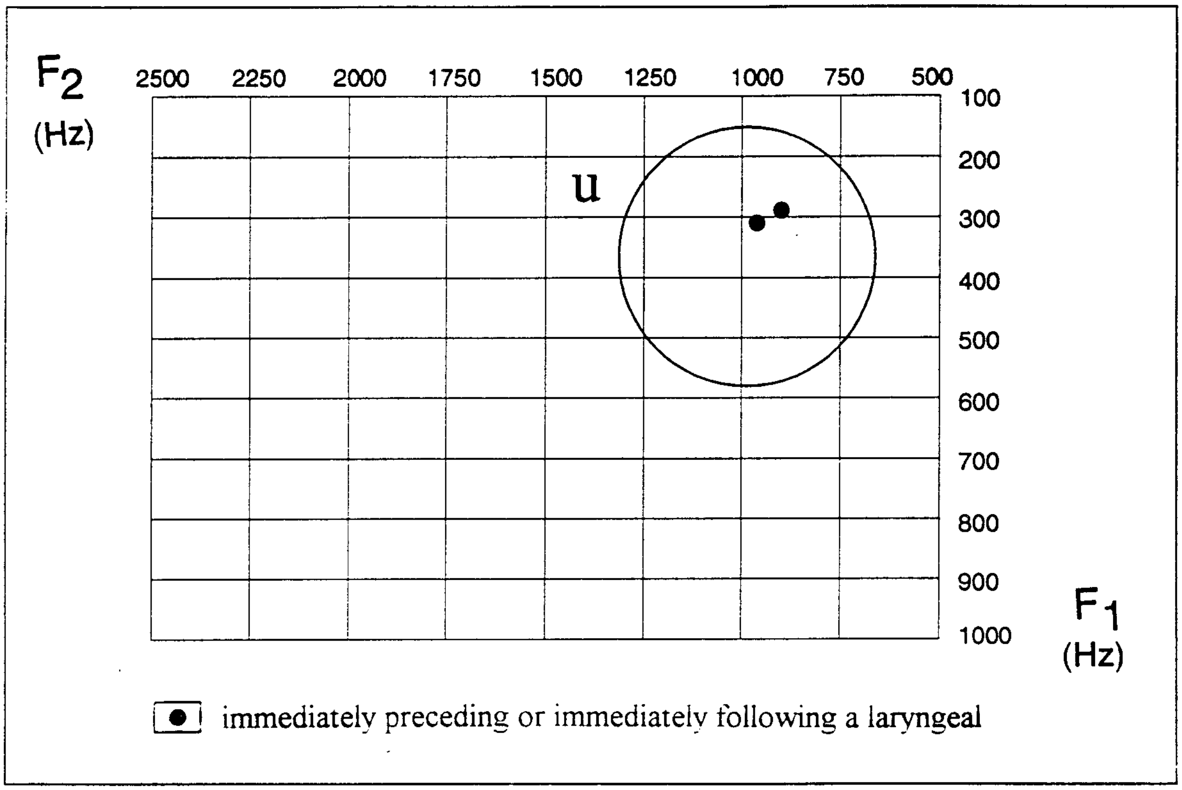


Figure 3:40 F_1 - F_2 plot of tokens of St'át'imcets /U/ in the (simultaneous) contexts: immediately preceding a laryngeal and immediately following a laryngeal. Speaker: LN.

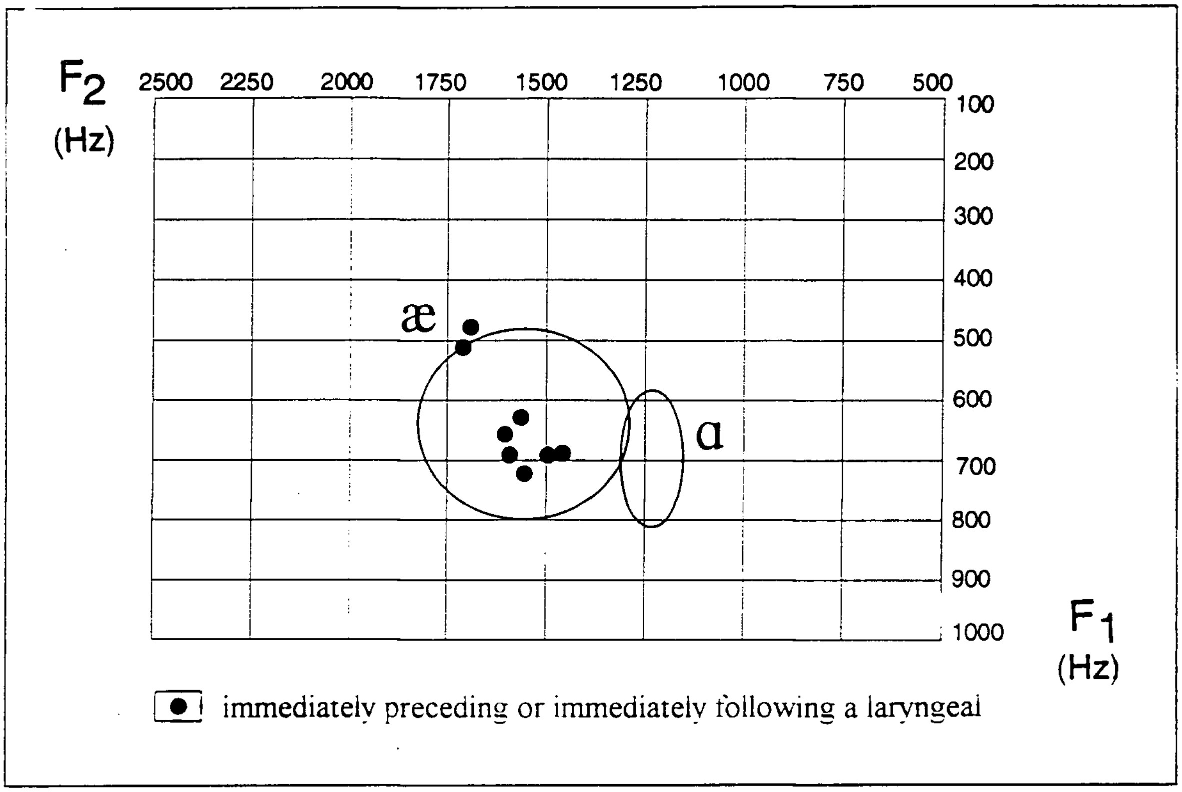


Figure 3:41 F_1 - F_2 plot of tokens of St'át'imcets /Æ/ in the contexts: immediately preceding a laryngeal or immediately following a laryngeal. Speaker: LC.

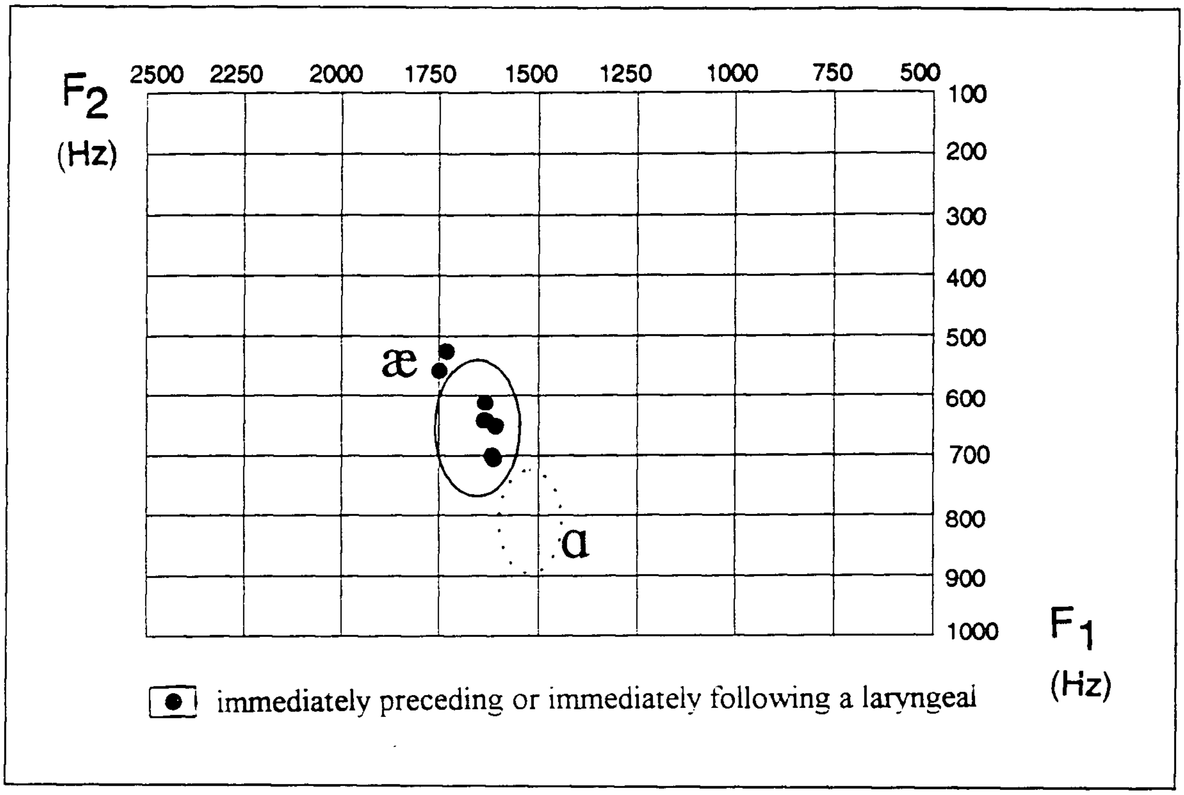


Figure 3:42 F_1 - F_2 plot of tokens of St'át'imcets /Æ/ in the contexts: immediately preceding a laryngeal or immediately following a laryngeal. Speaker: LN.

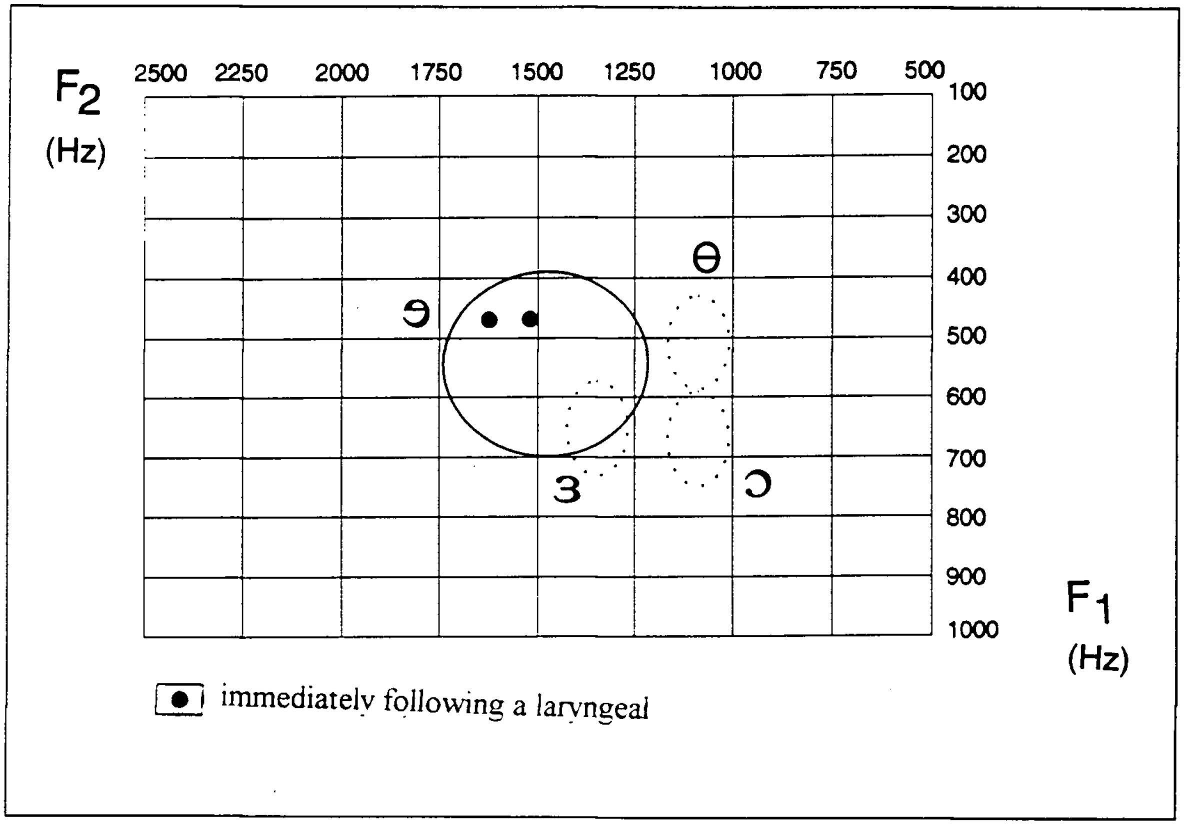


Figure 3:43 F_1 - F_2 plot of tokens of the St'át'imcets epenthetic vowel in the context: immediately following a laryngeal. Speaker: LC.

The tokens in Figures 3:37 - 3:43 are all non-rtr. That is, they do not show the F_1 and F_2 effects expected for vowels produced with pharyngealisation. This supports the assumption that the tokens in both contexts were not pharyngealised. Of particular interest is the support for the assumption that the tokens immediately preceding a laryngeal were not pharyngealised. In Figures 3:25 - 3:27, 3:31 - 3:32, vowel tokens which occurred immediately preceding a guttural were observed to be rtr. The fact that tokens which occurred immediately preceding a laryngeal are not rtr is here interpreted as support for the phonological claim that St'át'imcets laryngeals are not gutturals.

3.4.2. A Theoretical Account

It is assumed that [HI], [LOW], and [LAB] are the place features defining the St'át'imcets underlying vowels. Evidence for active [HI] comes from the highly ranked grounded constraint HI/*Sec-DOR ∧ Sec-RTR ('A segment specified for [HI] is not specified for secondary-[DOR] and secondary-[RTR]'). In §3.5.3 it will be shown that St'át'imcets high vowels do not undergo uvularisation harmony. The same was shown for Palestinian high vowels in §2.5.5. In §3.5.4 it will be argued that, as in Palestinian, this is the effect of HI/*Sec-DOR ∧ Sec-RTR.

Evidence for active [LOW] comes from an aspect of St'át'imcets vowel distribution documented by Eijk (1985), *viz.*: epenthetic NA { ə } never occurs immediately preceding a glottal stop; in that context, only NA { a } occurs. His data, which will not be reviewed here, indicate that { a } in that context is epenthetic, suggesting that the lack of NA { ə } in that context is due to a lowering of the epenthetic vowel, that is, insertion of [LOW] on the epenthetic vowel.

Evidence for active [LAB] comes from the rounding harmony discussed in §3.2.2.2. In that section it was shown that the epenthetic vowel rounds under adjacency to a labialised consonant.

By Combinatorial Specification, [HI], [LOW], and [LAB] yield $2^3 = 8$ feature sets:

3.4.2. A Theoretical Account

(52)

	1 (epenth. vowel)	2 /I/	3 *	4 /Æ/	5 *	6 *	7 /U/	8 *
HI		+	+				+	+
LO			+	+	+			+
LAB					+	+	+	+

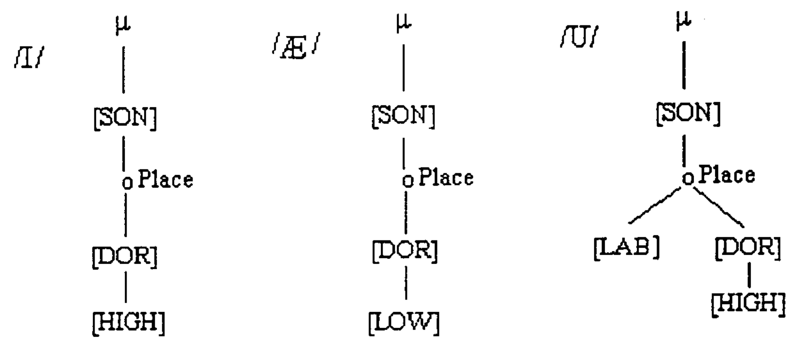
Of the eight vowels defined in (52), St'át'imcets makes use of only four. Combinations 5 and 6 are here hypothesized to be excluded by the markedness condition LAB/HI ('If [LAB], then [HI]') discussed in §2.3.3.3. Combinations 3 and 8 are hypothesised to be excluded by a markedness condition on complexity of height specifications. (Mid vowels are assumed to bear specification for two height features, [HI] and [LOW]; see §2.3.3.3 for further discussion. In chapter 2 it was argued that Palestinian has underlying mid vowels, with complex height specifications. The Palestinian underlying vowel inventory is thus considered marked with respect to height.)

The St'át'imcets epenthetic vowel is combination 1, the null feature set. It is assumed to arise via insertion of [SON] in the input-output mapping, where necessary to satisfy σNUC ('Syllables must have nuclei') (Prince and Smolensky (1993), Shaw (1996b)).

The representations of the St'át'imcets underlying vowels are presented below:

3.4.2. A Theoretical Account

(53) The Representations of the St'át'imcets Underlying Vowels



The epenthetic vowel, following Shaw (1996d), is analysed as weightless; that is, it is dominated by no mora. Evidence for its weightlessness comes from St'át'imcets lexical stress assignment, as will now be explained.

Basic primary lexical stress is assigned to the leftmost vowel. This is illustrated by (54), in which syllable breaks and primary stress are marked.

(54) a. IPA /tʃUtʃIn/	{ˈtʃu.tʃin}	'mouth'
NA /cUcIn/	{ˈcu.cin}	
b. IPA /ʃ-nUɰʷÆ/	{ˈʃ-nu.ɰʷæ}	'you (sg.)'
NA /s-nUwÆ/	{ˈs-nu.wa}	
c. IPA /RED, n-kʷUtʃÆ/	{n̩.-ˈkʷu-kʷ.-tʃæ}	'downstream area'
NA /RED, n-kʷUcÆ/	{n̩.-ˈkʷu-kʷ.-ca}	
d. IPA /ptʃkɬ/	{ˈpətʃ.kəɬ}	'leaf'
NA /pckɬ/	{ˈpəc.kəɬ}	
e. IPA /RED, ʃx/	{ˈʃəx.-ʃəx}	'partly crazy'
NA /RED, sx/	{ˈsəx.-səx}	

However, if the the word contains one of /I Æ U/ and one of {ə ɵ ɜ ɘ ʌ ɔ}, then primary stress falls on the leftmost /I/, /Æ/, or /U/, as illustrated below:

(55) a. IPA /mxÆɹ̟/	{mə.ˈxɑɹ̟}	'huckleberry' (Lower dialect)
NA /mxÆẓ/	{mə.ˈxa̤ẓ}	
b. IPA /lhÆtʃ'/	{lə.ˈhætʃ'}	'otter'
NA /lhÆc'/	{lə.ˈhac'}	

The generalisation illustrated by (54) - (55) is stated informally by Shaw (1996b:5) as: "[.ə́.. ə] but [*.ə́..V.]", where 'ə' corresponds to one of {ə ɵ ɜ ɘ ʌ ɔ}, and 'V' corresponds to one of /I Æ U/. Following Shaw, the lack of primary stress on the leftmost vowel in forms like those in (55) is analysed as showing that (i) the epenthetic vowel differs in prosodic weight from /I Æ U/, *viz.*, it is weightless, whereas /I Æ U/ have weight; (ii) stress falls preferentially on a syllable with weight. In forms which contain only epenthetic vowels, weight is not a determining factor and stress falls per usual on the leftmost vowel, as illustrated by (54d-e).

Note that although the epenthetic vowel bears no mora, it is nevertheless syllabified as a nucleus. That is, its representation in forms like (54d-e) is as seen in (56). (Only features relevant to the discussion are shown.)

(56)
```
 N
 |
[SON]
```

Since the epenthetic vowel does not bear [CONS], it is a vowel. It can be syllabified as a nucleus because, after Zec (1988) and Shaw (1993), vowels project a nucleus.

It is assumed that St'át'imcets pharyngealisation harmony introduces the feature [RTR] into the basic combinatorial system of (52). This yields the four new output vowels seen double-boxed in (57). St'át'imcets uses all of them. The [RTR] specification resulting from pharyngealisation harmony is assumed to be added as a secondary specification for reasons discussed in §2.3.3.3. (Likewise, the [LAB] specification from rounding harmony is assumed to have secondary status. A theoretical account of St'át'imcets rounding harmony will not be presented in this thesis.)

(57)

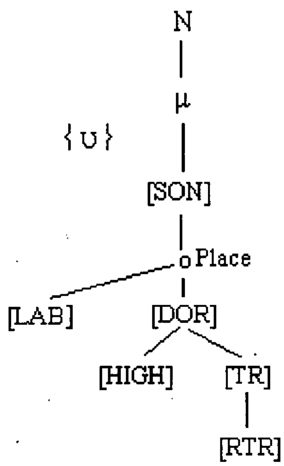
	ɘ	ɜ	ɵ	ɞ	i	ɪ	æ	a	u	ʊ
HI					+	+			+	+
LO							+	+		
LAB			+	+					+	+
RTR		+		+		+		+		+

As seen from (57), [HI] freely combines with [RTR] in St'át'imcets. This shows that the grounded constraint HI/*RTR ('A segment specified for [HI] is not specified for [RTR]') is lowly ranked in the language. It is lowly ranked also in Palestinian, but highly ranked in some Niger-Congo languages, as shown, e.g., by Archangeli and Pulleyblank (1994a); see §2.3.3.3 for further discussion.

The representational change resulting from pharyngealisation is illustrated with {ʊ} in (58).

3.4.2. A Theoretical Account

(58)



It is assumed that a harmonising epenthetic vowel receives specification for [DOR] under a Place node by node generation in the input-output mapping. After Archangeli and Pulleyblank (1994a:23), node generation refers to the automatic generation of hierarchical structure in the representation.

All St'át'imcets postvelars trigger pharyngealisation harmony. Assuming (43) and (44), [RTR] is a secondary specification for all the triggers. Based on these observations, St'át'imcets pharyngealisation harmony is here identified as [RTR] 'AS' ('articulation secondary') harmony. That is, it is harmony of [RTR] triggered by segments which are specified for secondary-[RTR].

At this point, an alternative analysis of the St'át'imcets underlying vowel inventory will be considered. It might be defined by [DOR], [TR], and [LAB]. An analysis along these lines is proposed by E. Pulleyblank (1989) for Coeur d'Alene (Southern Interior Salish). (Under Pulleyblank's (1989) representational assumptions, [TR] is '[RADICAL]' which dominates [±RTR].) Evidence that [DOR], [TR], and [LAB] are active in St'át'imcets comes from the distinctions within the consonantal inventory, e.g., between its underlying postvelars in (43) and (44). The alternative analysis would claim the combinatorial specifications:

(59)

	1 (epenth. vowel)	2 /I/	3 *	4 /Æ/	5 *	6 *	7 /U/	8 *
DOR		+	+				+	+
TR			+	+	+			+
LAB					+	+	+	+

Combinations 5 and 6 would be hypothesised to be ruled out by a markedness condition LAB/DOR ('If [LAB], then [DOR]'). This condition is supported by the inventory of rounded consonants in the language: the only rounded consonants are velar /k^w ḳ^w k'^{w} ḳ'^{w} x^w x̣^{w} ɰ^w ɰ'^{w}/ and uvular /ʁ^w ʁ'^{w}/. Under the present representational assumptions, both sets bear [DOR].

However, the claim that /Æ/ bears [TR] is problematic. The basis for this claim is the following: if /Æ/ were specified for [TR], it would be expected to trigger pharyngealisation harmony. Relevant data are presented in (60). In each form in (60), /U/ or /I/ precedes /Æ/ with a laryngeal intervening between it and the /Æ/. As seen, the /U/ and /I/s surface non-rtr.

(60)

a. IPA /kÆ-p'Uʔ-Æ/	{kæ-p'uʔ-æ}	(*{kæ-p'ʊʔ-æ})	'to fart audibly'
NA /kÆ -p'Uʔ-Æ/	{ka -p'uʔ-a}	(*{ka -p'-ụʔ-a})	
b. IPA /hIʔ-Ætk̟ʷÆʔ/	{hiʔ-ætk̟ʷæʔ}	(*{hɪʔ-ætk̟ʷæʔ})	'water inhabited by *hi7*'
NA /hIʔ-ÆtqʷÆʔ/	{hiʔ-atqʷaʔ}	(*{hịʔ-atqʷaʔ})	[*hi7* 'supernatural being, powerful spirit']
c. IPA /ʔIʔÆj/	{ʔiʔæj}	(*{ʔɪʔæj})	(exclamation, used to urge a storyteller to continue his story)
NA /ʔIʔÆy/	{ʔiʔay}	(*{ʔịʔay})	

Forms such as /GLOT, mʁ/ {mɜ-'-ʁ}, seen earlier in (46e), show that glottalised vowels which precede a postvelar surface rtr; see also the carrier forms in Table 3:5.I.B, II.A. Based on the present database, St'át'imcets glottalised vowels are phonetically implemented as two consecutive tokens of the vowel separated by a glottal stop, yielding, e.g., {mɜ-'-ʁ} [mɜʔɜʁ]. The fact that both phonetic tokens are rtr indicates that the intervening phonetic laryngeal is transparent to the harmony. (Consider also that St'át'imcets laryngeals are transparent to phonetic lowering, as illustrated by IPA /x̟ʷʔUtʃIn/ {x̟ʷʔutʃin} [x̟ʷʔotʃin] (*[x̟ʷʔutʃin]) 'fourteen'.) Based on these observations, it is here hypothesised that a phonological laryngeal would likewise be transparent to pharyngealisation harmony. Given this, the lack of pharyngealisation for the /U/ and /I/s in (60) is here analysed as showing that St'át'imcets /Æ/ does not trigger pharyngealisation harmony: if it did, assuming laryngeal transparency, the /U/ and /I/s would be expected to surface rtr.

3.4.2. A Theoretical Account

Based on the foregoing analysis, it is concluded that the prediction made by the featural analysis in (59) is not borne out. On this basis, the alternative analysis is not adopted here.

I propose that the data in (45) - (51) require the constraints in (61).

(61) a. ALIGN-L([RTR], NUC)
The left edge of [RTR] is aligned with the left edge of a NUC.

b. ALIGN-R([RTR], NUC)
The right edge of [RTR] is aligned with the right edge of a NUC.

c. DEP-IO
Every segment in the output has a correspondent in the input.

d. MAX-RTR
Every [RTR] in the input corresponds to an [RTR] in the output.

e. MAX-LINK
Every association in the input corresponds to an association in the output.

f. DEP-LINK
Every association in the output corresponds to an association in the input.

These constraints were discussed in chapter 2. DEP-IO requires that there be no segmental epenthesis. MAX-RTR requires that no [RTR] be deleted. MAX-LINK requires that no link be deleted. DEP-LINK requires that no link be added.

ALIGN-L([RTR], NUC) and ALIGN-R([RTR], NUC) require that [RTR] surface left- and right-aligned, respectively, with a vowel. They were proposed in §2.4.2 as auditory grounding constraints which follow from the optimal surface realisation of [RTR] on a vowel, to enhance its underlying distinctiveness on consonants; see §2.4.2 for the full motivation of these constraints.

3.4.2. A Theoretical Account

Chapter 2 argued that the constraints in (61), under a particular ranking, are responsible for a core set of properties of pharyngealisation harmony as it occurs in Palestinian Arabic. I propose that they are ranked in St'át'imcets as seen in (62).

(62) DEP-IO, MAX-RTR, MAX-LINK >>
    ALIGN-L([RTR], NUC) >>
        DEP-LINK >>
            ALIGN-R([RTR], NUC)

The surface effect of this re-ranking is illustrated by the following two tableaux:

(63)

input: /tIʁ'^{w}-In'/ | [RTR] 'to untie some-thing, to turn an animal loose (tr.)'; see (46)	DEP-IO	MAX-RTR	MAX-LINK	ALIGN-L ([RTR],NUC)	DEP-LINK	ALIGN -R ([RTR],NUC)
1. {tiɰ'^{w}-in}		*!	*			
2. {tiʁ'^{w}-in} | [RTR]				*!		*
☞ 3. {tɪʁ'^{w}-in} \\\| [RTR]					*	*
4. {tɪʁ'^{w}-ɪn} \\\| / [RTR]					**!	
5. {tɪʁ'^{w}-in} \\\\\| [RTR]				*!	**	*

(64)

input: /ʁɪʃ/ | [RTR] 'to shrink'; see (48)	DEP-IO	MAX-RTR	MAX-LINK	ALIGN-L ([RTR],NUC)	DEP-LINK	ALIGN -R ([RTR],NUC)
1. {ɰiʃ}		*!	*			
☞ 2. {ʁiʃ} | [RTR]				*		*
3. {ʒʁiʃ} \\\| [RTR]	*!				*	*
4. {ʁɪʃ} |/ [RTR]				*	*!	

The ranking MAX-RTR, MAX-LINK >> ALIGN-L([RTR], NUC) is established by the winning candidate 3 in (63). In candidate 3, the vowel leftward of the postvelar surfaces bearing [RTR]. If MAX-RTR and MAX-LINK were not ranked above ALIGN-L([RTR], NUC) or if the three constraints were equally ranked, then [RTR] and its link with with the postvelar could be deleted, resulting in vacuous satisfaction of ALIGN-L([RTR], NUC). However, a form with such deletion is non-optimal; this is shown by the losing candidate 1 in the same tableau.

In the losing candidate 3 in (64), a vowel is epenthesised to supply a leftward vowel which can align with [RTR], in satisfaction of ALIGN-L([RTR], NUC). The fact that candidate 3 is non-optimal shows that violation of DEP-IO is more serious than violation of ALIGN-L([RTR], NUC). This shows that DEP-IO is ranked with DEP-RTR and DEP-LINK above ALIGN-L([RTR], NUC).

The present data provide no evidence for a crucial ranking between DEP-IO, DEP-RTR and DEP-LINK. On this basis, the three constraints are assumed here to be non-crucially equally ranked.

The winning candidate 3 in (63) contains a non-underlying link between [RTR] and the vowel leftward of the postvelar in violation of DEP-LINK but in satisfaction of ALIGN-L([RTR], NUC). This shows that violation of DEP-LINK is less serious than violation of ALIGN-L([RTR], NUC) and establishes the ranking ALIGN-L([RTR], NUC) >> DEP-LINK.

In the candidates 4 in both tableaux, the rightward vowel pharyngealises. By result, each of those candidates incurs one more violation of DEP-LINK than the winner in its tableau. The fact that the candidates 4 are non-optimal shows that violation of DEP-LINK is more serious than violation of ALIGN-R([RTR], NUC). Hence, DEP-LINK >> ALIGN-R([RTR], NUC).

Candidate 5 in (63) contains a non-underlying link between [RTR] and { t}. Because of that link, it violates ALIGN-L([RTR], NUC) because [RTR] is left-aligned with { t}, not with a NUC. By contrast, the winning candidate does not violate ALIGN-L([RTR], NUC). By result, candidate 5 is non-optimal. The non-underlying link [RTR] and { t} also incurs a violation of DEP-LINK.

At this point we ask: what is the evidence that candidate 5 in (63) is non-optimal? It is here claimed that candidate 5 is non-optimal because St'át'imcets consonants do not undergo pharyngealisation harmony. In chapter 2, the same was asserted for Palestinian. The basis of this claim for St'át'imcets will be explained next.

In the acoustic study of this thesis, formant effects were observed for tokens of consonants in a pharyngealisation context, compared to tokens in a non-pharyngealisation context. Here our focus will be on F_1, as the present data indicate it is the most salient acoustic effect of pharyngealisation. An F_1 rise of up to 200 Hz was observed for tokens of a consonant in a pharyngealisation context, compared to F_1 of tokens of the same consonant not in a pharyngealisation context (e.g., for a token of the leftmost {l} in {ʁəl-ʁəl} 'strong, healthy, vigorous', which is in a pharyngealisation context, compared to F_1 of a token of {l} in {tʃi-tʃ-l-uʃæʔ} 'fresh fruit', which is not in a pharyngealisation context). In §3.4.1.2, a raised F_1 was observed for tokens of St'át'imcets vowels under pharyngealisation harmony. However, unlike the F_1 effect for vowels, the F_1 effect for consonants is here considered to be due not the St'át'imcets phonology, but solely to the phonetics. Perceptual data which support this assumption will now be presented.

AA, an adult female native speaker of St'át'imcets was asked to identify certain sounds in St'át'imcets words. AA speaks both Lower and Upper dialects. She is literate in both English and St'át'imcets. (St'át'imcets is written using the 'van Eijk orthography'. This orthography is seen in Appendix VII, also in Table 3:7.) She is linguistically trained to recognise vowels vs. consonants and to analyse words in terms of syllables. The sounds for which judgments were elicited were instances of /l/ and /I/ in a non-pharyngealisation vs. pharyngealisation context. The judgments were produced as the oral responses reported below:

Table 3:7 Judgments of St'át'imcets /l/ and /I/ in a non-pharyngealisation vs. pharyngealisation context

<table>
<tr><th>Task: Please identify...</th><th>Response</th><th>Notes</th></tr>
<tr><td>1. the sound at the beginning of the second syllable in tsitslúsa7 [{tʃi-tʃ-l-uʃæʔ} 'fresh fruit'] = /l/ IN A NON-PHARYNGEALISATION CONTEXT</td><td>"l."</td><td rowspan="2">as response to 1 and 2, AA named the English letter 'l'</td></tr>
<tr><td>2. the sound at the end of the first syllable in gélgel [the leftmost [l] in {ʁəl-ʁəl} 'strong, healthy, vigorous'] = /l/ IN A PHARYNGEALISATION CONTEXT</td><td>"l."</td></tr>
<tr><td>3. the vowel sound in the first syllable in ki'tsin' [{kitʃ-in'} 'to lay something down (intr., tr.)'] = /I/ IN A NON-PHARYNGEALISATION CONTEXT</td><td rowspan="2">"The vowel in t'iiq is different from the vowel in ki'tsin'. They're not close. They're not even cousins. I think they would be written differently."</td><td rowspan="2">orthographic i = i, ii = ɛ (St'át'imcets phonetic [ɛ] is analysed in this thesis as surface {ɪ} implemented with phonetic lowering; see §3.2.2.3)</td></tr>
<tr><td>4. the vowel sound in t'iiq [{t͡ɬ'ɪḳ} 'to arrive (here)'] = /I/ IN A PHARYNGEALISATION CONTEXT</td></tr>
</table>

As seen in Table 3:7, the judgments for /l/ in both a non-pharyngealisation and a pharyngealisation context were the same. However, the judgements for /I/ in the two contexts were different. These judgements parallel those reported for Palestinian in Table

2:3. As with the Palestinian results in Table 2:3, the results for St'át'imcets in Table 3:7 are here interpreted as indicating that pharyngealisation has no categorical affect on consonants, that is, that no distinct rtr allophone results for a consonant in a pharyngealisation context. They are further interpreted as demonstrating the categorical effect that pharyngealisation has on vowels. For vowels the result is a perceptual distinction between non-rtr and rtr vowel allophones. The categorical effect on St'át'imcets vowels but not consonants is considered support for the assumption that a raised F_1 observed for St'át'imcets consonant tokens in a pharyngealisation context is not due to St'át'imcets phonology, but is solely a phonetic effect.

On this basis, it is here claimed that St'át'imcets consonants do not undergo pharyngealisation harmony.

Because St'át'imcets consonants do not undergo pharyngealisation harmony, the anchor for [RTR] in St'át'imcets is here identified as the NUC. In §2.3.3 the same anchor was identified for [RTR] in Palestinian. The constraint which imposes St'át'imcets pharyngealisation harmony, ALIGN-L([RTR], NUC), requires alignment of [RTR] only with a NUC.

Finally, in Palestinian Arabic, pharyngealisation harmony usually affects all vowels in the word. In §2.3.2.3 this was argued to be the effect of ALIGN([RTR], L; Wd, L) and ALIGN([RTR], R; Wd, R), which require the word and any [RTR] to be left- and right-edge aligned, respectively. The effects of these constraints are not observed in St'át'imcets. E.g., candidate 4 in (63) is ⟨tɪʁ'ʷ-ɪn⟩, in which all vowels in the word pharyngealise; the fact that it is non-optimal shows that in St’át’imcets, ALIGN([RTR], L; Wd, L) and ALIGN([RTR], R; Wd, R) are at least as lowly ranked as ALIGN-R([RTR], NUC). Thus, the ranking responsible for the properties of St’át’imcets pharyngealisation harmony as revealed by the data in §3.4.1.1 is:

(65) DEP-IO, MAX-RTR, MAX-LINK >>
  ALIGN-L([RTR], NUC) >>
    DEP-LINK >>
      ALIGN-R([RTR], NUC), ALIGN([RTR], L; Wd, L), ALIGN([RTR], R; Wd, R)

3.5. St’át’imcets Uvularisation Harmony

3.5.1. Harmony With an Emphatic

3.5.1.1. Analysis

St’át’imcets uvularisation harmony is triggered by the emphatics /tʃ̙ ʃ̙ ɹ̙ ɹ̙’ l̙ l̙’ k̙ k̙’ k̙ʷ k̙’ʷ x̙ x̙ʷ/ and affects only one segment in a word. Consider first the data in (66). These forms show that in forms which do not contain an emphatic, the epenthetic vowel surfaces as one of non-back {ə ɜ ɵ ɞ}, /Æ/ surfaces as one of non-back {æ a}, and /tʃ n/ surface as non-emphatic {tʃ n}. (As seen in (66c-d) and (66i-k), the rtr variants of the epenthetic vowel ({ɜ ɞ}) and /Æ/ ({a}) are observed immediately preceding a guttural; this was analysed in §3.4.1.1 as the effect of pharyngealisation harmony triggered by the following guttural postvelar. As seen in (66d-e), rounded variants of the epenthetic vowel (⟨ɵ ɘ⟩) are observed under adjacency to a rounded consonant; this was analysed in §3.2.2.2 as the effect of rounding harmony triggered by the adjacent rounded consonant. The ⟨h⟩ in (66m) is epenthetic; St'at'imcets' epenthetic ⟨h⟩ will be discussed in §3.5.6.)

(66)

a. IPA /RED, ʃx/ NA /RED, sx/	⟨ʃəx-ʃəx⟩ ⟨səx-səx⟩	'partly crazy'
b. IPA /ptʃkɬ/ NA /pckɬ/	⟨pətʃkəɬ⟩ ⟨packəɬ⟩	'leaf'
c. IPA /tʃʁ-n/ NA /cʕ-n/	⟨tʃɜʁ-ən⟩ ⟨cəʕ-ən⟩	'to rip, tear something (tr.)'
d. IPA /lʁʷ-n/ NA /lʕʷ-n/	⟨lɵʁʷ-ən⟩ ⟨ləʕʷ-ən⟩	'to hide something (intr., tr.)'
e. IPA /RED, tɰʷt/ NA /RED, twt/	⟨tɵwɵ-ɰʷ-ɰ'ʷɵt⟩ ⟨təw-əw-w'ət⟩	'(young) boy'
f. IPA /tʃ'ɰʷÆn/ NA /c'wÆn/	⟨tʃ'ɰʷæn⟩ ⟨c'wan⟩	'wind-dried salmon'
g. IPA /kÆɬÆʃ/ NA /kÆɬÆs/	⟨kæɬæʃ⟩ ⟨kaɬas⟩	'three'
h. IPA /t͡ɬ'pÆʔ/ NA /ƛ'pÆʔ/	⟨t͡ɬ'pæʔ⟩ ⟨ƛ'paʔ⟩	'marrow'
i. IPA /s-p'Æʁ/ NA /s-p'Æʕ/	⟨s-p'aʁ⟩ ⟨s-p'aʕ⟩	'burned forest, any area where a fire went through'

j. IPA /RED, mÆʁ/	{mɜʁ-maʁ}	'light, bright'
NA /RED, mÆʕ/	{məʕ-maʕ}	
k. IPA /RED, lÆʁ'ʷ/	{loʁʷ-laʁ'ʷ}	'room, spaces in between things'
NA /RED, lÆʕʷ/	{ləʕʷ-laʕ'ʷ}	
l. IPA /RED, ʔUʃÆʔ/	{ʔu-ʔ-ʃæʔ}	'egg'
NA /RED, ʔUsÆʔ/	{ʔu-ʔ-saʔ}	
m. IPA /kÆ-ʔÆmÆ-ɬkÆn-Æ/	{kæ-ʔæmhæ-ɬkæn-æ}	'I've become better'
NA /kÆ-ʔÆmÆ-ɬkÆn-Æ/	{ka-ʔamha-ɬkan-a}	

The data in (67) show that the St'át'imcets epenthetic vowel surfaces as backed {ʌ} or {ɔ}, /Æ/ surfaces as backed {ɑ}, and /tʃ n/ surface as emphatic {tʃ̣ ṇ} immediately preceding an emphatic consonant. (In (68e), via rounding harmony, rd {ɔ} occurs under adjacency to the rounded emphatic; see §3.2.2.2.) That (67m) contains underlying non-emphatic /tʃ/ is supported by a variant of this form which was produced by LN, an Upper dialect speaker: {tʃɔḳʷ-ænæʔ}. The manner in which this variant indicates underlying /tʃ/ is explained as follows: as seen in (67), St'át'imcets uvularisation harmony occurs under strict leftward adjacency. In {tʃɔḳʷ-ænæʔ}, /tʃ/ surfaces non-emphatic because it does not immediately precede the underlying emphatic /ḳʷ/. The epenthetic vowel harmonises instead, to surface as backed {ɔ}, as it is left adjacent to the emphatic. (A tableau for (67d) will be presented in §3.5.2.)

3.5.1. Harmony with an Emphatic

(67)

a. IPA /mk̙'/	{mʌk̙'}	(*{mɜk̙'})	'to get stuffed, to eat too much'
NA /mq'/	{mə̣q'}	(*{məq'})	
b. IPA /ʃ-pl̙xʷ/	{ʃ-pʌ̙l̙xʷ}	(*{ʃ-pɜl̙xʷ})	'to stick out from something (e.g., from a pocket or a house)'
NA /s-pḷx̌ʷ/	{s-pə̣ḷx̌ʷ}	(*{s-pəḷx̌ʷ})	
c. IPA /ɬtʃ̙/	{ɬʌtʃ̙}	(*{ɬɜtʃ̙})	'to cave in, to get caved in'
NA /ɬc̣/	{ɬə̣c̣}	(*{ɬə c̣})	
d. IPA /tx̙/	{tʌx̙}	(*{tɜx̙})	'bitter'
NA /tx̌/	{tə̣x̌}	(*{t əx̌})	
e. IPA /ʃ-tx̙ʷ/	{ʃ-tɔx̙ʷ}	(*{ʃ-təx̙ʷ})	'really, very much'; to be in the way'
NA /s-tx̌ʷ/	{s-tə̣x̌ʷ}	(*{s-tə x̌ʷ})	
f. IPA /ʃ-k̙j̙Æx̙/	{ʃ-k̙jɑx̙}	(*{ʃ-k̙jæ̙x̙})	'drunk'
NA /s-qyÆx̌/	{s-qyạ x̌}	(*{s-qyax̌})	

3.5.1. Harmony with an Emphatic

g. IPA /RED, k̙ʷÆx̙/	{k̙ʷɑ-k̙ʷ-x̙}	(*{k̙ʷæ-k̙ʷ-x̙})	'to have a nightmare, to sleep-walk'
NA /RED, qʷÆx̌/	{qʷạ-qʷ-x̌}	(*{qʷa-qʷ-x̌})	
h. IPA /ʔÆl̙ʃ̙-m/	{ʔɑl̙ʃ̙-əm}	(*{ʔæl̙ʃ̙-əm})	'sick, ill'
NA /ʔÆḷṣ-m/	{ʔạḷṣ-əm}	(*{ʔaḷṣ-əm})	
i. IPA /mxÆɹ̙/	{məxɑɹ̙}	(*{məxæɹ̙})	'huckleberry' (Lower dialect)
NA /mxÆẓ/	{məxạẓ}	(*{məxaẓ})	
j. IPA /mÆk̙Æʔ/	{mɑk̙æʔ}	(*{mæk̙æʔ})	'snow'
NA /mÆqÆʔ/	{mạqaʔ}	(*{maqaʔ})	
k. IPA /RED, n-ʃ̙Æl̙'-tʃ/	{n̙-ʃ̙ɑl̙'-l̙'-ətʃ}	(*{n-ʃ̙æl̙'-l̙'-ətʃ} *{n̙-ʃ̙æl̙'-l̙'-ətʃ}, *{n-ʃ̙ɑl̙'-l̙'-ətʃ})	'to drool, slobber (e.g., like cows)'
NA /RED, n-ṣÆḷ'-c/	{ṇ-ṣạḷ'-ḷ'-əc}	(*{n-ṣaḷ'-ḷ'-əc}, *{ṇ-ṣaḷ'-ḷ'-əc}) *{n-ṣạḷ'-ḷ'-əc})	
l. IPA /tʃk̙ʷ-ÆnÆʔ/	{t̙ʃ̙k̙ʷ-ænæʔ}	(*{tʃk̙ʷ-ænæʔ})	'lynx'
NA /cqʷ-ÆnÆʔ/	{c̣qʷ-anaʔ}	(*{cqʷ-anaʔ})	

m.	IPA /ʁtʃ-k̙In-Upʔ-Æm/	{ʁət̙ʃ-k̙in-upʔ-æm}	(*{ʁətʃ-k̙in-upʔ-æm})	'to lead horses by tying them to the tail of the horse in front'
	NA /ʕc-qIn-Upʔ-Æm/	{ʕəc̣-qin-upʔ-am}	(*{ʕəc-qin-upʔ-am})	

The forms in (66c-d) and (66i-k) showed that the epenthetic vowel and /Æ/ surface non-backed immediately preceding one of the uvular gutturals /ʁ ʁ' ʁʷ ʁ'ʷ/. That is, the primary uvulars do not trigger the harmony. Acoustic findings which support this generalisation will be presented in §3.5.1.2.

Crosslinguistic evidence that gutturals do not trigger uvularisation harmony comes from Arabic: as was shown in §2.5.1.1, primary uvular /ʁ χ/ and pharyngeal /ʕ ħ/ do not trigger uvularisation harmony in Palestinian Arabic. Further evidence comes from Nxa'amxcin Salish: the forms in (68) show that Nxa'amxcin /Æ/ surfaces non-back immediately preceding the pharyngeal guttural /ħ/.[14] That is, pharyngeal /ħ/ does not trigger uvularisation harmony in that language. (For documentation of Nxa'amxcin uvularisation harmony, see, e.g., Bessell & Czaykowska-Higgins (1991), in which it is refered to as 'retraction' harmony.)

[14]I thank M.D. Kinkade for the Nxa'amxcin data in (68).

(68)	a. /lÆħ-p/	{laħ-p}	(*{lɑħ-p})	'flow' (V)
	b. /nÆ-ħUj-nÆʔ/	{na-ħuj-naʔ}	(*{nɑ-ħuj-naʔ}	'get annoyed by a noise'
	c. /RED, pÆħ/	{paħ-paħ}	(*{pɑħ-pɑħ})	'Plymouth Rock (chicken)'

The forms in (69) show that the epenthetic vowel and /Æ/ surface non-back and /tʃ n/ surface non-emphatic when immediately following an emphatic (unless they occur between two emphatics, as the epenthetic vowel in (69e).) (A tableau for (69a) will be presented in §3.5.2.)

(69)

a. IPA /x̘ʷÆʔs/	{x̘ʷæʔs}	(*{x̘ʷɑʔs})	'sockeye
NA /x̌ʷÆʔs/	{x̌ʷaʔs}	(*{x̌ʷạʔs})	salmon' (Upper dialect)
b. IPA /mIx̘Æɬ/	{mɪx̘æɬ}	(*{mɪx̘ɑɬ})	'black bear'
NA /mIx̌Æɬ/	{mịx̌aɬ}	(*{mịx̌ạɬ})	
c. IPA /x̘Um-k̘Æʔ/	{x̘um-k̘æʔ}	(*{x̘um-k̘ɑʔ})	'salmon
NA /x̌Um-qÆʔ/	{x̌um-qaʔ}	(*{x̌um-q ạʔ})	head'

d. IPA /RED, n-ʃÆl'-tʃ/	{n-ʃɑl'-l'-ətʃ}	(*{n-ʃɑl'-l'-ʌtʃ})	'to drool,
NA /RED, n-ṣÆḷ'-c/	{ṇ-ṣạ ḷ'-ḷ'əc}	(*{ṇ-ṣạ ḷ'-ḷ'ạc})	slobber (e.g., like cows)'
e. IPA /RED, kl-nUxʷ-mIn/	{kʌl-kʌl-nuxʷ-min}	(*{kʌl-kʌl-nuxʷ-min})	'to be un-
NA /RED, qḷ-nUx̌ʷ-mIn/	{qəḷ-qəḷ-nux̌ʷ-min}	(*{qạḷ-qạḷ-ṇux̌ʷ-min})	friendly to to some- one (tr.)'
f. IPA /RED, tʃIk-In'/	{tʃʌk-tʃɪk-in'}	(*{tʃʌk-tʃɪk-ɪn'})	'to stab
NA /RED, cIq-In'/	{cəq-ciq-in'}	(*{cəq-ciq-in'})	someone all over'

The generalisation from (66), (67) and (69) are that the epenthetic vowel and /Æ/ surface backed and /tʃ n/ surface as emphatic /tʃ ṇ/ immediately preceding an underlying emphatic; otherwise, they surface non-back, and as non-emphatic /tʃ n/, respectively. The effects in (67) are analysed as uvularisation harmony triggered by the immediately following emphatic.

As noted in §3.2.1.2, an exhaustive study of the affect of St'át'imcets uvularisation harmony on consonants was not undertaken for this thesis. Determination of whether or not consonants other than /tʃ n/ undergo the harmony is thus left for future study.

The documentation of van Eijk (1987) indicates that in certain St'át'imcets forms, the harmony pattern differs from that described above: one or more segments following an emphatic are sometimes affected. Example forms in which this is observed, from van Eijk (1987), are:

(70) a. {ka-ƛ'ḷ-ə̣p-a} 'to get sprained'
b. {qə̣ḷ-ạm} 'undertaking something one cannot accomplish'
c. {qə̣ḷ-wịḷ'x} 'to get spoiled (e.g., meat, potatoes), to break down (car, wagon)'

The present database contains only one such form: { k̞ʌ̞l-ɰʷɪ̞l'x} □ {qə̣ḷ-wịḷ'x}, (70c). That this form is underlyingly /k̞ʌ̞l-ɰʷIl'x/, with non-emphatic suffixal /l'/ is seen from forms such as { ʔæmæ-ɰʷil'x} in which the same suffix, /-ɰʷIl'x/ 'to get into a certain state', occurs but with non-emphatic { l'}. Because the present corpus lacks further relevant data, forms with rightward uvularisation harmony, such as those in (70), will be addressed no further here.

Phrases such as those in (71) show that St'át'imcets leftward uvularisation harmony is not observed across a word boundary: in (71) a (clitic-) word-final /Æ/ is followed by a word-initial emphatic. As seen, the vowel immediately preceding the emphatic across the word boundary does not uvularise. This indicates the morphological word as the harmony domain.

(71)

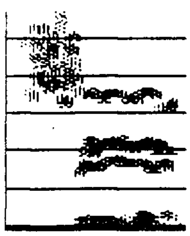
IPA /nÆ ‿# k̙mUt-Æ/	{ næ ‿# k̙əmut-æ }	(*{ nɑ ‿# k̙əmut-æ })	'the hat (absent, known)' (Upper dialect)
NA /nÆ ‿# qmUt-Æ/	{ na ‿# qəmut-a }	(*{ nạ ‿# qəmut-a })	

Finally, data such as those in (72) show that the leftward harmony does not affect all eligible leftward segments in the word. The eligible segments are here assumed to be the epenthetic vowel, /Æ/, /tʃ/ and /n/. Rather, it affects only the segment immediately preceding the underlying emphatic. St'át'imcets thus differs from Palestinian Arabic, in which uvularisation harmony affects all eligible segments leftward in the word. Palestinian uvularisation harmony is in fact across-the-word; for data showing this, see §2.5.1.1. (A tableau for (72a) will be presented in §3.5.2.)

(72)

a. IPA /mxÆɹ̙/	{ məxɑɹ̙ }	(*{ mʌxɑɹ̙ })	'huckleberry' (Lower dialect)
NA /mxÆẓ/	{ məxạẓ }	(*{ mẹxạẓ })	
b. IPA /tʃk̙ʷ-ÆnÆʔ/	{ tʃɔk̙ʷ-ænæʔ }	(*{ tʃ̙ɔk̙ʷ-ænæʔ })	'lynx' (Upper dialect or idiolectal variant)
NA /cqʷ-ÆnÆʔ/	{ cəqʷ-anaʔ }	(*{ c̣ə̣qʷ-anaʔ })	

c. IPA /tʃk̟-n/	{ tʃʌk̟-ən}	(*{ t̟ʃʌk̟-ən})	'to put down a container with the opening turned upwards, to put it upright (tr.)'
NA /cq-n/	{ cəq̣-ən}	(*{ c̣əq̣-ən})	
d. IPA /ʁtʃ-k̟In-Upʔ-Æm/	{ ʁət̟ʃ-k̟in-upʔ-æm}	(*{ ʁʌt̟ʃ-k̟in-upʔ-æm})	'to lead horses by tying them to the tail of the horse in front'
NA /ʕc-qIn-Upʔ-Æm/	{ ʕə c̣-qin-upʔ-am}	(*{ ʕəc̣-qin-upʔ-am})	



3.5.1.2. Acoustic Support

In Figures 3:44 - 3:47, the data on /Æ/ and the epenthetic vowel which were seen earlier in Figures 3:12 - 3:15 are replotted according to the contexts relevant to uvularisation harmony: immediately preceding an emphatic, or preceding an emphatic with a phonetic laryngeal intervening between the vowel and the emphatic, vs. all other contexts. 'All other contexts' refers to all contexts in which the vowels did not occur immediately preceding an emphatic or preceding an emphatic with a phonetic laryngeal intervening between the vowel and the emphatic. (No tokens of the epenthetic vowel immediately preceding a laryngeal are plotted in Figures 3:46 - 3:47, due to lack of data.) Data on /I U/ in a uvularisation harmony context will be presented and discussed in §3.5.3.

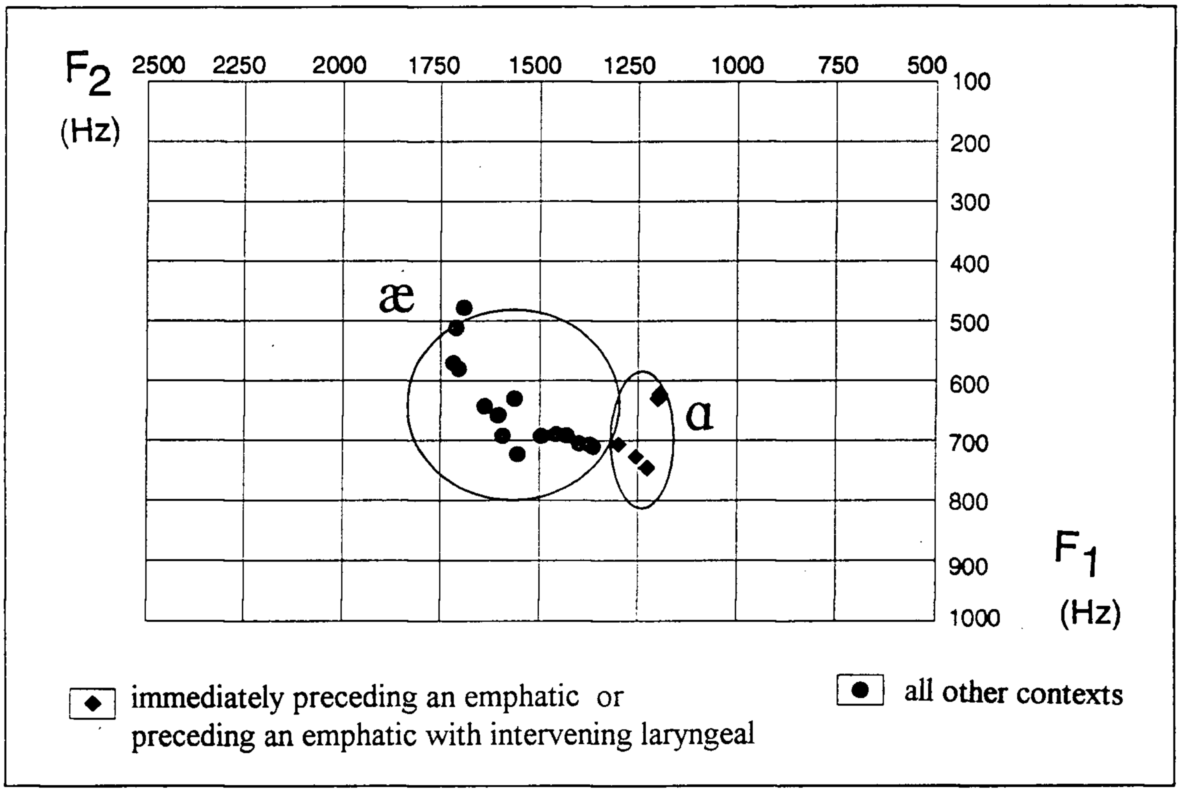


Figure 3:44 F_1 - F_2 plot of tokens of St'át'imcets /Æ/ in the contexts: immediately preceding an emphatic, or preceding an emphatic with an intervening phonetic laryngeal vs. all other contexts. Speaker: LC.

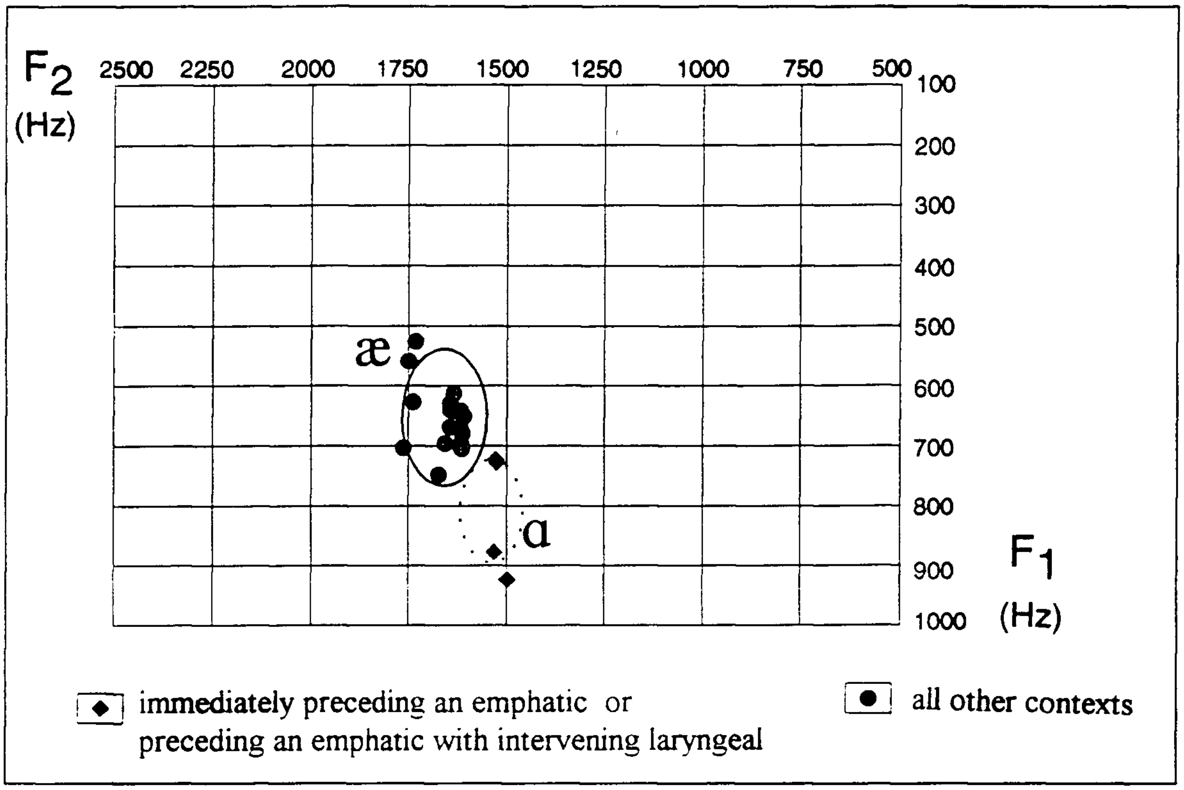


Figure 3:45 F_2 - F_2 plot of tokens of St'át'imcets /Æ/ in the contexts: immediately preceding an emphatic, or preceding an emphatic with an intervening phonetic laryngeal vs. all other contexts. Speaker: LN.

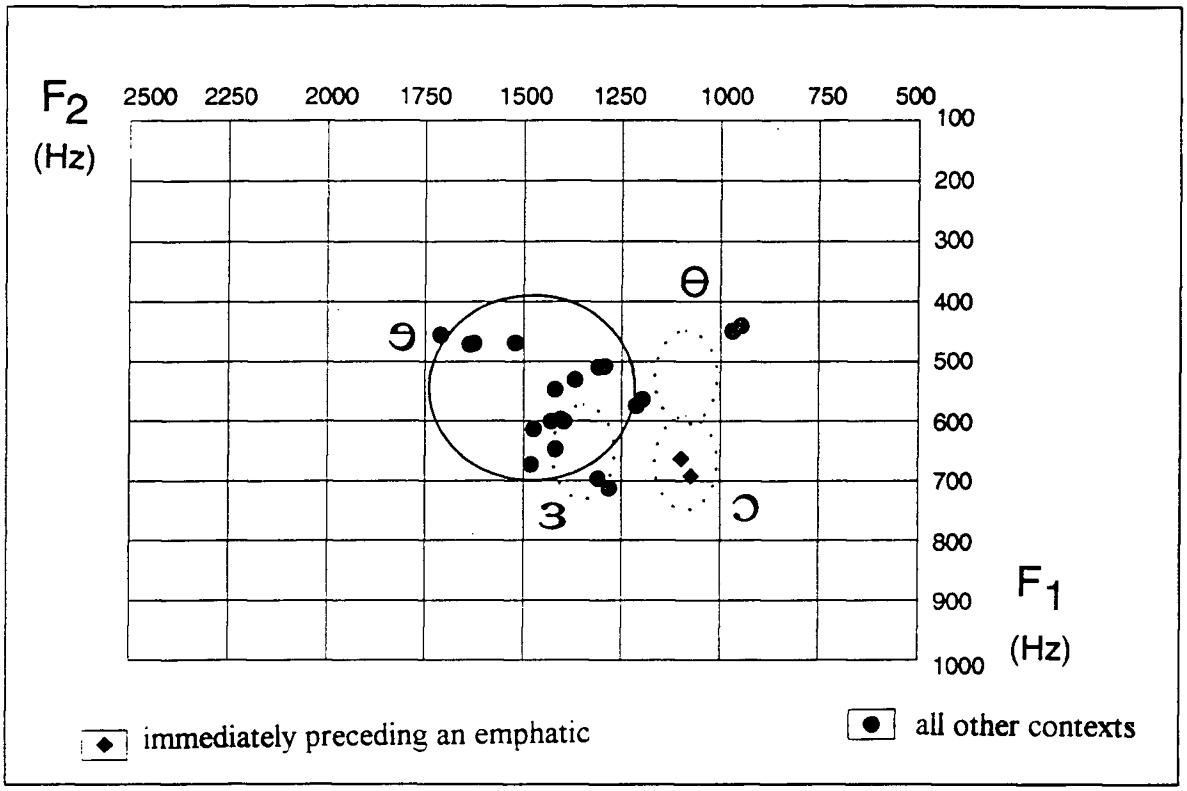


Figure 3:46 F_1 - F_2 plot of tokens of the St'át'imcets epenthetic vowel in the contexts: immediately preceding an emphatic vs. all other contexts. Speaker: LC.

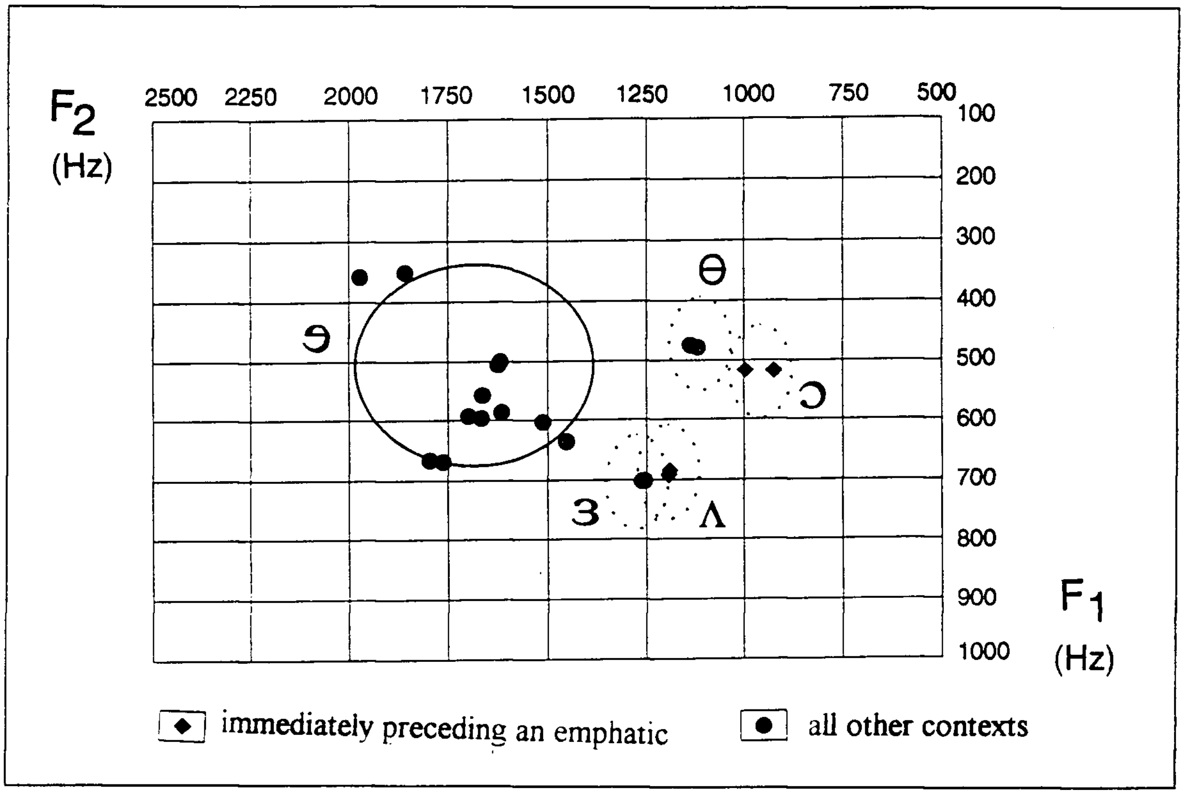


Figure 3:47 F_1 - F_2 plot of tokens of the St'át'imcets epenthetic vowel in the contexts: immediately preceding an emphatic vs. all other contexts. Speaker: LN.

In each of Figures 3:44 - 3:47, the tokens which occurred immediately preceding an emphatic, or preceding an emphatic with an intervening phonetic laryngeal, cluster together and are perceptually the back allophones of the respective vowels: back {ɑ} for /Æ/ and back {ʌ} or {ɔ} for the epenthetic vowel. The tokens which occurred in all other contexts cluster together and are perceptually non-back allophones: non-back {æ} for /Æ/ and non-back {ɘ}, {ɜ}, or {ɵ} for the epenthetic vowel.

In each of Figures 3:44 - 3:47, the tokens of the back variants cluster in a region of the F_1 - F_2 plane which is characterised by a lowered F_2, compared to the region within which the non-back variants cluster. In Figure 3:45, the tokens of LN's back {ɑ} cluster within a higher F_1 region than the tokens of front ⟨ ɑ⟩. (For discussion of the lowered F_2 of the non-rtr rounded variant of the epenthetic vowel, ⟨ ɵ⟩, see §3.4.1.2.) In §1.4.3, the F_1 and F_2 effects predicted for a segment with uvularisation and pharyngealisation articulation were identified as a medium or large F_1 rise and a large F_2 drop. The expected F_1 effects are not apparent in this data. However, the F_2 effect is. Based on the F_1 and F_2 means reported in Figures 3:8 - 3:15, the back tokens have a large F_2 drop. Thus, with respect to F_2, the data are consistent with the assumption that the tokens which occurred immediately preceding an emphatic, or preceding an emphatic with an intervening phonetic laryngeal, were produced with a uvularisation articulation that the tokens in all other contexts lacked. This supports the phonological claim that /Æ/ and the epenthetic vowel uvularise immediately preceding an emphatic. (The tokens in the context 'preceding an emphatic with an intervening phonetic laryngeal' will be addressed further in §3.5.5.)

Some tokens of the epenthetic vowel which are plotted as occurring in 'all other contexts' in Figures 3:46 and 3:47 occurred immediately preceding one of /ʁ ʁ' ʁʷ ʁ'ʷ/. (This is seen from the list of carrier forms in Appendix VI.) That those tokens do not cluster with the tokens which occurred immediately preceding an emphatic, but are perceptually a non-back variant of the epenthetic vowel, supports the phonological claim that St'át'imcets uvular gutturals do not trigger uvularisation harmony.

Figures 3:48 and 3:49 replot those tokens of the epenthetic vowel which occurred preceding an emphatic with a consonant other than a laryngeal intervening between the vowel and the emphatic (e.g., the epenthetic vowel in /ʁtʃ-k̥In-Upʔ-Æm/

{ʁətʃ-ḳin-upʔ-æm} 'to lead horses by tying them to the tail of the horse in front').
(Graphs for /Æ/ in this context will be presented in §3.5.5.2.) The context 'preceding an emphatic with an intervening non-laryngeal' is a subcontext of 'all other contexts'.

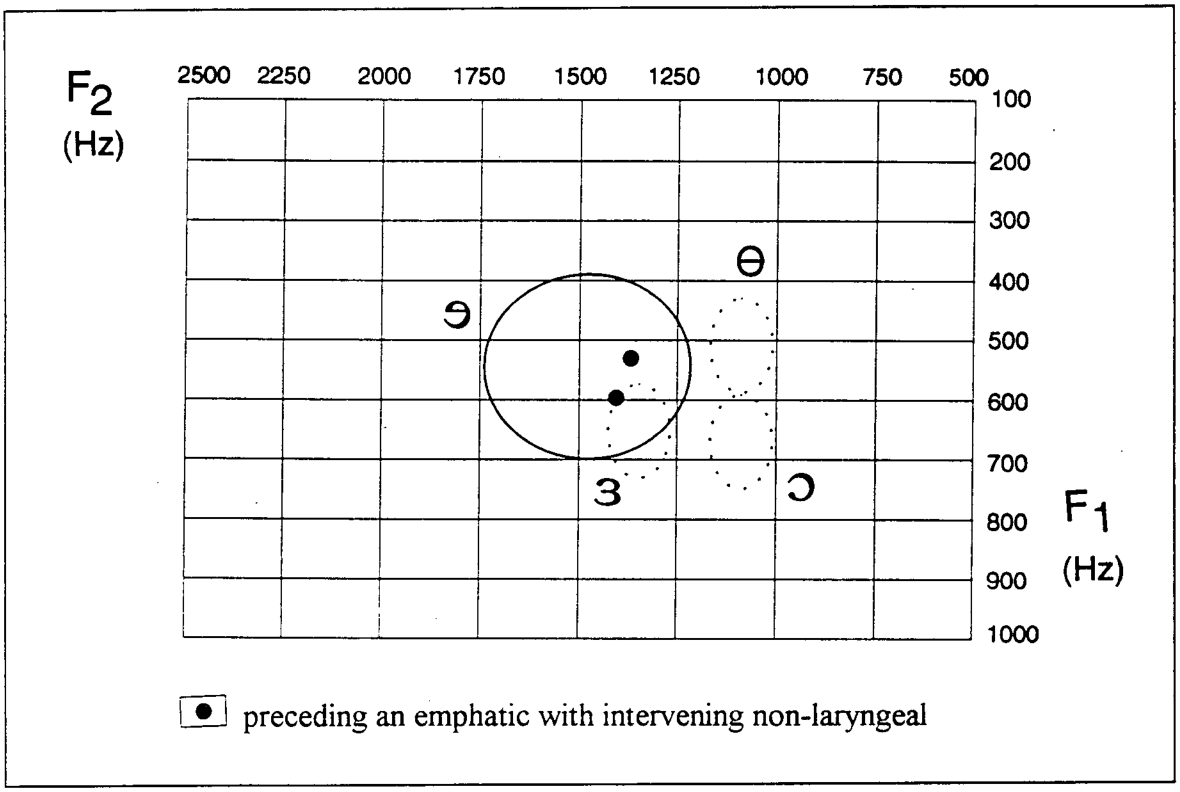


Figure 3:48 F_1 - F_2 plot of tokens of the St'át'imcets epenthetic vowel in the context: preceding an emphatic with intervening non-laryngeal. Speaker: LC.

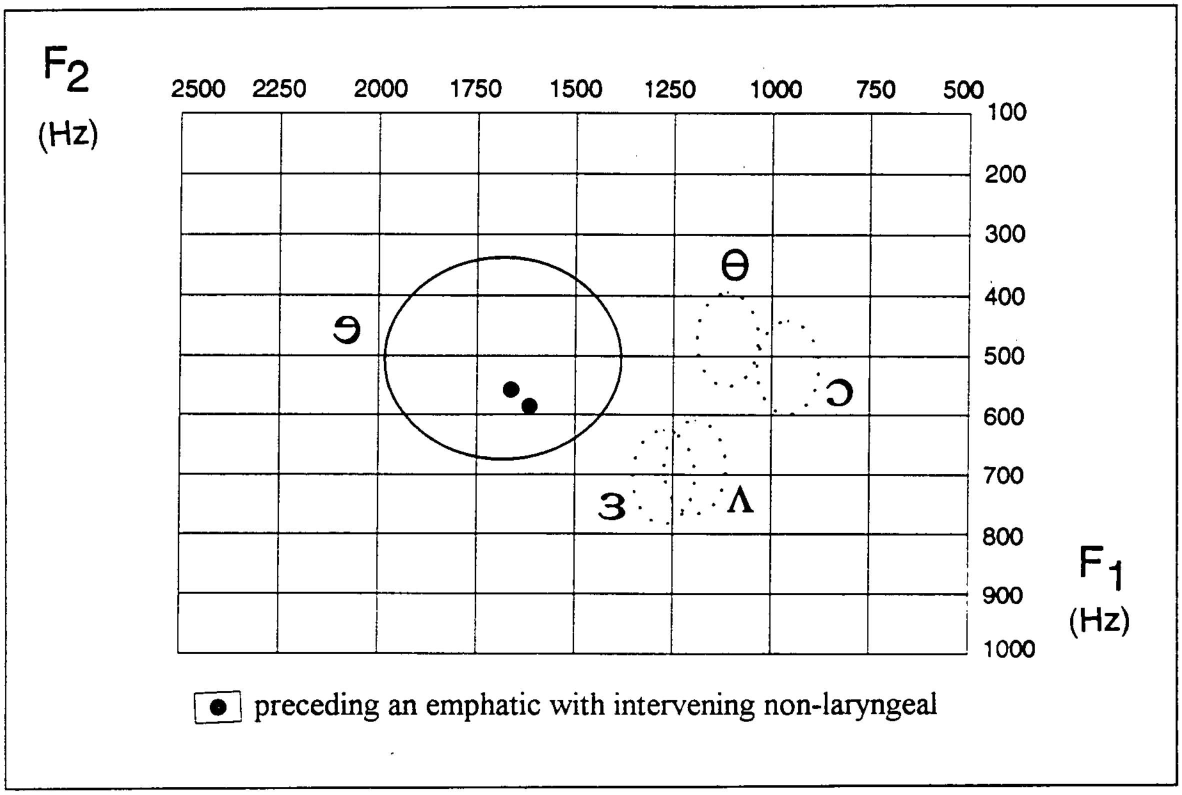


Figure 3:49 F_1 - F_2 plot of tokens of the St'át'imcets epenthetic vowel in the context: preceding an emphatic with intervening non-laryngeal. Speaker: LN.

As seen, the tokens in Figures 3:48 and 3:49 are all non-back. This supports the phonological claim that the epenthetic vowel uvularises only immediately preceding an emphatic (or preceding an emphatic with an intervening laryngeal).

Figure 3:50 presents a wideband spectrogram showing two tokens of /ʧ/: one occurred in a word containing no emphatic; the other occurred preceding an emphatic with a vowel intervening between the /ʧ/ and the emphatic. The carrier forms are identified in the figure caption, which also reports the frequency of the spectral peaks for each [ʧ].

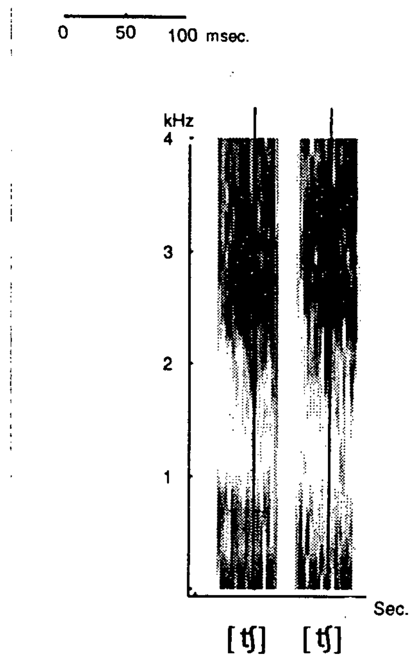


Figure 3:50 Wideband spectrogram of tokens of St'át'imcets /ʧ/ in non-uvularisation contexts. The token on the left is a token of /ʧ/ in { ʁəʧ-n } 'to tie something (intr., tr.)'. The token on the right is a token of /ʧ/ in { m i ʧ ɑ -'-k̟ } [m i ʧ ɑ ʔ k̟] 'to assume a sitting position'. (Spectral peaks measured at the points indicated by the vertical lines.)
Spectral Peaks of the [ʧ] on the left: 588 Hz, 1895 Hz.
Spectral Peaks of the [ʧ] on the Right: 540 Hz, 1910 Hz.

In Figure 3:50, the spectral peaks of both [ʧ]s are very similar. In particular, compared to data on surface emphatic { ʧ̟ } to be presented shortly in Figure 3:57, no lowered resonance in the second formant region is observed for the [ʧ] which occurred preceding an emphatic with an intervening vowel. This supports the assumption that both [ʧ]s in Figure 3:50 were not produced with a uvularisation gesture. This, in turn, supports the phonological claim that St'át'imcets /tʃ/ does not uvularise when non-immediately preceding an emphatic.

Figures 3:51 - 3:53 replot a subset of the data in Figures 3:44 - 3:47: those tokens which occurred in the contexts: immediately preceding an emphatic vs. immediately following an emphatic.

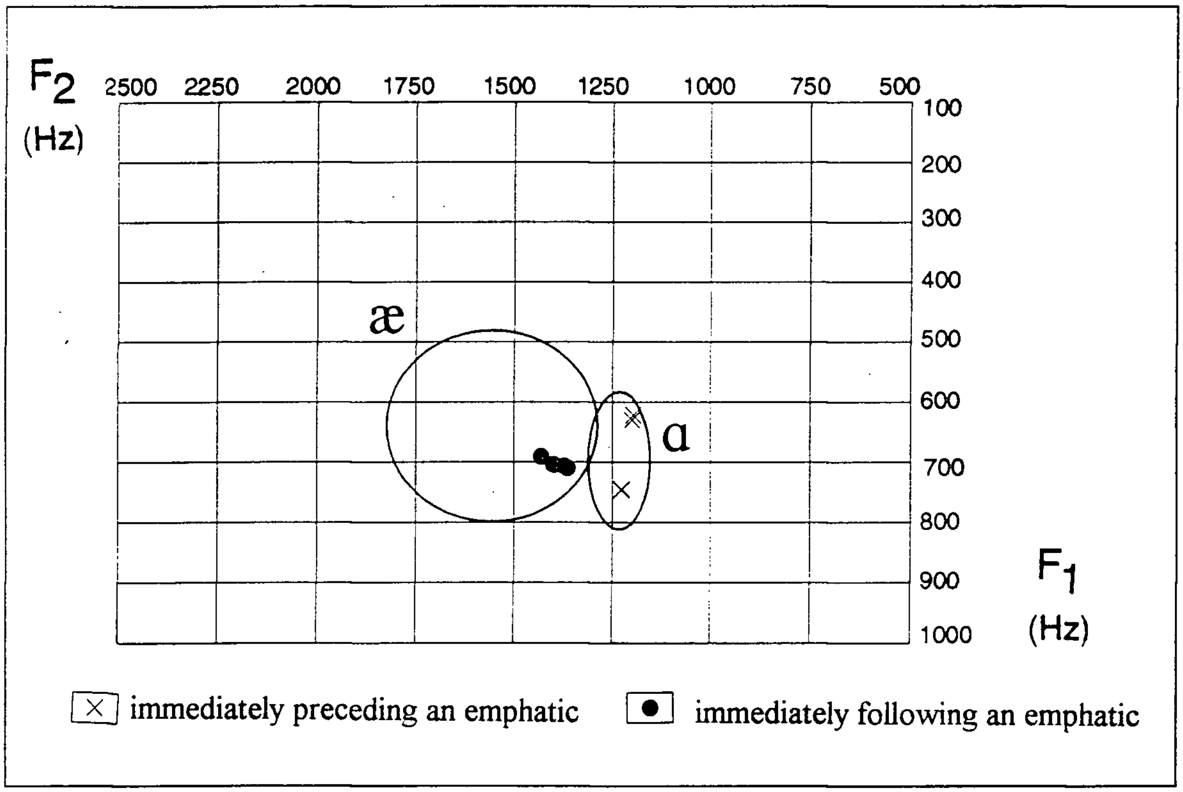


Figure 3:51 F_1 - F_2 plot of tokens of St'át'imcets /Æ/ in the contexts: immediately preceding an emphatic vs. immediately following an emphatic. Speaker: LC.

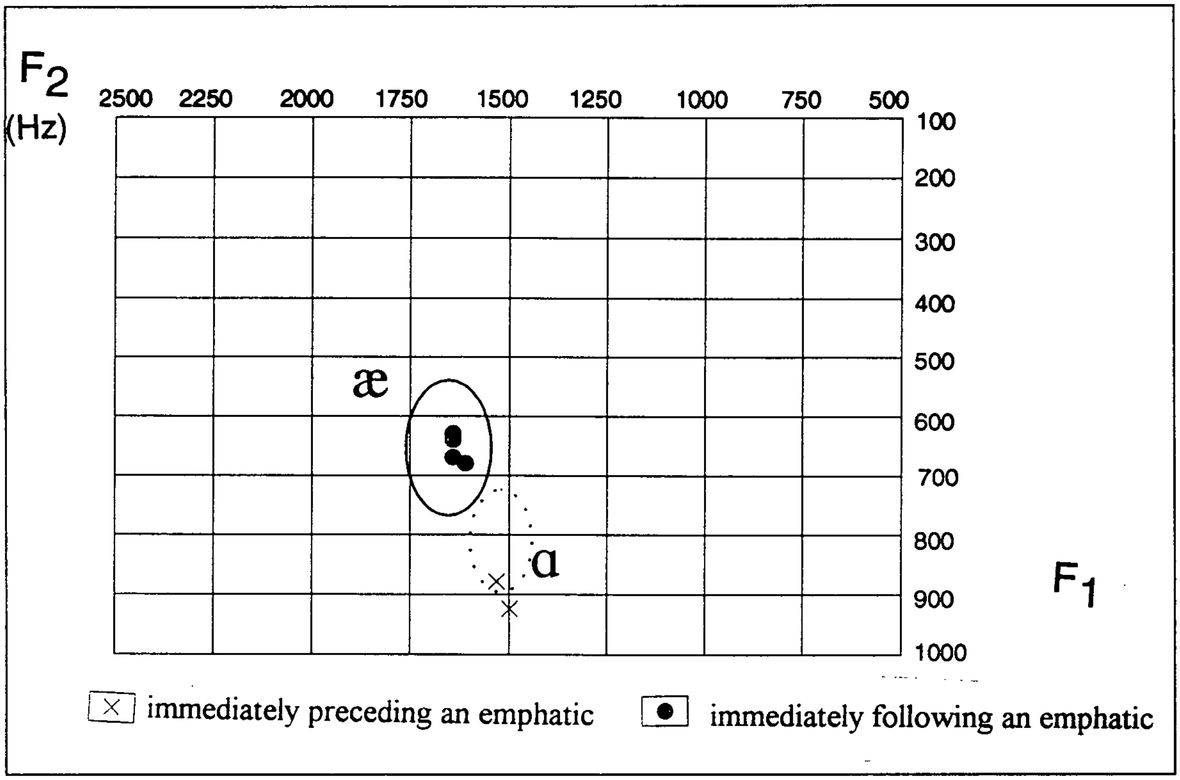


Figure 3:52 F_1 - F_2 plot of tokens of St'át'imcets /Æ/ in the contexts: immediately preceding an emphatic vs. immediately following an emphatic. Speaker: LN.

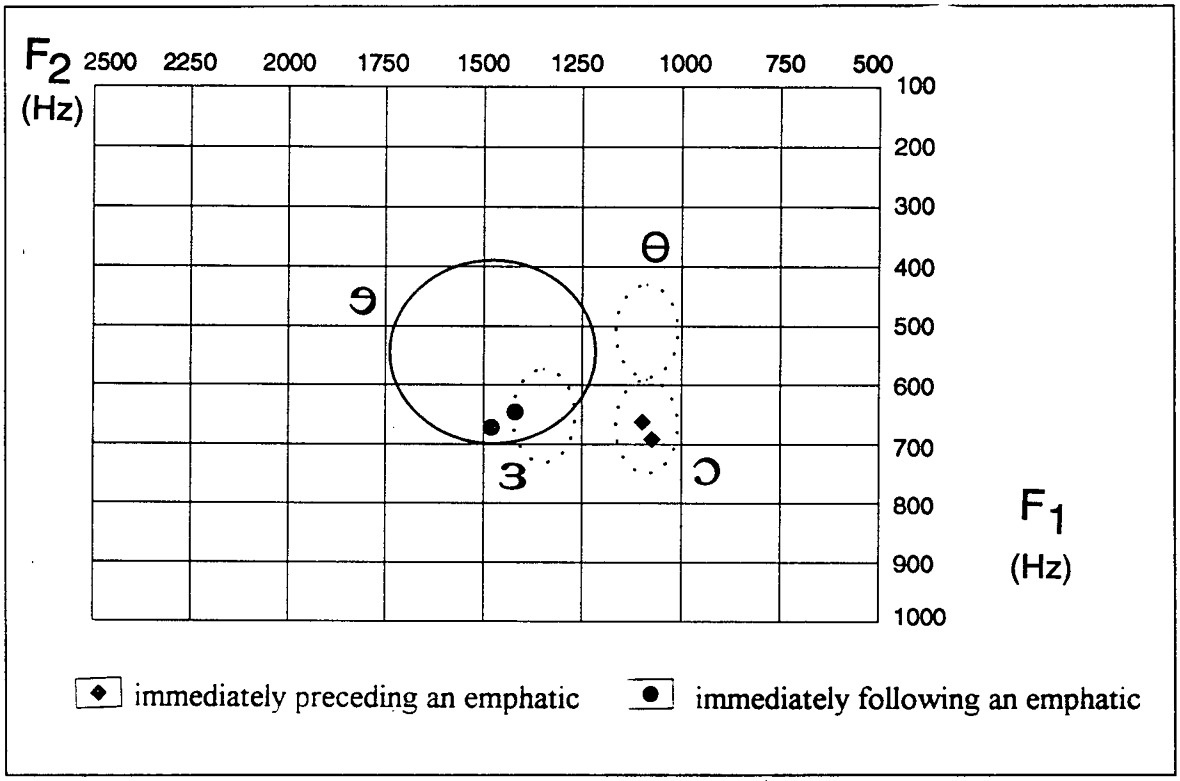


Figure 3:53 F_1 - F_2 plot of tokens of the St'át'imcets epenthetic vowel in the contexts: immediately preceding an emphatic vs. immediately following an emphatic. Speaker: LC.

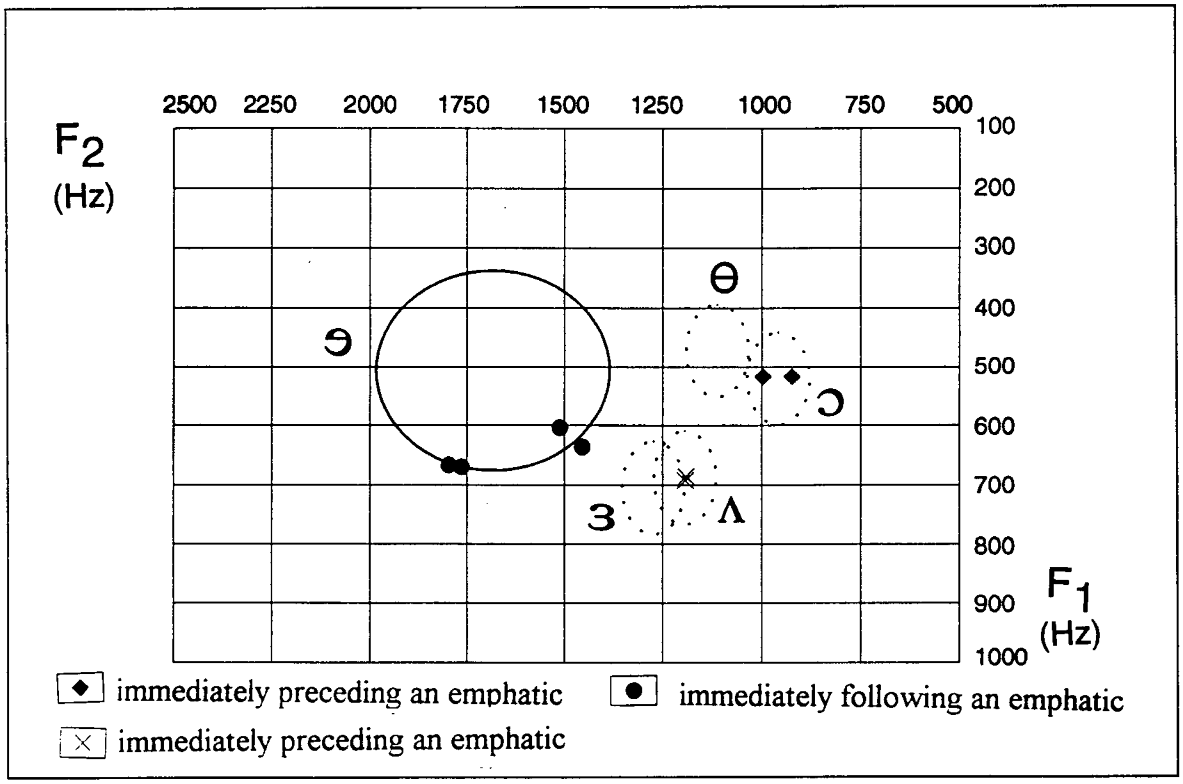


Figure 3:54 F_1 - F_2 plot of tokens of the St'át'imcets epenthetic vowel in the contexts: immediately preceding an emphatic vs. immediately following an emphatic. Speaker: LN.

In Figures 3:51 - 3:54, the tokens immediately preceding an emphatic are back. The tokens immediately following an emphatic are non-back. As seen, the back tokens have a lowered F_2, compared to F_2 of the non-back tokens, per vowel. This provides some support for an assumption that the tokens which occurred immediately preceding an emphatic were produced with a uvularisation articulation that the tokens which occurred immediately following an emphatic lacked. This supports the phonological claims that /Æ/ and the epenthetic vowel uvularise immediately preceding an emphatic, and do not uvularise immediately following an emphatic.

3.5.1. Harmony with an Emphatic

Figure 3:55 presents a wideband spectrogram showing two tokens of /Æ/: a token of non-back {æ} and a token of back {ɑ}. Figure 3:56 presents a wideband spectrogram showing two tokens of the epenthetic vowel: a token of non-back {ɘ} and a token of back {ɔ}. The carrier forms are identified in the figure captions, which also record F_1 and F_2 of each vowel. In Figure 3:55, F_2 of [ɑ] is about 100 Hz lower than F_2 of [æ]. The F_2 difference for [ɑ] vs. [æ] is slight; this illustrates the general finding of this study, that tokens of St'át'imcets {ɑ} are phonetically central rather than back. In Figure 3:56, F_2 of [ɔ] is about 950 Hz lower than F_2 of [ɘ].

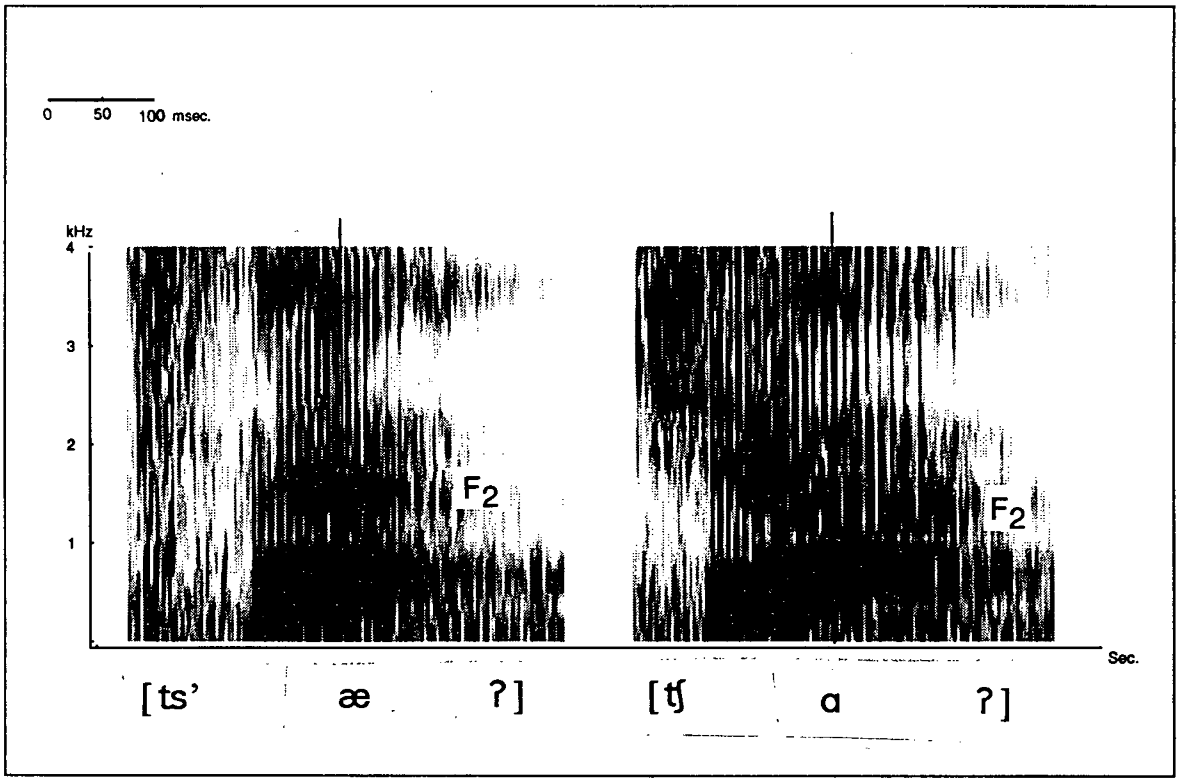


Figure 3:55 Wideband spectrogram of tokens of St'át'imcets /Æ/ in a non-uvularisation vs. uvularisation context. The token on the left is a loken of /Æ/ {æ} in {ʁʷuj't-itʃ'æʔ} 'pajamas, nightie'. The token on the right is a token of /Æ/ {ɑ} in {mitʃɑ-'-ḳ} 'to assume a sitting position'. (Formants measured at the points indicated by the vertical lines.)
[æ]: F_1 = 581 Hz; F_2 = 1439 Hz.
[ɑ]: F_1 = 692 Hz; F_2 = 1343 Hz.

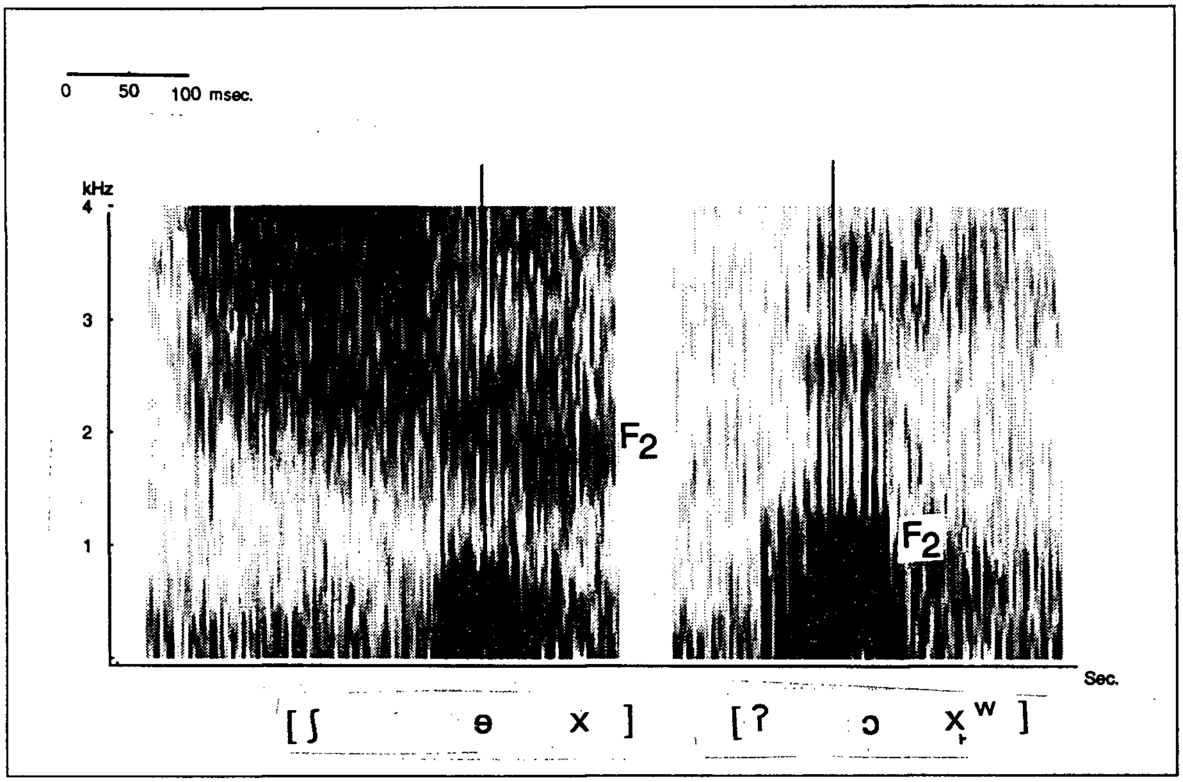


Figure 3:56 Wideband spectrogram of tokens of the St'át'imcets epenthetic vowel in a non-uvularisation vs. uvularisation context. The token on the left is a token of epenthetic {ə} in {ʃəx-ʃəx} 'partly crazy'. The token on the right is a token of epenthetic {ɔ} in {ʔɔx̣ʷʔ-un} 'to cough'.
[ə]: $F_1 = 353$ Hz; $F_2 = 1950$ Hz.
[ɔ]: $F_1 = 533$ Hz; $F_2 = 1004$ Hz.

The spectrograms show that the lowered F_2 of uvularised [ɑ] and [ɔ] are reached and maintained for a steady state. (For a spectrogram showing that the lowered F_2 of uvularised [ʌ] is also reached and maintained, see Figure 3:16.) This is interpreted as support for attributing their uvularisation to some discrete phonological feature, as discussed in §3.4.1. It contrasts with the acoustic effect of a uvularisation context on high vowels, as will be discussed in §3.5.3.2.

Figure 3:57 presents a wideband spectrogram of two tokens of /tʃ/. One token, seen earlier in Figure 3:50, occurred in a word containing no emphatic. The other occurred immediately preceding an emphatic and is emphatic [tʃ̙]. The carrier forms are identified in the figure caption. The frequency of the spectral peak of the [tʃ] and [tʃ̙] are also reported. The arrow seen in the spectrogram will be explained shortly.

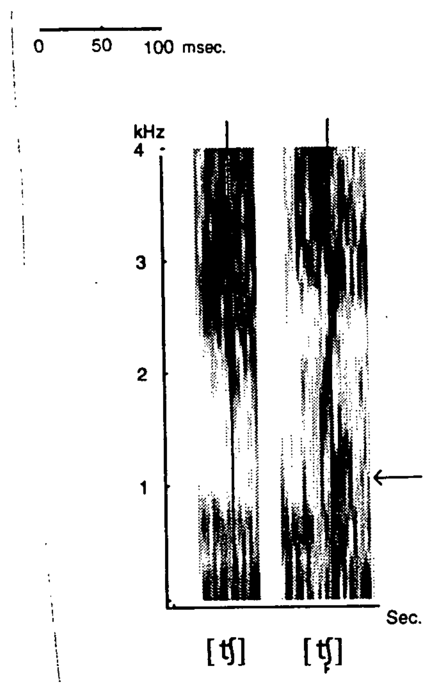


Figure 3:57 Wideband spectrogram of tokens of St'át'imcets /tʃ/ in a non-uvularisation vs. uvularisation context. The token on the left is a token of /tʃ/ {tʃ} in {ʁətʃ-ən} 'to tie something (intr., tr.)'. The token on the right is a token of /tʃ/ {tʃ̙} in {ʁətʃ̙-k̙in-upʔ-æm} 'to lead horses by tying them to the tail of the horse in front'. (Spectral peaks measured at the points indicated by the vertical lines.)

Spectral Peaks of [tʃ]: 588 Hz, 1895 Hz.

Spectral Peaks of [tʃ̙]: 565 Hz, 1050 Hz, 1600 Hz.

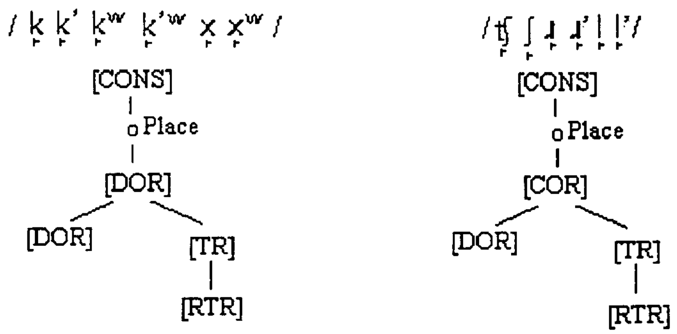
In Figure 3:57, the spectral peaks of the surface emphatic [tʃ̙] are different from those of non-emphatic [tʃ]: while both tokens have a low peak between 565 and 590 Hz, a peak corresponding to that at 1895 Hz for [tʃ] is observed at 1600 Hz for [tʃ̙]. In addition, a peak which is absent for non-emphatic [tʃ] is observed for emphatic [tʃ̙] at 1050 Hz. The arrow in the spectrogram draws attention to it.

The 1050 Hz peak of [tʃ̙] is analysed here as a lowered resonance (in the region of a second formant) in the context of the immediately following underlying emphatic /k̙/. This supports the assumption that the [tʃ̙] was produced with a uvularisation articulation that the non-emphatic [tʃ] lacked. This, in turn, supports the phonological claim that St'at'imcets /tʃ/ uvularises immediately preceding an emphatic.

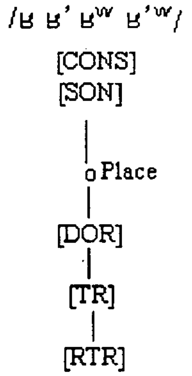
3.5.2. A Theoretical Account: Part I

The representations of the St'át'imcets emphatics, proposed earlier in (44), are repeated in (73). The representation of the uvular gutturals, proposed in (43), is repeated in (74).

(73) The Representations of St’át’imcets Emphatics
a. dorsal emphatics b. coronal emphatics



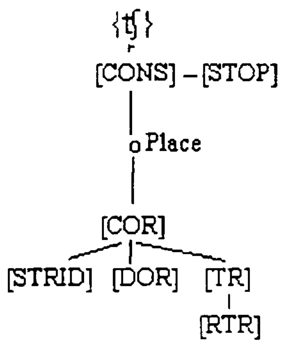
(74) The Representation of St’át’imcets Uvular Gutturals



The uvular gutturals do not trigger uvularisation harmony; this was shown in (66). Because of this, St’át’imcets uvularisation harmony is here identified as [DOR] + [RTR] ‘AS’ harmony. That is, it is harmony of [DOR] and [RTR] triggered by segments which are specified for [DOR] and [RTR] as secondary specifications. As seen from (73) and (74), this criterion is met only by the emphatics. In §2.5.2, Palestinian uvularisation harmony was also identified as [DOR] + [RTR] AS harmony.

A segment which undergoes uvularisation harmony is here claimed to receive specification for both secondary-[DOR] and secondary-[RTR]. It is assumed that, when co-occurring, those features represent secondary uvular articulation; see §2.3.1 for further discussion. This representational change is illustrated with (/tʃ/ →) {tʃ̙} below:

(75)



For vowels, the addition of [DOR] yields the five new output vowels seen boxed in (76). They are specified for both [DOR] and [RTR], which are represented with secondary status. Of the five new vowels, only the ones seen in double box, {ʌ ɔ ɑ}, are licit.

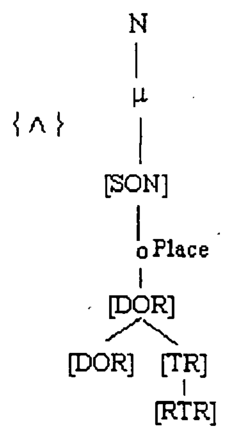
(76)

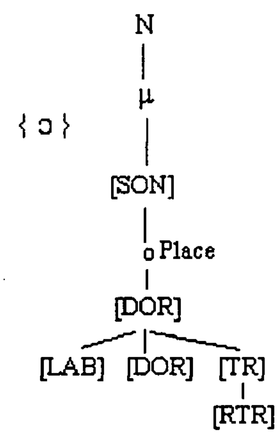
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	ɘ	ɜ	ʌ	ɵ	ɞ	ɔ	i	ɪ	ɪ	æ	a	ɑ	u	ʊ	ʊ>
HI							+	+	+				+	+	+
LO										+	+	+			
LAB				+	+	+							+	+	+
RTR		+	+		+	+		+	+		+	+		+	+
DOR			+			+			+			+			+

In §3.5.4, it will be argued that feature sets 9 and 15 in (76) are ruled out by the grounded constraint HI/*Sec-DOR ∧ Sec-RTR ('A segment specified for [HI] is not specified for secondary-[DOR] and secondary-[RTR]'), which is very highly ranked in St'át'imcets.

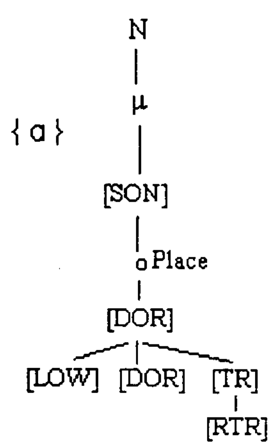
The representations of the uvularised variants of the epenthetic vowel are seen in (77). The representation of the uvularised variant of /Æ/ is seen in (78).

(77) The Representations of the Uvularised Variants of the St'át'imcets Epenthetic Vowel





(78) The Representation of the Uvularised Variant of St'át'imcets /Æ/



3.5.2. A Theoretical Account: Part I

Under the present assumptions, secondary-[RTR] is an integral part of the representation of a uvularised segment. An automatic consequence of this is that any uvularised segment is also pharyngealised; see §2.3.1 for further discussion. For this reason, the uvularised vowels {ʌ ɔ ɑ} are also pharyngealised. This is the basis of the claim made in §3.2.2, that St'át'imcets has no non-rtr back vowels.

I propose that the harmony properties shown by (66), (67), and (69) are the effect of the constraints in (79), in conjunction with DEP-IO, MAX-RTR, MAX-LINK, and DEP-LINK, which were explained in §3.4.2. (In (79), after McCarthy and Prince (1995), 'S_1' and 'S_2' refer to the input string and output string, respectively.)

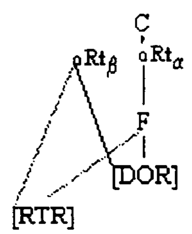
(79) a. α—Sec-[DOR] $\wedge$ Sec-[RTR]/ALIGN-L(Sec-[DOR] $\wedge$ Sec-[RTR], Rt_β)
Let α be a root node in S_1 or its correspondent in S_2. Let β be a different root node.
If α is secondary-[DOR] and secondary-[RTR] in S_1, then the left edge of secondary-[DOR] and the left edge of secondary-[RTR] are aligned with the left edge of β.

b. α—Sec-[DOR] $\wedge$ Sec-[RTR]/ALIGN-R(Sec-[DOR] $\wedge$ Sec-[RTR], Rt_β)
Let α be a root node in S_1 or its correspondent in S_2. Let β be a different root node.
If α is secondary-[DOR] and secondary-[RTR] in S_1, then the right edge of secondary-[DOR] and the right edge of secondary-[RTR] are aligned with the right edge of β.

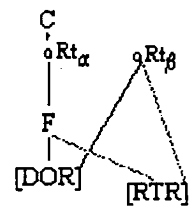
When unviolated, the constraints in (79) effect the edge alignments seen in (80), in which 'C̡' denotes an emphatic consonant and 'F' stands for some articulator feature.

3.5.2. A Theoretical Account: Part I

(80) a. the effect of unviolated
α—Sec-[DOR] $\wedge$ Sec-[RTR]/
ALIGN-L(Sec-[DOR], Rt_β)



b. the effect of unviolated
α—Sec-[DOR] $\wedge$ Sec-[RTR]/
ALIGN-R(Sec-[DOR], Rt_β)



For a feature specified on α to be left aligned with a particular edge of β, α and β must be adjacent. Thus, by specifying alignment for β vs. α, the α—Sec-[DOR] $\wedge$ Sec-[RTR]/ALIGN-L(Sec-[DOR] $\wedge$ Sec-[RTR], Rt_β) constraint requires secondary-[DOR] and secondary-[RTR] to surface left-aligned with a segment which left-adjacent to an underlyingly secondary-[DOR] and secondary-[RTR] segment. (Segment' is here used synonymously with 'root node'.) In parallel manner α—Sec-[DOR] $\wedge$ Sec-[RTR]/ALIGN-R(Sec-[DOR] $\wedge$ Sec-[RTR], Rt_β) requires secondary-[DOR] and secondary-[RTR] to surface right-aligned with a segment which right-adjacent to an underlyingly secondary-[DOR] and secondary-[RTR] segment.

The constraints in (79) are conjunctive, as they each require alignment of secondary-[DOR] and alignment of secondary-[RTR]. Their conjunctive formulation is based on the arguments presented in §2.5.6, that co-occurring secondary-[DOR] and secondary-[RTR], the representation of uvularisation, are referred to as a unit in phonology.

The data in (66), (67), and (69) indicate the ranking:

3.5.2. A Theoretical Account: Part I

(81) DEP-IO, MAX-RTR, MAX-DOR, MAX-LINK >>

α—Sec-[DOR] $\wedge$ Sec-[RTR]/ALIGN-L(Sec-[DOR] $\wedge$ Sec-[RTR], Rt_β) >>

DEP-LINK >>

α—Sec-[DOR] $\wedge$ Sec-[RTR]/ALIGN-R(Sec-[DOR] $\wedge$ Sec-[RTR], Rt_β)

The constraint interaction resulting from (81) is illustrated by the tableaux in (82) and (83). (All candidates in (81) incur a violation of IO-FAITH (DEP-IO) for the epenthetic vowel which occurs immediately preceding /x̣/. That violation is forced by very highly ranked σNUC, which is not included in the tableaux.)

(82)

input: /tx̣/ /\\ [DOR] [RTR] 'bitter'; see (67)	I-O FAITH	α—Sec-[DOR] $\wedge$ Sec-[RTR]/ ALIGN-L(Sec-[DOR] $\wedge$ Sec-[RTR], Rt_β)	DEP-LINK	α—Sec-[DOR] $\wedge$ Sec-[RTR]/ ALIGN-R(Sec-[DOR] $\wedge$ Sec-[RTR], Rt_β)
1. {təx}	**!***			
2. {təx̣} /\\ [DOR] [RTR]	*	*!		*
☞ 3. {tʌx̣} [RTR] [DOR]	*		**	*
4. {tʌx̣ʌ} [RTR] [DOR]	**!		****	

(83)

input: /x̣ʷÆʔʃ/ [DOR] [RTR] 'sockeye salmon' (Upper dialect); see (69)	I-O FAITH	α—Sec-[DOR] $\wedge$ Sec-[RTR]/ ALIGN-L(Sec-[DOR] $\wedge$ Sec-[RTR], Rt$_\beta$)	DEP-LINK	α—Sec-[DOR] $\wedge$ Sec-[RTR]/ ALIGN-R(Sec-[DOR] $\wedge$ Sec-[RTR], Rt$_\beta$)
1. {xʷæʔʃ}	*!***			
☞ 2. {x̣ʷæʔʃ} [DOR] [RTR]		*		*
3. {xʷɑʔʃ} [RTR] [DOR]		*	*!*	
4. {ʌxʷɑʔʃ} [RTR] [DOR]	*!		****	
5. {ʌxʷæʔʃ} [RTR] [DOR]	*!		**	*

In candidate 4 in (82) and candidates 4 and 5 in (83), a vowel is epenthesised to provide a segment left-adjacent to the emphatic. The vowel harmonises, in satisfaction of α—Sec-[DOR] $\wedge$ Sec-[RTR]/ALIGN-L(Sec-[DOR] $\wedge$ Sec-[RTR], Rt$_\beta$). However, because of the epenthesis, those candidates incur a violation of DEP-IO which is not incurred by the winning candidates 3 and 2 in the respective tableaux. The losing status of candidates 4 in (83) and 4 and 5 in (83) shows that violation of DEP-IO is more serious than violation of α—Sec-[DOR] $\wedge$ Sec-[RTR]/ALIGN-L(Sec-[DOR] $\wedge$ Sec-[RTR], Rt$_\beta$), and establishes DEP-IO >> α—Sec-[DOR] ∧ Sec-[RTR]/ALIGN-L(Sec-[DOR] ∧ Sec-[RTR], Rt_β).

The data that have been examined provide no evidence that the MAX constraints and DEP-IO are crucially ranked with respect to each other. For this reason, they are assigned non-crucial equal ranking in (81).

The winning candidate 3 in (82) contains non-underlying links between a left-adjacent segment and [DOR] and [RTR] in satisfaction of α—Sec-[DOR] ∧ Sec-[RTR]/ALIGN-L(Sec-[DOR] ∧ Sec-[RTR], Rt_β), but in multiple violation of DEP-LINK. Candidate 2 in the same tableau lacks such non-underlying links. By result, it violates α—Sec-[DOR] ∧ Sec-[RTR]/ALIGN-L(Sec-[DOR] ∧ Sec-[RTR], Rt_β) but satisfies DEP-LINK. The fact that candidate 2 loses and candidate 3 wins shows that violation of DEP-LINK is less serious than violation of the left alignment constraint. This establishes α—Sec-[DOR] ∧ Sec-[RTR]/ALIGN-L(Sec-[DOR] ∧ Sec-[RTR], Rt_β) >> DEP-LINK.

In candidate 4 in (82) and candidates 3 and 4 in (83), the segment right-adjacent to the emphatic harmonises, in satisfaction of α—Sec-[DOR] ∧ Sec-[RTR]/ALIGN-R(Sec-[DOR] ∧ Sec-[RTR], Rt_β). However, the rightward harmony results in two violations of DEP-LINK which are not incurred by the winner in the respective tableaux. The fact that candidate 4 in (82) and candidates 3 and 4 in (83) are non-optimal shows that violation of DEP-LINK is more serious than violation of the right alignment constraint. Hence, DEP-LINK >> α—Sec-[DOR] ∧ Sec-[RTR]/ALIGN-R(Sec-[DOR] ∧ Sec-[RTR], Rt_β).

3.5.2. A Theoretical Account: Part I

In §2.5.2, ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L) and ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], R; Wd, R) were proposed as the constraints responsible for the across-the-word effects of Palestinian uvularisation harmony. The first requires that the left edge of the word be aligned with the left edges of any co-occuring secondary-[DOR] and secondary-[RTR]. The second requires the same for the right edge of the word. The data in (72) showed that St'át'imcets leftward harmony does not extend to the left edge of the word. (The data in (71) showed that the word is the harmony domain.) This indicates that ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L) is lowly ranked in St'át'imcets. That is, it is ranked with the other uvularisation harmony constraints as seen in (84). ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L) is assumed to be non-crucially equally ranked with α—Sec-[DOR] $\wedge$ Sec-[RTR]/ALIGN-R(Sec-[DOR] $\wedge$ Sec-[RTR], Rt_β), as the data which have been examined provide no evidence for a crucial ranking between the them ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], R; Wd, R) is assumed non-crucial equal ranking with the two constraints just mentioned, although further investigation of the rightward harmony illustrated by (70) might reveal its actual ranking to be different.

(84) DEP-IO, MAX-RTR, MAX-DOR, MAX-LINK >>

α—Sec-[DOR] $\wedge$ Sec-[RTR]/ALIGN-L(Sec-[DOR] $\wedge$ Sec-[RTR], Rt_β) >>

DEP-LINK >>

α—Sec-[DOR] $\wedge$ Sec-[RTR]/ALIGN-R(Sec-[DOR] $\wedge$ Sec-[RTR], Rt_β),
ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L),
ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], R; Wd, R)

3.5.2. A Theoretical Account: Part I

The surface effect of this ranking is seen in the tableau in (85). (In (85), 'ALIGN-Sec-DOR-Sec-RTR-Wd' abbreviates ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L) and ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], R; Wd, R). A violation of these constraints is evaluated for each non-harmonising vowel, /ʧ/, or /n/. Each candidate violates DEP-IO because of the vowel epenthesis. The winner is marked by '☞'.)

(85)

input: /mxÆɹ/ / \\ [DOR] [RTR] 'huckleberry' (Lower dialect; see (72)	I-O FAITH	α—Sec-[DOR] $\wedge$ Sec-[RTR]/ ALIGN-L (Sec-[DOR] $\wedge$ Sec-[RTR], Rt_β)	DEP-LINK	α—Sec-[DOR] $\wedge$ Sec-[RTR]/ ALIGN-R (Sec-[DOR] $\wedge$ Sec-[RTR], Rt_β)	ALIGN-Sec-DOR-Sec-RTR-Wd
1. { məxæɹ}	**!** *				
2. { məxæɹ} / \\ [DOR] [RTR]	*	*!		*	**
☞ 3. { məxɑɹ} [RTR] [DOR]	*		**	*	*
4. { mʌxɑɹ} [RTR] [DOR]	*		***! ***	*	

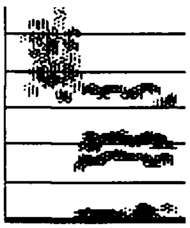
3.5.3. Neutral High Vowels

3.5.3.1. Analysis

St'át'imcets high vowels do not undergo uvularisation harmony. This claim is based on phonetic findings to be discussed in §3.5.3.2. Non-harmonising high vowels are seen in (86): the high vowels surface rtr due to pharyngealisation harmony with the immediately following emphatic, but not backed, as seen from the ungrammatical forms. (A tableau for (86a) will be presented in §3.5.4.)

(86) a. IPA /mIx̙Æɬ/	{mɪx̙æɬ}	(*{mɨx̙æɬ})	'black bear'
NA /mIx̌Æɬ/	{mịx̌aɬ}		
b. IPA /t͡ɬ'Ik̙/	{t͡ɬ'ɪk̙}	(*{t͡ɬ'ɨk̙})	'to arrive (here)'
NA /ƛ'Iq/	{ƛ'ịq}		
c. IPA /tʃ'Uk̙ʷÆɹ̙/	{tʃ'ʊk̙ʷɑɹ̙}	(*{tʃ'ʊ˃k̙ʷɑɹ̙})	'fish, (any kind of) salmon'
NA /c'UqʷÆẓ/	{c'ụqʷÆẓ}		

As St'át'imcets uvularisation harmony affects only the segment which is left adjacent to an emphatic, whether or not the high vowels are opaque or transparent to the harmony is untestable.



3.5.3.2. Acoustic Support

Figure 3:58 presents a wideband spectrogram showing three tokens of St'át'imcets /I/. The token on the left is a token of /I/ {ɪ} in a non-uvularisation context; the other two are tokens of /I/ {ɪ} in a uvularisation context. The carrier forms are identified in the figure caption which also reports the F_2 of each vowel, measured at onset and at the third quarter of the vowel (that is, at halfway between onset and midpoint for the leftmost token, and at halfway between midpoint and offset for the other two tokens.) For the middle token in the spectrogram, a second formant maximum is observed between onset and the third quarter. For that token, F_2 at the maximum is also reported.

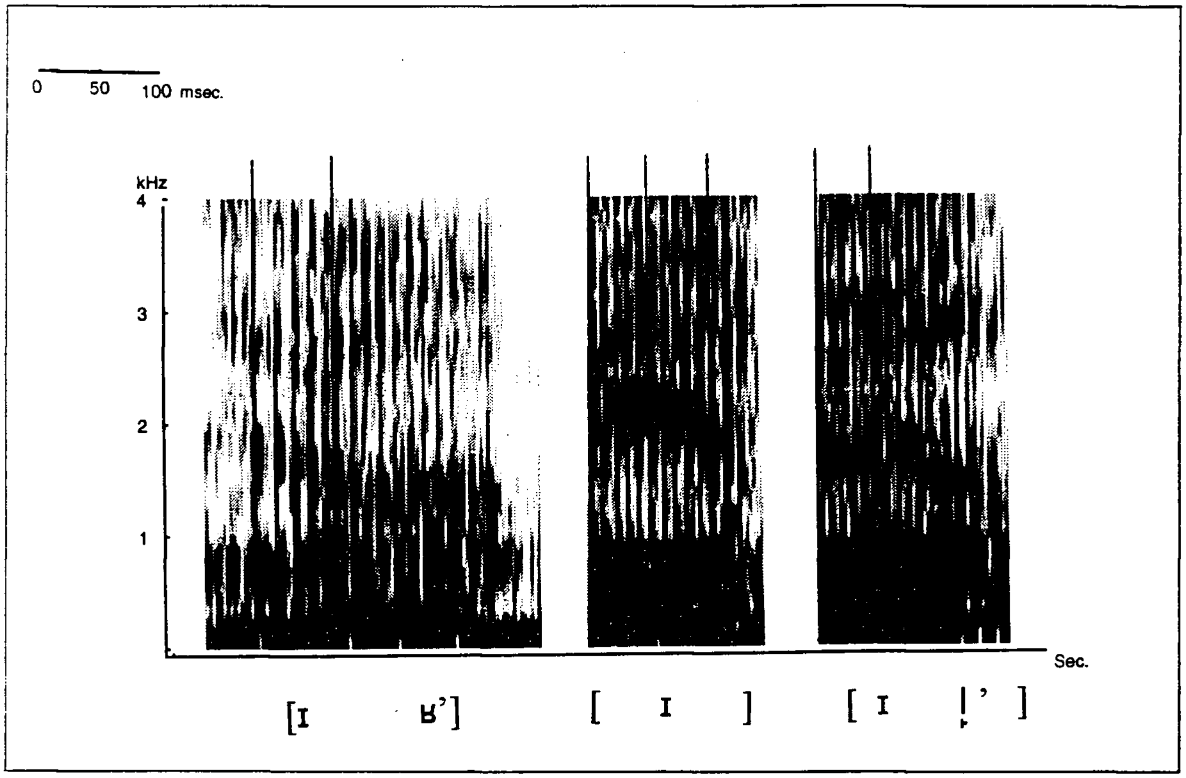


Figure 3:58 Wideband spectrogram of tokens of St’át’imcets /I/ in a non-uvularisation vs. uvularisation context. The token on the left is the a token of /I/ {ɪ} in {ɬɪ-’-ʁ’} [ɬɪʔɪʁ’] ‘to scatter (e.g., people leaving from a gathering)’ (rightmost phonetic [ɪ]). The one in the middle is a token of /I/ {ɪ} in {t͡ɬ’ɪḳ} ‘to arrive (here)’. The one on the right is a token of /I/ {ɪ} in {ḳʌ̣l-ɰʷɪḷ’x} ‘to get spoiled (e.g., meat, potatoes), to break down (car, wagon)’. (Formants measured at the points indicated by the vertical lines.)

F_2 of [ɪ] on the left: at onset = 1848 Hz, at third quarter = 1571 Hz.

F_2 of [ɪ] in the middle: at onset = 2027 Hz, at maximum = 2062 Hz, at third quarter = 1777 Hz.

F_2 of [ɪ] on the right: at onset = 1681 Hz, at third quarter = 1764 Hz.

None of the [ɪ]s in Figure 3:58 has a steady F_2. That is, the second formant of each [ɪ] is a trajectory from higher at onset to lower at the third quarter, or from lower at onset to higher at the third quarter. For the middle [ɪ] in the spectrogram, F_2 varies from lower at onset to higher at the second formant maximum to lowest at the third quarter.

The lack of a steady F_2 for the two [ɪ]s in a uvularisation context is here interpreted as indicating that /I/ has no emphatic target. The high vowel /I/ thus contrasts with the non-high vowels, which have an emphatic target, as illustrated in Figures 3:16, 3:55 and 3:56. This supports the phonological claim that, like Palestinian non-low vowels, St'át'imcets high vowels do not undergo uvularisation harmony. (See §2.5.5.2 for data showing a lack of emphatic target for Palestinian non-low vowels.) Any transitional lowered F_2 effect which might be observed for some tokens of the high vowels in the context of an emphatic is here considered not to result from a phonological effect, but to be due solely to the phonetics.

3.5.4. A Theoretical Account: Part II

I propose that the non-harmony of high vowels observed in (86) is the effect of the grounded constraint HI/*Sec-DOR ∧ Sec-RTR, which says 'A segment specified for [HI] is not specified for secondary-[DOR] and secondary-[RTR]'. This constraint was proposed for Palestinian Arabic in §2.5.6 as paradigmatically grounded in the incompatibility of simultaneous high and uvularised gestures. The fact that St'át'imcets high vowels immediately preceding an emphatic do not undergo uvularisation harmony shows that HI/*Sec-DOR ∧ Sec-RTR is ranked above α—Sec-[DOR] ∧ Sec-[RTR]/ALIGN-L(Sec-[DOR] ∧ Sec-[RTR], Rt_β).

The adjusted constraint ranking for St'át'imcets uvularisation harmony is seen in (87). The data which have examined provide no evidence that HI/*Sec-DOR ∧ Sec-RTR is crucially ranked with respect to DEP-IO, MAX-RTR, MAX-DOR, or MAX-LINK. Because of this, these five constraints are assumed to be non-crucially equally ranked.

(87) DEP-IO, MAX-RTR, MAX-DOR, MAX-LINK, HI/*Sec-DOR ∧ Sec-RTR >>

α—Sec-[DOR] ∧ Sec-[RTR]/ALIGN-L(Sec-[DOR] ∧ Sec-[RTR], Rt_β) >>

DEP-LINK >>

α—Sec-[DOR] ∧ Sec-[RTR]/ALIGN-R(Sec-[DOR] ∧ Sec-[RTR], Rt_β),
ALIGN(Sec-[DOR] ∧ Sec-[RTR], L; Wd, L),
ALIGN(Sec-[DOR] ∧ Sec-[RTR], R; Wd, R)

The surface effect of HI/*Sec-DOR ∧ Sec-RTR is illustrated in (88). (The constraint interaction effecting the pharyngealisation of the initial-syllable vowel is ignored in the tableau.)

(88)

input: /mIxÆɬ/ [DOR] [RTR] 'black bear'; see (86)	I-O FAITH	HI/ *Sec-DOR ∧ Sec-RTR	α—Sec-[DOR] ∧ Sec-[RTR]/ ALIGN-L (Sec-[DOR] ∧ Sec-[RTR], Rt_β)	DEP-LINK	α—Sec-[DOR] ∧ Sec-[RTR]/ ALIGN-R (Sec-[DOR] ∧ Sec-[RTR], Rt_β)	ALIGN-Sec-DOR-Sec-RTR-Wd
1. { mixæɬ }	*!***					
☞ 2. { mɪxæɬ } [DOR] [RTR]			*		*	**
3. { mɪxæɬ } [DOR] [RTR]		*!		**	*	*
4. { mɪxɑɬ } [DOR] [RTR]			*	*!*		*

3.5.5. 'Transparent Laryngeals'

3.5.5.1. Analysis

Consider the data in (89), which presents van Eijk's (1985, 1987) surface transcription of two forms in which, under his analysis, /Æ/ surfaces backed despite the laryngeal intervening between it and /ḳ/ □ /q/. Remnant (1990) and Bessell (1992), assuming this analysis, have analysed forms like these as showing that St'át'imcets laryngeals are transparent to uvularisation harmony (which they refer to as 'retraction').

(89)	a. /mIcÆʔq/	{ micạʔq}	'to assume a sitting position'
	b. /GLOT, nÆq/	{ nạ-ʔ-q}	'to rot, get rotten'

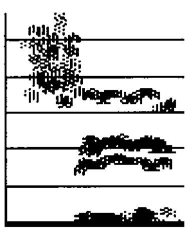
In this chapter, forms which van Eijk records as containing a vowel-glottal stop sequence have been transcribed as illustrated in (90). Forms such as that in (91) involve /ʔ/-reduplication: the fact that the glottal stop is picked out for reduplication is taken as evidence that it is underlying.

3.5.5. ‘Transparent Laryngeals’

(90) a. IPA /mItʃÆʔk̟/	{ mitʃɑ’k̟ }	[mitʃɑʔk̟]	‘to assume a sitting
NA /mIcÆʔq/	{ micạ’q }	[micạʔq]	position’
b. IPA /GLOT, nÆk̟/	{ nɑ-’-k̟ }	[nɑʔk̟]	‘to rot, get rotten’
NA /GLOT, nÆq/	{ nạ-’-q }	[nạʔq]	

(91) IPA /RED, ʔUʃÆʔ/	{ ʔu-ʔ-ʃæʔ }		‘egg’
NA /RED, ʔUsÆʔ/	{ ʔu-ʔ-saʔ }		

The present OT account entails that forms such as those in (90) contain a glottalised vowel; the glottalisation on the vowel is implemented in the phonetics as a glottal stop. The manner in which this is entailed by the account will be explained in §3.5.6.



3.5.5.2. Acoustic Support

Figures 3:59 and 3:60 replot those tokens of St’át’imcets /Æ/, from Figures 3:44 and 3:45, which occurred preceding an emphatic with a phonetic laryngeal intervening between the /Æ/ and the emphatic. Figure 3:60 also replots the tokens of LN’s /Æ/ which occurred preceding an emphatic with a non-laryngeal consonant intervening between the /Æ/ and the emphatic. (No tokens of LC’s /Æ/ in this context are plotted in Figure 3:59, due to lack of data. For the same reason, no tokens of the epenthetic vowel immediately preceding a laryngeal are plotted for either speaker. For data on the epenthetic vowel preceding an emphatic with an intervening non-laryngeal, see Figures 3:48 and 3:49.)

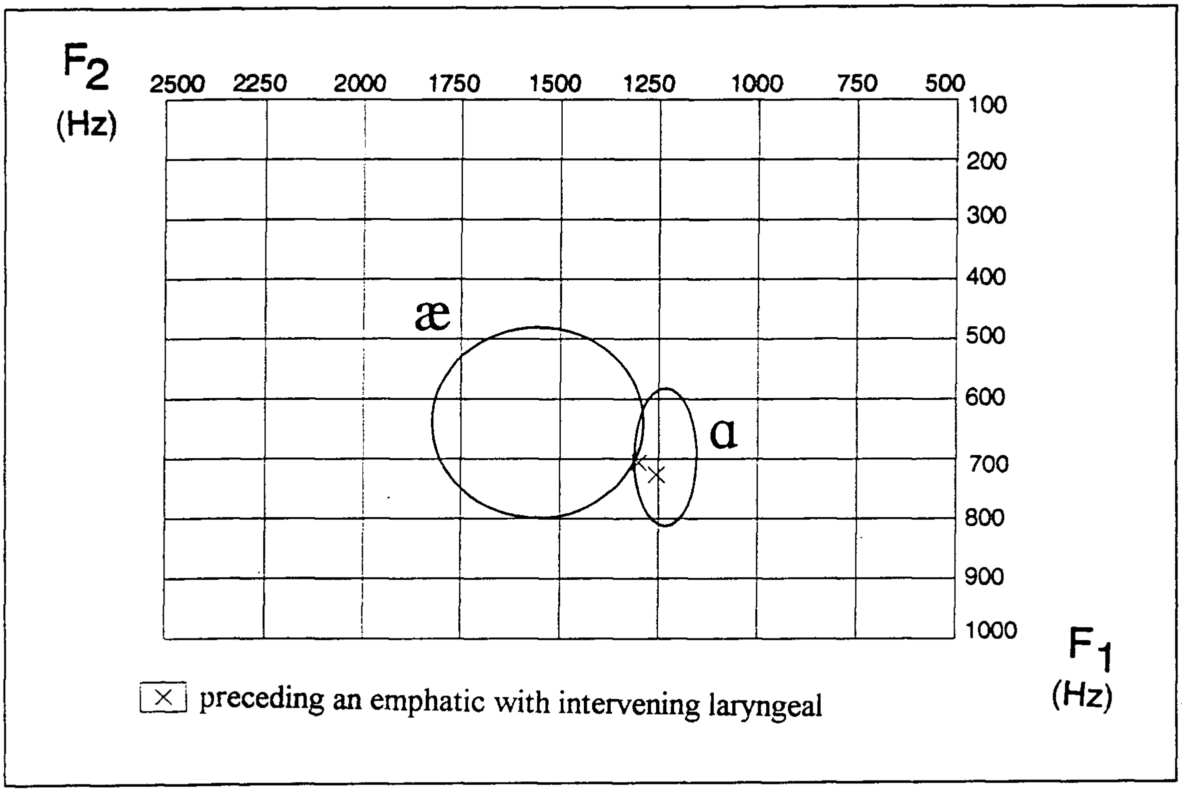


Figure 3:59 F_1 - F_2 plot of tokens of St'át'imcets /Æ/ in the context: preceding an emphatic with intervening phonetic laryngeal. Speaker: LC.

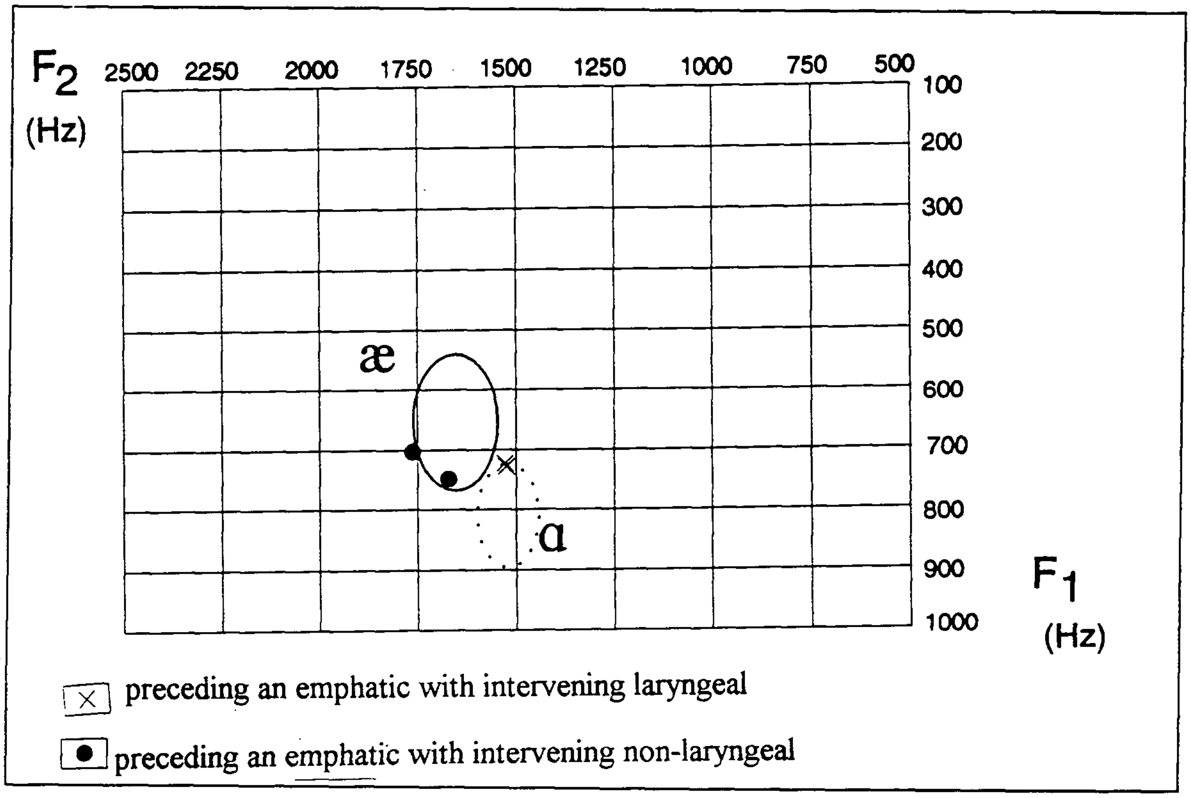


Figure 3:60 F_1 - F_2 plot of tokens of St'át'imcets /Æ/ in the context: preceding an emphatic with intervening phonetic laryngeal. Speaker: LN.

In Figures 3:59 - 3:60, the tokens of /Æ/ which occurred preceding an emphatic with an intervening phonetic laryngeal fall within the F_1 - F_2 region of the back allophone ⟨ ɑ⟩. In Figure 3:60, the tokens which occurred preceding an emphatic with an intervening non-laryngeal fall within the F_1 - F_2 region of the non-back allophone ⟨ æ⟩. The relevant observation is that the tokens preceding an emphatic with an intervening phonetic laryngeal have a lowered F_2. This supports the assumption that the tokens which occurred in that context were produced with uvularisation.

3.5.6. A Theoretical Account: Part III

I suggest that the apparent transparency of St'át'imcets laryngeals in surface forms such as those in (89) can be explained by recognising that such forms contain glottalised vowels. This section first presents perceptual support for this reinterpretation. It then argues that the analysis illustrated in (89), *viz.*, that the forms at issue each involve a surface vowel-laryngeal sequence, in which the vowel left adjacent to the laryngeal harmonises 'through' a transparent laryngeal, is not amenable to an OT analysis consistent with the constraints and hypotheses otherwise argued for in the present work. Rather, the present acccount implies the glottalised vowels in (90).

Perceptual support for the proposed reinterpretation comes from the description provided by St'át'imcets consultant AA for the word /GLOT, kIx̟/ ⦃ kɪ-'-x̟ ⦄ □/GLOT, kI x̆/ ⦃ k i̥-'-x̆ ⦄ 'cranky (child), fussing (because it wants attention or is sick)'. In her description of this word, AA did not identify a '7'. (The symbol '7' is used in the van Eijk orthography to denote a glottal stop.) Rather, she said: "the vowel is a little more complicated. There's more sound in it." It is here hypothesised that a larger set of native speaker judgements of forms such as ⦃ kɪ-'-x̟ ⦄ □ ⦃ k i̥-'-x̆ ⦄ and those in (89)/(90) would likewise not identify a glottal stop. This would support the present claim that they contain a glottalised vowel rather than a glottal stop.

The theoretical argument against the former analysis is as follows: an account based on the analysis illustrated by (89) would appeal to the evidence that St'át'imcets laryngeals are phonologically placeless, that is, that they lack a place node. Their placelessness is seen in the representations in (92), which are here assumed. See Shaw (1991a, 1993) for proposal of these representations for laryngeals in Nisga. (Shaw assumes /ʔ/ bears '[-CONT]'; under the present representational assumptions, that feature is [STOP].)

(92) The Representation of St'át'imcets /ʔ h/

ʔ	h
[CONS] —— [STOP]	[CONS]

Salish laryngeals have been claimed to be phonologically placeless by Remnant (1990), Bessell & Czaykowska-Higgins (1991) and Bessell (1992), based on the apparent transparency of Salish laryngeals to 'retraction' harmony (which St'át'imcets has been reanalysed in this chapter as comprised of distinct pharyngealisation and uvularisation harmonies). However, there is independent evidence for their placelessness, and for the representations in (92): the St'át'imcets epenthetic consonant is {h}. This is shown by forms like that in (93), compared to forms like that in (94). In (93), the occurrence of {h} breaks up vowel hiatus. (The underlying root-final /Æ/ deletes.) The form in (94) contains the same root as (93). As (94) involves no hiatus, it lacks {h}-epenthesis. See van Eijk (1985, 1987) for further data establishing /h/ as the St'át'imcets epenthetic consonant.

3.5.6. A Theoretical Account: Part III

(93) IPA /ʔÆmÆ-Uʃ/ {ʔæmh-uʃ} 'handsome (in face)'

NA /ʔÆmÆ -Us/ {ʔamh-us}

(94) IPA /ʔÆmÆ-ɰ^{w}Il'x/ {ʔæmæ-ɰ^{w}il'x} 'to get better, to recover

NA /ʔÆmÆ -wIl'x/ {ʔama-wil'x} (e.g., from a sickness)'

Under a transparency analysis of (89), laryngeal transparency to uvularisation harmony would be the effect of the constraints in (95), which would be ranked with the other uvularisation harmony constraints as seen in (96).

(95) a. DEP-Place
Every Place node in the output corresponds to a Place node in the input.

b. DEP-DOR
Every [DOR] in the output corresponds to a [DOR] in the input.

c. DEP-RTR
Every [RTR] in the output corresponds to a [DOR] in the input.

(96) DEP-IO, MAX-RTR, MAX-DOR, MAX-LINK, HI/*Sec-DOR $\wedge$ Sec-RTR, DEP-Place >>

α—Sec-[DOR] $\wedge$ Sec-[RTR]/ALIGN-L(Sec-[DOR] $\wedge$ Sec-[RTR], Rt_β) >>

DEP-LINK >>

α—Sec-[DOR] $\wedge$ Sec-[RTR]/ALIGN-R(Sec-[DOR] $\wedge$ Sec-[RTR], Rt_β),
ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L),
ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], R; Wd, R) >>

DEP-DOR, DEP-RTR

DEP-Place requires that no Place node be inserted in the representation. DEP-DOR requires that no [DOR] be inserted; DEP-RTR requires the same for [RTR]. For previous discussion of these constraints, see §2.3.3.3, §2.5.2, and §2.5.4. Laryngeal transparency resulting from (96) would be illustrated by a tableau such as that in (97). (In (97), 'ALIGN-Sec-DOR-Sec-RTR- Wd' abbreviates ALIGN(Sec-[DOR] ∧ Sec-[RTR], L; Wd, L) and ALIGN(Sec-[DOR] ∧ Sec-[RTR], R; Wd, R); '☞' marks the winning candidate.)

(97)

input: /GLOT, nÆk/ /\ [DOR] [RTR] 'to rot, get rotten'; see (89)	I-O FAITH	HI/ *Sec-DOR ∧ Sec-RTR	DEP-Place	α—Sec-[DOR] ∧ Sec-[RTR]/ ALIGN-L (Sec-[DOR] ∧ Sec-[RTR], Rt_β)	DEP-LINK	α—Sec-[DOR] ∧ Sec-[RTR]/ ALIGN-R (Sec-[DOR] ∧ Sec-[RTR], Rt_β)	ALIGN-Sec-DOR-Sec-RTR-Wd	DEP-DOR	DEP-RTR
1.{ næ-ʔ-k}	*!***								
☞ 2.*{ næ-ʔ-k} /\ [DOR] [RTR]				*		*	**		
3.{ næ-ʔ-k} [RTR] [DOR]			*!		**	*	**		
4. { nɑ-ʔ-k} [RTR] [RTR] [DOR] [DOR]				*	*!*	*	*	*	*

Under this account, the non-underlying Place node which a harmonising laryngeal receives by interpolation is prohibited by highly ranked DEP-Place. The segment left-adjacent to the laryngeal can harmonise, as observed for candidate 3 in the tableau. This results in greater satisfaction of ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L) than a candidate without such harmony (e.g., candidates 2 and 4), though resulting in violations of DEP-DOR and DEP-RTR.

Note that the DEP-LINK >> ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L) was established in §3.5.2, based on the lack of uvularisation harmony to the left edge of the word. (If ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L) were more highly ranked than DEP-LINK, then harmony to the left edge of the word would be observed. However, the data in (72) showed it is not.) Thus, given (96), the problem with this account is that it predicts the actual output form to be ungrammatical: in (97), candidate 2 wins because it incurs two less violations of DEP-LINK than are incurred by the runner-up candidate 4, but candidate 4 is the actual output form. On this basis, the analysis illustrated in (89) is not adopted here.

I suggest that the apparent laryngeal transparency in (89) can be explained if the phonetic vowel-laryngeal sequence in each form is recognised instead as a single surface segment: a glottalised vowel, as seen in (90). Under this analysis, each harmonising vowel in (90) is left-adjacent to an emphatic, and its harmony follows per usual from the constraint ranking in (87).

3.6. Summary

This chapter has argued that St'át'imcets Salish, like Palestinian Arabic, has two postvelar harmonies: pharyngealisation harmony and uvularisation harmony. St'át'imcets pharyngealisation harmony was argued to be [RTR] AS harmony in St'át'imcets, that is, harmony of [RTR] triggered by segments which are specified for [RTR] as a secondary specification. The triggers thus include all St'át'imcets postvelars: the uvular gutturals and the emphatics. Pharyngealisation harmony is implemented with retracted tongue root articulation.

St'át'imcets uvularisation harmony was argued to be [DOR] + [RTR] AS harmony, that is, harmony of co-occurring [DOR] and [RTR] triggered by segments which are co-specified for those two features as secondary specifications. The triggers for the uvularisation harmony are the St'át'imcets emphatics. This second harmony is implemented with a retracted tongue back articulation, with automatic concommittant retraction of the tongue root.

The distinct properties of St'át'imcets' pharyngealisation and uvularisation harmonies were shown. Acoustic data which support the distinct properties were presented.

The anchor for [RTR] in St'át'imcets was identified as the NUC; the anchor for simultaneous secondary-[DOR] and secondary-[RTR] in St'át'imcets was identified as the root node. In chapter 2, the same anchors were identified for these features in Palestinian.

The distinct properties of St'át'imcets' two postvelar harmonies are listed in Table 3:8 with the constraint which imposes each property. The constraint rankings which were argued to produce the two harmonies are presented in (98). Two separate rankings are presented, as the present investigation has revealed no evidence that the pharyngealisation harmony and uvularisation harmony rankings interact.

Table 3:8

The distinct properties of St'át'imcets' two postvelar harmonies

	PHARYNGEALISATION HARMONY	UVULARISATION HARMONY
1. <u>triggers</u>	emphatics gutturals	emphatics
	MAX-RTR; MAX-LINK	MAX-DOR; MAX-RTR; MAX-LINK
2. <u>undergoers</u>	one leftward vowel	one leftward consonant or vowel
	ALIGN-L([RTR], NUC)	α—Sec-[DOR] $\wedge$ Sec-[RTR]/ALIGN-L(Sec-[DOR] $\wedge$ Sec-[RTR], Rt_{β})
3. <u>neutral segments</u>	(none)	high vowels
		HI/*Sec-DOR $\wedge$ Sec-RTR

gutturals = IPA /ʁ ʁ' ʁʷ ʁ'ʷ/; NA /ʕ ʕ' ʕʷ ʕ'ʷ/

emphatics = IPA /t̙ʃ̙ ʃ̙ ɹ̙ ɹ̙' l̙ l̙' k̙ k̙' k̙ʷ k̙'ʷ x̙ x̙ʷ/; NA /c̣ ṣ ẓ ẓ' ḷ ḷ' q q' qʷ q'ʷ x̌ x̌ʷ/

3.6. Summary

(98) Constraint Ranking Responsible for Pharyngealisation and Uvularisation Harmonies in St'át'imcets Salish

a. Pharyngealisation Harmony Ranking

DEP-IO, MAX-RTR, MAX-LINK >>

ALIGN-L([RTR], NUC) >>

DEP-LINK >>

ALIGN-R([RTR], NUC),
ALIGN([RTR], L; Wd, L), ALIGN([RTR], R; Wd, R)

b. Uvularisation Harmony Ranking

DEP-IO, MAX-RTR, MAX-DOR, MAX-LINK, HI/*Sec-DOR $\wedge$ Sec-RTR >>

α—Sec-[DOR] $\wedge$ Sec-[RTR]/ALIGN-L(Sec-[DOR] $\wedge$ Sec-[RTR], Rt_{β}) >>

DEP-LINK >>

α—Sec-[DOR] $\wedge$ Sec-[RTR]/ALIGN-R(Sec-[DOR] $\wedge$ Sec-[RTR], Rt_{β}),
ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L),
ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], R; Wd, R)

Chapter 4: Conclusion

4.1. Summary of the Thesis

This thesis had three aims. The first was to present the evidence that both Palestinian Arabic and St'át'imcets Salish have two distinct postvelar harmonies: pharyngealisation harmony and uvularisation harmony. For each language, the distinction between these two harmonies was shown from an array of phonological data. Acoustic data which support the distinct harmonies were presented.

The second aim was to identify the features responsible for each harmony. The harmonic feature of pharyngealisation was argued to be [RTR]. Two co-occurring features were argued to be the source of uvularisation harmony: secondary-[DOR] and secondary-[RTR]. It was argued that Palestinian pharyngealisation harmony is [RTR] 'A' ('Articulation') harmony triggered by segments that are specified for primary- or secondary-[RTR]; the triggering class thus comprises the Palestinian guttural and emphatic postvelars, and closed-syllable-pharyngealised vowels. It was argued that St'át'imcets pharyngealisation harmony is [RTR] 'AS' ('Articulation') harmony, triggered by segments that are specified for secondary-[RTR]; the triggering class comprises the St'át'imcets guttural and emphatic postvelars. In Palestinian, which has both short and long vowels, pharyngealisation harmony affects only short vowels.

Based on the behaviour of [RTR] in the Arabic and Salish, it was suggested that [RTR] optimally surfaces as a vocalic feature: although [RTR] enters the phonology on postvelar consonants in Palestinian and St'át'imcets, the pattern of pharyngealisation harmony in both languages indicates that the lexical distinctiveness of [RTR] on consonants is optimally enhanced by its surface realisation on a vowel.

Uvularisation harmony in both Palestinian and St'át'imcets was argued to be [DOR] + [RTR], 'AS' ('Articulation-secondary') harmony, triggered by segments which are co-specified for those two features as secondary specifications. The triggers thus are emphatic postvelars. Uvularisation harmony was shown to affect both consonants and vowels in both languages.

Two distinct anchors were identified: the anchor for [RTR] in both Palestinian and St'át'imcets was identified as the NUC; the anchor for secondary-[RTR] and secondary-[DOR] in both languages was identified as the root node.

The third aim of the thesis was to provide an OT account of the two harmonies in Palestinian and St'át'imcets. Correspondence, Alignment, and Grounded constraints had a central role in this account. The constraints proposed in this thesis are listed in Table 4:1. Most were proposed as phonetically grounded constraints, as indicated in the table.

Table 4:1

Postvelar constraints proposed in this thesis

Constraint	Requires that...	Grounding
a. NUC]$_{Stm}$/*RTR (NON-FINALITY)	a NUC at a right stem edge is not [RTR]	
b. NUC$\mu\mu$ /*RTR	a bimoraic NUC is not [RTR]	articulatory: phonetic undershoot
c. NUC-C]$_\sigma$/RTR	a NUC in a closed syllable is [RTR]	articulatory: phonetic undershoot
d. ALIGN-L([RTR], NUC), ALIGN-R([RTR], NUC)	[RTR] is aligned with the {L,R} edge of a NUC because [RTR] optimally surfaces on a vowel	auditory: the acoustic effects of (non-underlying) pharyngealisation are categorical only for vowels
e. ALIGN([RTR], L; Wd, L), ALIGN([RTR], R; Wd, R)	[RTR] in a word is specified on all NUCs to the {L,R} edge of the word	articulatory: sluggishness of the tongue root
f. ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L), ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], R; Wd, R)	where co-specified on a segment, secondary-[DOR] and secondary-[RTR] are specified on all segments to the {L,R} edge of the word	articulatory: sluggishness of the tongue back
g. α—Sec-[DOR] $\wedge$ Sec-[RTR]/ ALIGN-L(Sec-[DOR] $\wedge$ Sec-[RTR], Rt$_\beta$), α—Sec-[DOR] $\wedge$ Sec-[RTR]/ ALIGN-R(Sec-[DOR] $\wedge$ Sec-[RTR], Rt$_\beta$)	secondary-[DOR] and secondary-[RTR] are aligned with the {L,R} edge of the segment {L,R}-adjacent, respectively, to an underlying emphatic	articulatory: sluggishness of the tongue back
h. FRONT/*Sec-DOR $\wedge$ Sec-RTR	a segment that is [FRONT] is not secondary-[DOR] and secondary-[RTR]	articulatory: incompatibility of simultaneous front and uvularised articulation
i. HI/*Sec-DOR $\wedge$ Sec-RTR	a segment that is [HI] is not secondary-[DOR] and secondary-[RTR]	articulatory: incompatibility of simultaneous high and uvularised articulation
j. LO/*Sec-DOR $\wedge$ Sec-RTR (*COMPLEX)	a segment that is [LOW] is not secondary-[DOR] and secondary-[RTR]	cognitive: feature overload

4.1. Summary of the Thesis

The constraint ranking responsible for Palestinian postvelar harmonies was proposed as that in (1). The reranking in (2) was proposed as that responsible for the harmonies in St'át'icmets. The rankings in (1) and (2) include all postvelar harmony constraints discussed in the thesis; as seen, constraints for which effects were observed in one language but not in the other are listed as bottom-ranked for the language in which no effects were observed.

(1) Postvelar Grammar: Palestinian Arabic

a. Pharyngealisation Harmony

DEP-IO, MAX-RTR, MAX-LINK (for features other than [LOW]), NUC]$_{Stm}$/*RTR, NUCμμ /*RTR >>

ALIGN-L([RTR], NUC), ALIGN-R([RTR], NUC) >>

LO/*Sec-DOR ∧ Sec-RTR >>

NUC-C]$_{\sigma}$/RTR >>

DEP-RTR >>

ALIGN([RTR], L; Wd, L), ALIGN([RTR], R; Wd, R) >>

DEP-LINK, MAX-LOW, MAX-LINK$_{LO}$

b. Uvularisation Harmony

DEP-IO, MAX-RTR, MAX-DOR, MAX-LINK, NUC]$_{Stm}$/*RTR, NUCμμ /*RTR, DEP-DOR, FRONT/*Sec-DOR ∧ Sec-RTR, HI/*Sec-DOR ∧ Sec-RTR >>

ALIGN(Sec-[DOR] ∧ Sec-[RTR], L; Wd, L), ALIGN(Sec-[DOR] ∧ Sec-[RTR], R; Wd, R) >>

NO-GAP, DEP-RTR >>

DEP-LINK,
α—Sec-[DOR] ∧ Sec-[RTR]/ALIGN-L(Sec-[DOR] ∧ Sec-[RTR], Rt$_{\beta}$),
α—Sec-[DOR] ∧ Sec-[RTR]/ALIGN-R(Sec-[DOR] ∧ Sec-[RTR], Rt$_{\beta}$)

(2) Postvelar Grammar: St'át'imcets Salish

a. Pharyngealisation Harmony

DEP-IO, MAX-RTR, MAX-LINK >>

ALIGN-L([RTR], NUC) >>

DEP-LINK >>

ALIGN-R([RTR], NUC),
ALIGN([RTR], L; Wd, L), ALIGN([RTR], R; Wd, R),
NUC]$_{Stm}$/*RTR, NUC$\mu\mu$ /*RTR, LO/*Sec-DOR,
LO/*Sec-DOR $\wedge$ Sec-RTR, NUC-C]$_{\sigma}$/RTR, MAX-LOW,
MAX-LINK$_{LO}$

b. Uvularisation Harmony

DEP-IO, MAX-RTR, MAX-DOR, MAX-LINK, HI/*Sec-DOR $\wedge$ Sec-RTR >>

α—Sec-[DOR] $\wedge$ Sec-[RTR]/ALIGN-L(Sec-[DOR] $\wedge$ Sec-[RTR], Rt$_{\beta}$) >>

DEP-LINK >>

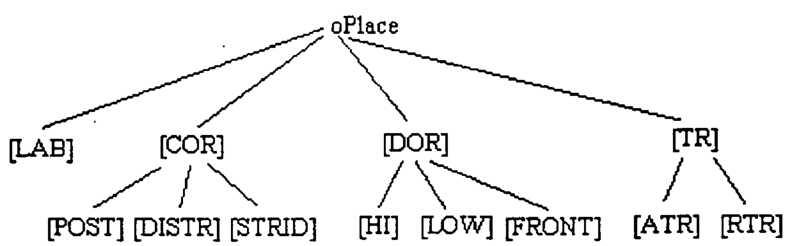
α—Sec-[DOR] $\wedge$ Sec-[RTR]/ALIGN-R(Sec-[DOR] $\wedge$ Sec-[RTR], Rt$_{\beta}$),
ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], L; Wd, L),
ALIGN(Sec-[DOR] $\wedge$ Sec-[RTR], R; Wd, R),
FRONT/*Sec-DOR $\wedge$ Sec-RTR, NO-GAP, DEP-RTR

The major crosslinguistic difference evidenced by (1) vs. (2) is in harmonic domain, *viz.*: in Palestinian, postvelar harmony has a wide extent throughout the word whereas in St'át'imcets, it maximally extends to one leftward segment. The wider extent of harmony in Palestinian gives rise to a more complex array of neutrality properties for both harmonies in Palestinian than in St'át'imcets.

4.2. A Residual Issue

In several studies of Niger-Congo and Nilotic tongue root harmony, the active feature for cases involving tongue root retraction has been identified as '[-ATR]'; see, e.g., Archangeli and Pulleyblank (1989, 1994a, 1994b), Clements (1985, 1991), and Odden (1991). This thesis has assumed privative features with Place features organised as seen below:

(3)



Assuming (3), the privative expression of '[-ATR]' is [RTR]. I suggest that it follows that [-ATR] = [RTR] because the 'two' features label the same thing. Which label is used depends on the working assumptions with respect to privative vs. binary features.

With [-ATR] identified as [RTR], a comparison of the [RTR] harmonies (that is, pharyngealisation harmonies) in Niger-Congo and Nilotic with those in Palestinian and St'át'imcets is possible. Previous work, e.g., Archangeli and Pulleyblank (1994a), has shown that Niger-Congo and Nilotic [RTR] harmony (i) has a non-consonantal source: it is triggered by either a floating [RTR] or a low vowel, and (ii) affects only vowels. Given this, Niger-Congo and Nilotic languages are here considered to bear out the prediction identified in §2.4.2, that there are languages with [RTR] on vowels, either underlyingly or via the input-output mapping, but not on consonants. The fact that Niger-Congo and Nilotic [RTR] harmony affects only vowels is also considered support for the present claim that [RTR] optimally surfaces on a vowel. In Palestinian and St'át'imcets, in which [RTR] enters the phonology specified on postvelar consonants, [RTR] also seeks to surface on a vowel.

Appendix I: Abbreviations and Symbols

A. Abbreviations

[ATR]	[ADVANCED TONGUE ROOT]
[-ATR]	[-ADVANCED TONGUE ROOT]
[CG]	[CONSTRICTED GLOTTIS]
[CONS]	[CONSONANTAL]
[COR]	[CORONAL]
[DISTR]	[DISTRIBUTED]
[DOR]	[DORSAL]
[HI]	[HIGH]
[LAB]	[LABIAL]
[LAT]	[LATERAL]
[NAS]	[NASAL]
[POST]	[POSTERIOR]
[RTR]	[RETRACTED TONGUE ROOT]
[SG]	[SPREAD GLOTTIS]
[SON]	[SONORANT]
[STRID]	[STRIDENT]
[TR]	[TONGUE ROOT]
$]_{Stm}$	right stem edge
1	first person
2	second person
3	third person
A harmony	articulation harmony
A/ℓ	cross-sectional area of the front resonating tube of the vocal tract/length of the front resonating tube; i.e., area/length
Adj.	adjective
ALV	alveolar
ALV-LAT	alveolateral
AP harmony	primary articulation harmony
AS harmony	secondary articulation harmony
C	consonant
$\d{C}$	emphatic consonant
d	distance of the articulatory constriction from the glottis
DENT	dental
F	phonological feature
F	formant frequency
f_0	fundamental frequency
F_1	first formant frequency
F_2	second formant frequency
F_3	third formant frequency
fem.	feminine
G	guttural consonant
GL	glottal

GLOT	glottalisation morpheme
H	heavy syllable
Hz	Hertz
INTER-DENT	interdental
intr.	intransitive
L	light syllable
LAB	labial
masc.	masculine
N	noun
NUC	nucleus
NUCμ	nuclear mora
NUCμμ	bimoraic nucleus
obj.	object
OT	Optimality Theory
PAL	palatal
PHAR	pharyngeal
pl.	plural
POST-ALV	post-alveolar
r_0	radius of the resonating tube at the point of constriction
rd	round
RED	reduplicative morpheme
Rt	root node
rtr	retracted tongue root
s.d.	standard deviation
sg.	singular
subj.	subject
tr.	transitive
UV	uvular
V	vowel
VEL	velar

B. Symbols

1. International Phonetic Alphabet (revised to 1993, corrected to 1996)
   (http://www.arts.gla.uk/IPA/ipa.html)

CONSONANTS (PULMONIC)

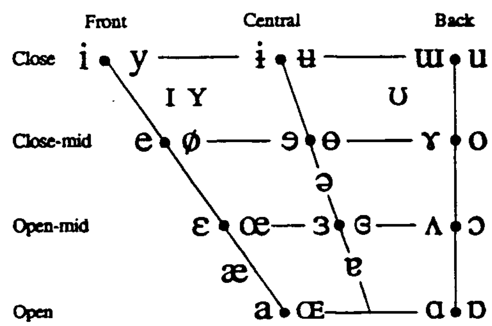
	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d		ʈ ɖ	c ɟ	k ɡ	q ɢ		ʔ
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	ɴ		
Trill	ʙ			r					ʀ		
Tap or Flap				ɾ		ɽ					
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Lateral fricative				ɬ ɮ							
Approximant		ʋ		ɹ		ɻ	j	ɰ			
Lateral approximant				l		ɭ	ʎ	ʟ			

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

CONSONANTS (NON-PULMONIC)

Clicks		Voiced implosives		Ejectives	
ʘ	Bilabial	ɓ	Bilabial	ʼ	Examples:
ǀ	Dental	ɗ	Dental/alveolar	pʼ	Bilabial
ǃ	(Post)alveolar	ʄ	Palatal	tʼ	Dental/alveolar
ǂ	Palatoalveolar	ɠ	Velar	kʼ	Velar
ǁ	Alveolar lateral	ʛ	Uvular	sʼ	Alveolar fricative

VOWELS



Where symbols appear in pairs, the one to the right represents a rounded vowel.

OTHER SYMBOLS

ʍ Voiceless labial-velar fricative
w Voiced labial-velar approximant
ɥ Voiced labial-palatal approximant
ʜ Voiceless epiglottal fricative
ʢ Voiced epiglottal fricative
ʡ Epiglottal plosive
ɕ ʑ Alveolo-palatal fricatives
ɺ Alveolar lateral flap
ɧ Simultaneous ʃ and x

Affricates and double articulations can be represented by two symbols joined by a tie bar if necessary. k͡p t͜s

SUPRASEGMENTALS

ˈ Primary stress
ˌ Secondary stress
ˌfoʊnəˈtɪʃən
ː Long eː
ˑ Half-long eˑ
˘ Extra-short ĕ
| Minor (foot) group
‖ Major (intonation) group
. Syllable break ɹi.ækt
‿ Linking (absence of a break)

DIACRITICS Diacritics may be placed above a symbol with a descender, e.g. ŋ̊

̥ Voiceless	n̥ d̥	̤ Breathy voiced	b̤ a̤	̪ Dental	t̪ d̪
̬ Voiced	s̬ t̬	̰ Creaky voiced	b̰ a̰	̺ Apical	t̺ d̺
ʰ Aspirated	tʰ dʰ	̼ Linguolabial	t̼ d̼	̻ Laminal	t̻ d̻
̹ More rounded	ɔ̹	ʷ Labialized	tʷ dʷ	̃ Nasalized	ẽ
̜ Less rounded	ɔ̜	ʲ Palatalized	tʲ dʲ	ⁿ Nasal release	dⁿ
̟ Advanced	u̟	ˠ Velarized	tˠ dˠ	ˡ Lateral release	dˡ
̠ Retracted	e̠	ˤ Pharyngealized	tˤ dˤ	̚ No audible release	d̚
̈ Centralized	ë	̴ Velarized or pharyngealized	ɫ		
̽ Mid-centralized	e̽	̝ Raised	e̝ (ɹ̝ = voiced alveolar fricative)		
̩ Syllabic	n̩	̞ Lowered	e̞ (β̞ = voiced bilabial approximant)		
̯ Non-syllabic	e̯	̘ Advanced Tongue Root	e̘		
˞ Rhoticity	ɚ a˞	̙ Retracted Tongue Root	e̙		

TONES AND WORD ACCENTS

LEVEL			CONTOUR		
e̋ or	˥	Extra high	ě or	˩˥	Rising
é	˦	High	ê	˥˩	Falling
ē	˧	Mid	e᷄	˦˥	High rising
è	˨	Low	e᷅	˩˨	Low rising
ȅ	˩	Extra low	e᷈	˧˦˧	Rising-falling
↓		Downstep	↗		Global rise
↑		Upstep	↘		Global fall

2. Other Sound Symbols

I E Æ O U	underlying vowels
˫	uvularisation (with concomitant pharyngealisation)
◌̯	marks the second half of a diphthong

3. Miscellaneous

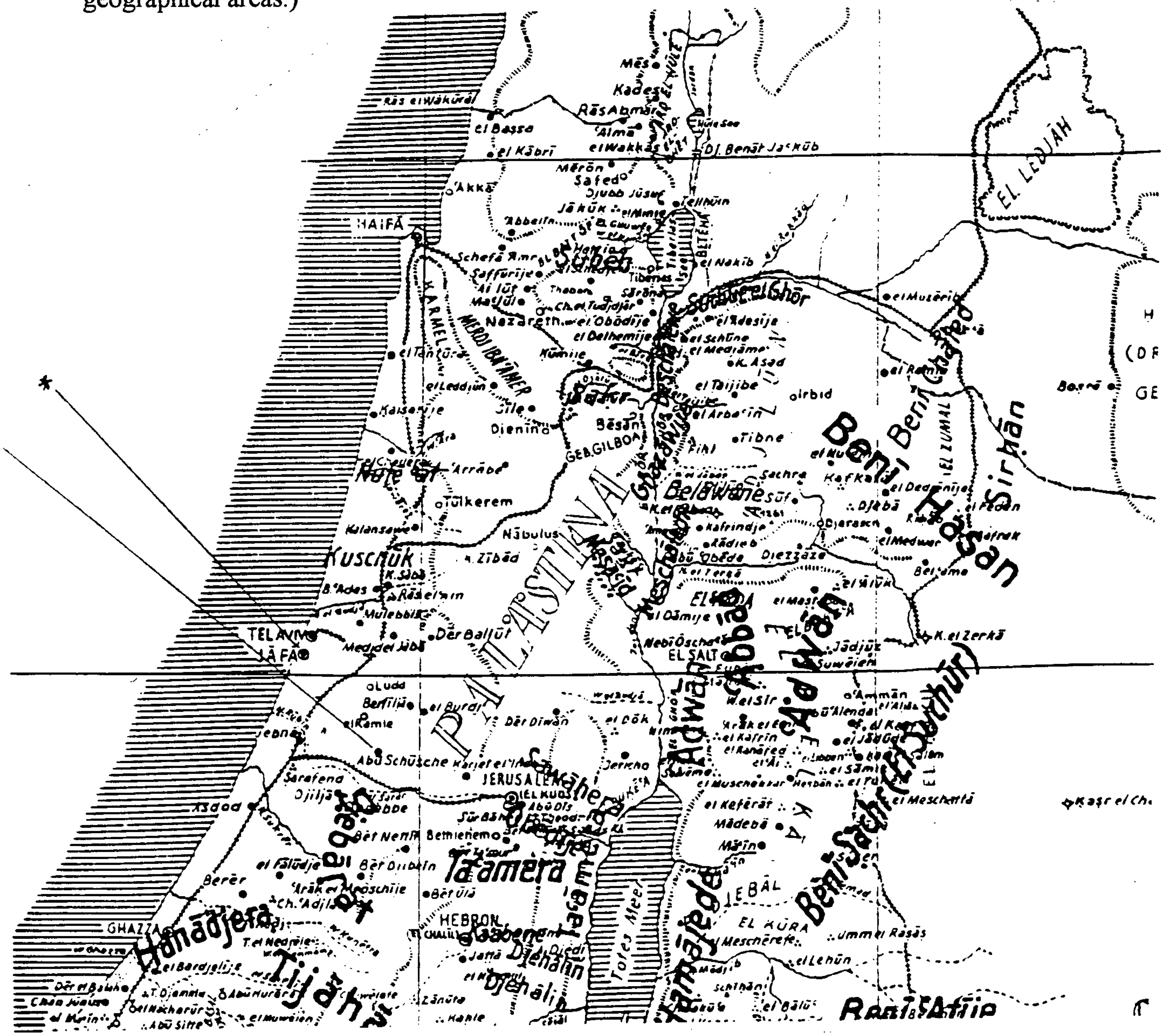
μ	mora
σ	syllable
-	morpheme boundary
‿#	clitic word boundary
#	word boundary
√	precedes a morphological root
/ /	encloses a phonological underlying form
{ }	encloses a phonological surface form
[ ]	encloses a phonetic form
*	ungrammatical
*	constraint violation
*	'is not', e.g., in the constraint LO/*Sec-DOR ∧ Sec-RTR
>>	is more highly ranked than
☞	marks a winning candidate output form
👎	marks a winning candidate output form
!	fatal constraint violation
<	is less marked than
>	surfaces as
/	separates antecedent from consequent in a conditional constraint, e.g., in LO/*Sec-DOR ∧ Sec-RTR
( )	encloses an optional element
~	alternating with

Appendix II:

Original Location of the Abu Shusha

and Jafa Palestinian Dialects

(Map from von Oppenheimer 1943/83; names of bedouin tribes are written across various geographical areas.)[1]



[1]Abu Shusha is currently spoken among the Palestinian diaspora in various locations; Jafa is currently spoken in and around the city of Jafa, and among the Palestinian diaspora.

Appendix III: Details of the Palestinian Acoustic Study

1. Segmentation

Segmentation for the acoustic studies of Palestinian and St’át’imcets followed the procedures of Peterson & Lehiste (1967:192-196), which are photographed on the following pages.

SEGMENTATION

An essential problem in the measurement of the duration of syllable nuclei is that of segmentation. Segmentation has long been and continues to be a major problem in speech analysis. Basic difficulties in the concept of segmentation have been discussed previously by one of the present authors.[7] Since vowel and consonant lengths contrast in some languages there can be no question but that duration may be linguistically distinctive. The specification of those cues which are perceptually significant in linguistic judgments of duration is a subject which should receive further study.

Successive speech sounds not only involve physiological targets and controlled movements, but they often involve changes from one sound type to another. These changes often occur at distances far removed from the targets and, for the purposes of this study, were considered the segment boundaries. Such changes obviously represent major points of transition in the activities of the vocal mechanism. If speech perception is closely correlated with these activities, it seems probable that the transitional regions may be of considerable linguistic significance. The perceptual and linguistic significance of such boundaries merit much further investigation. For purposes of automatic speech recognition, it is obviously necessary to employ some procedure for segmentation or quantization.

There are many instances in which the cues signalling the beginning and the end of a syllable nucleus are relatively unambiguous, but there are many other instances where it is very difficult to specify the point of segmentation. An attempt will be made to describe the major cues that were used in the segmentation basic to the measurements of the present study. It should be emphasized that the procedures employed in this study sometimes involved a great deal of human judgment. In several instances, segmental cues of a type not anticipated were observed. We are in no position to consider the universality of these cues, but it appears profitable to investigate some of them further.

In the present study, instrumental accuracy is in general considerably greater than the accuracy with which the segmental boundaries can be determined. It was usually possible to determine segmental boundaries within one or two centiseconds. In some instances, however, the transitions between consonants and vowels involve an overlapping of cues, and in such instances it does not appear meaningful to attempt to determine exact time boundaries.

1. Initial and Final Plosives

The release of a voiceless initial plosive appears as a spike on the spectrogram. The duration of the explosion depends on the bandwidth of the major resonance and is followed by a period of frication and a period of aspiration.[8] Two separate measurements were made for syllable nuclei following aspirated plosives, one from the center of the releasing spike and the other from the onset of voicing immediately after the aspiration. There was usually a measurable concentration of fricative energy in the regions of higher formants throughout the aspiration period, and it was difficult to decide whether at a given moment the pattern in these formants represented breathy phonation or modulated fricative energy. The onset of voicing could be determined relatively accurately, however, by observing the first formant. There was often a weak energy concentration at the frequency of the first formant during the period of aspiration, and the onset of voicing was clearly distinguishable. Thus it was usually possible to determine the frequency of the first formant, both immediately after the release of the plosive and at the onset of voicing after the aspiration. In vowels involving high first formants (particularly /ɑ/, /æ/, and /ɔ/), the energy concentration in the region of the first formant during aspiration was often comparable to that at other formant frequencies, but the onset of voicing was usually clearly distinguishable as the moment in time at which periodic striations started in the first formant frequency.

After voiced initial plosives, the period of aspiration was absent, but the period of frication following the

[6] The Mingograph, a recording oscillograph with a relatively high-frequency response, and the 48-channel spectrograph are described by C. G. M. Fant, "Modern instruments and methods for acoustic studies of speech," *Proceedings of the VIII International Congress of Linguists* (Oslo University Press, Oslo, 1958).

[7] G. E. Peterson, Language 31, 414–427 (1955).

[8] The distinction between explosion and frication is a matter of source. Explosion is considered to be the sound produced by the shock excitation of the vocal cavities due to the pressure release, and frication is the sound which originates from turbulence produced by the flow of air through the narrow passage which is formed immediately after the release. Cf. Fant, footnote reference 6, pp. 307–308.

spike was usually more prominent than in the case of voiceless plosives. The measurements were again made from the center of the spike, so that the frication period was included in the duration of the vowel. The duration of the frication varied between about 0.5 and 2.5 csec.

The beginning of final voiceless plosives was determined by the abrupt cessation of all formants. The final voiced plosives were often pronounced with full voicing and a voiced release: under the conditions of recording, a considerable amount of energy was present in the voiced plosives, and up to fifteen harmonics appeared in some of the narrow-band spectrograms. Thus the cessation of voicing was not a proper cue for the termination of the syllable nucleus. Instead, the beginning of final voiced plosives was determined by comparing narrow-band and broad-band spectrograms, from which the moment in time when the energy in the higher harmonics was suddenly greatly diminished could be ascertained. In general, it was possible to specify the boundary with an accuracy of about one vocal-fold period.

Examples of initial and final plosives may be seen on Figs. 1–4. Figures 3 and 4 illustrate initial voiced and voiceless plosives; Figs. 1 and 2 contain examples

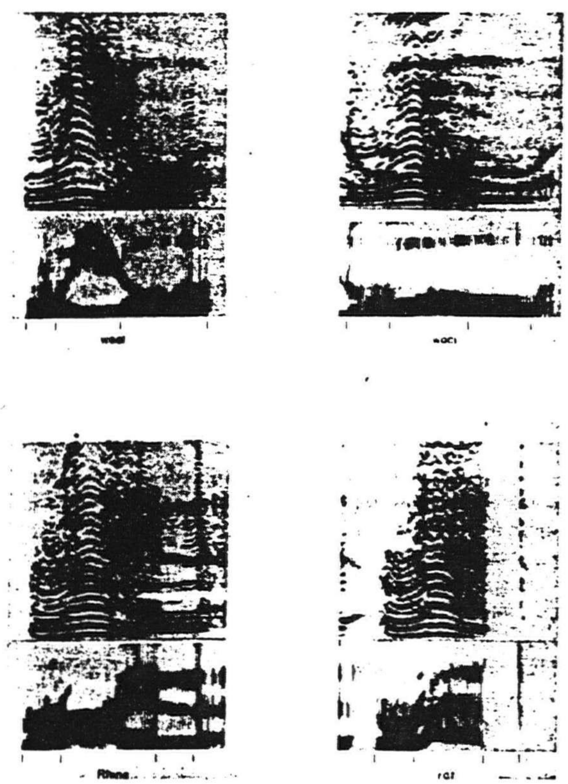


FIG. 1. Broad-band and narrow-band spectrograms of four CNC words spoken by informant GEP. Approximate segmentation points for identifying the boundaries of initial and final consonants have been provided.

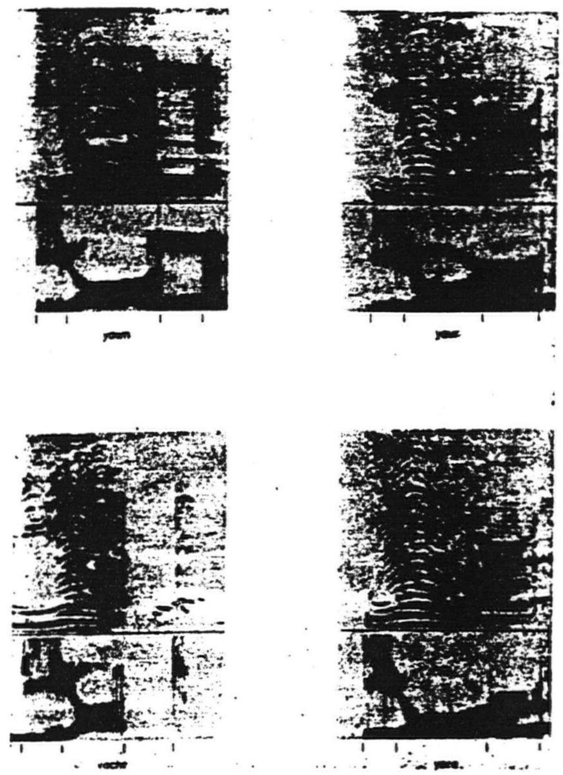


FIG. 2. Broad-band and narrow-band spectrograms of four CNC words spoken by informant GEP. Approximate segmentation points for identifying the boundaries of initial and final consonants have been provided.

of final voiceless plosives, and Fig. 4 contains examples of both voiced and voiceless final plosives.

2. Initial and Final Nasals

In the measurement of syllable nuclei durations, initial nasals offered no difficulty. It was usually possible to identify the vocal-fold period which followed the velar closure by observing the abrupt change from steady formant pattern to rapid onglide movement. Final nasals share the characteristic of steady resonances with initials. In the case of two speakers from the smaller set of data, however, the vowels were nasalized considerably. This had no significant effect upon the identification of the initial boundary of the syllable nucleus, but for these two speakers the nasalization of the vowels obscured the transition from the syllable nucleus to the final nasal consonant on the broad-band spectrograms. The control set of 70 words contained 14 final nasals, but only 3 initial nasals; the relative ease of identifying the boundaries of initial nasals may be due to the very limited data. In the narrow-band spectrograms for these speakers, it was possible to locate the approximate boundaries as the position at which there was a sudden change in the relative marking of the various harmonics. Those

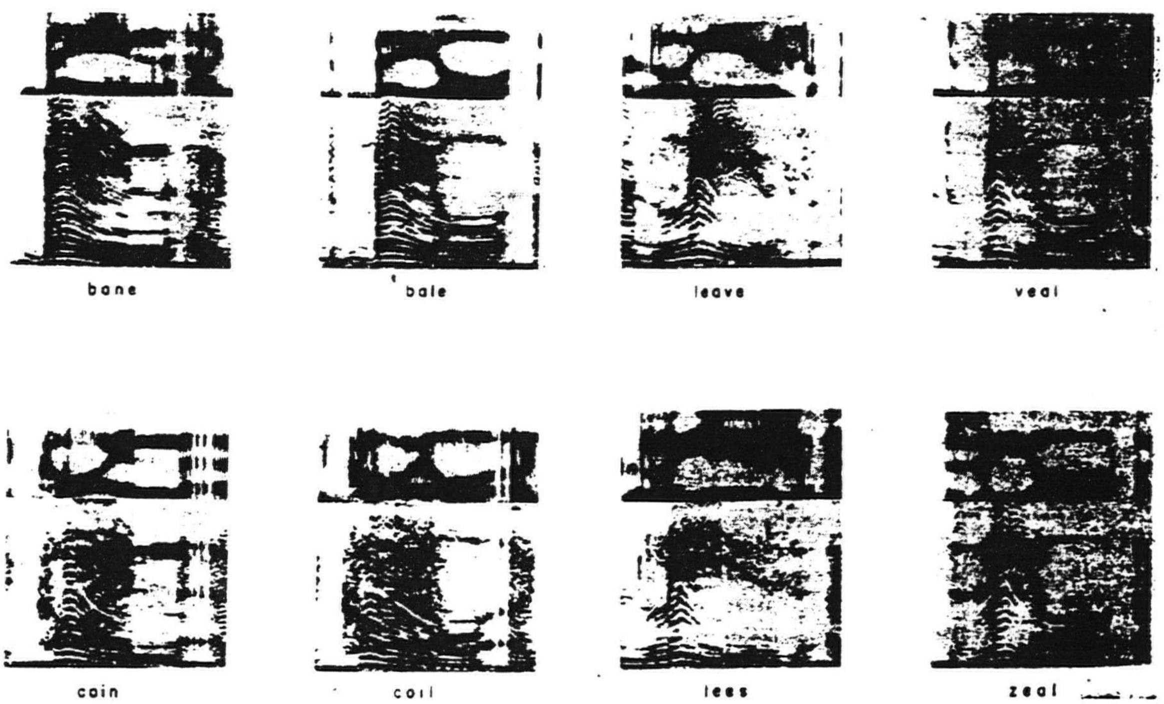


FIG. 3. Broad-band and narrow-band spectrograms of eight CNC words uttered by informant GEP. The tenth harmonic has been traced in white paint on the narrow-band spectrograms; the fifth harmonic has been traced with a dotted white line on some of the spectrograms.

harmonics that were not within the frequency region of either the oral or nasal resonances were marked much more lightly following the vocalic period, and thus a boundary point could be established. Information on relative changes in energy level among the vowel and nasal formants and the minima (or valleys) between is not yet available. Thus the extent to which the marking changes are due to energy-level changes cannot be specified at present. The pattern changes result in part, of course, from the automatic adjustments of the narrow-band marking control to the decrease in over-all output energy during the formation of nasals.

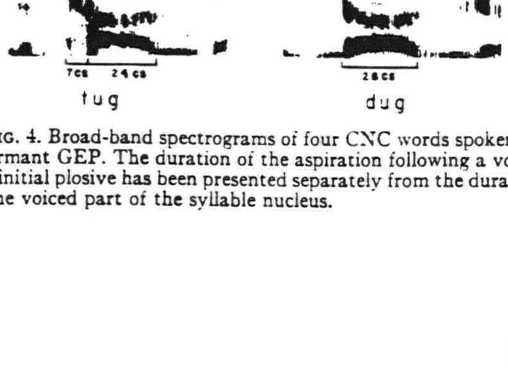


FIG. 4. Broad-band spectrograms of four CNC words spoken by informant GEP. The duration of the aspiration following a voiceless initial plosive has been presented separately from the duration of the voiced part of the syllable nucleus.

Some examples of final nasals may be found on Figs. 1, 2, and 3. The narrow-band patterns in Figs. 1 and 2 are particularly good illustrations of the changes in marking of the harmonics outside the resonances.

3. Initial and Final Fricatives

The beginning of a vowel after an initial voiceless fricative was determined by the onset of voicing in the region of the first formant. This cue was also employed in determining the beginning of the syllable nucleus after an initial /h/, as formant movements were not adequate indications of the points of transition. In such cases, the intensity curves provided a valuable additional reference. There was a period of "breathy" quality for initial /h/ on broad-band spectrograms after the onset of voicing (noise pattern superimposed upon a rather clear formant pattern), but the intensity curves provided a relatively unambiguous cue. Some of the initial voiceless fricatives registered considerable energy on both Mingograph traces and the oscillogram, but there was a cessation of fricative energy before the onset of phonation, and a sharp minimum in the intensity curves provided an appropriate boundary point.

The terminal boundaries of initial voiced fricatives were, in general, rather easily recognized on broad-band spectrograms. The superimposed noise usually ended abruptly. Final voiceless fricatives were recognized by the onset of random noise: The vowel was considered terminated at the point where the noise pattern began, even though voicing in a few low harmonics continued for a few centiseconds in most cases. Final voiced fricatives were more troublesome. In broad-band and narrow-band spectrograms, the transition between vowel and consonant appeared rather gradual, but the onset of high-frequency energy in the case of /z/ and /ʒ/ provided a clear boundary on the intensity curves. The boundaries preceding final /v/ and /ð/ were recognized chiefly by the rapid decrease of energy that could usually be detected on the intensity curves.

Figure 5 presents 4-channel Mingograph tracings of two of the frame utterances spoken by informant Br. Curves *a* and *b* display the sound intensity; low-frequency pre-emphasis was employed in constructing curve *a* and high-frequency pre-emphasis was employed for curve *b*; *c* is a fundamental frequency contour, and *d* a duplex oscillogram.[5] The top utterance represents the sentence "Say the word 'voice' again," and may be compared with "Say the word 'noise' again," presented in the lower half of the illustration. The sharp boundary between initial /s/ and the following vowel in *say* can be observed in both utterances. The boundaries of the voiceless sibilant /s/ in *voice* are more clearly demarcated than the initial boundary of the /z/ in *noise*; curve *b*, which emphasizes energy in the higher frequencies, provides the best clue for isolating final /z/. The initial voiced fricative /v/ in *voice* can be best isolated on curve *a*, with low-frequency pre-emphasis. Initial and final voiced fricatives may also be observed on Fig. 3, which is a good illustration of the difficulty of finding a clear-cut boundary line for final voiced fricatives if only broad-band and narrow-band spectrograms are used for the analysis.

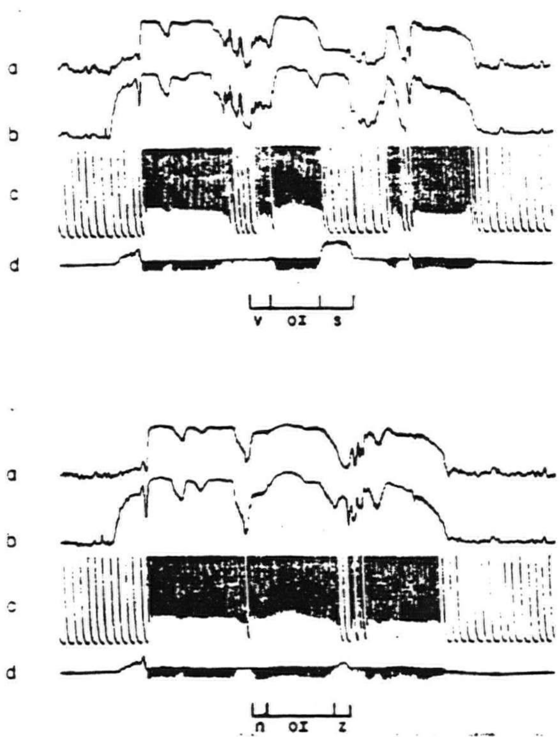


FIG. 5. Four-channel Mingograph tracings of two utterances by informant Br: "Say the word 'voice' again," and "Say the word 'noise' again." Curve *a* is an intensity curve with low-frequency pre-emphasis; curve *b* is an intensity curve with high-frequency pre-emphasis; curve *c* is a pitch curve (modified Grützmacher method); and curve *d* is a duplex oscillogram. The analysis was performed at the Royal Institute of Technology in Stockholm.

4. Initial /w/ and /y/

Both of these initial consonants involved a steady-state period. Since they were fully voiced and had only a minimal amount of friction, the formant movements from the consonant to the syllable nucleus were uninterrupted. Nevertheless, certain cues appeared with a fair amount of regularity, and together provided reasonably usable criteria for segmentation. For initial /w/ the region in which the slope of the second formant acquired a positive value was considered the boundary. This directional change was often accompanied by a sharp increase in energy, and the energy change was accompanied on the narrow-band spectrogram by a darker marking of the harmonics not in the frequency regions of resonance. Such energy cues were particularly useful in sequences where /w/ was followed by a vowel with a low second formant. Figure 1 contains initial /w/ followed by a front and a back vowel. A steady state for /w/ is followed by a rather sharp upward inflection of the second formant in the sequence /wi/; there is a noticeable change in the marking of the formants and also in the harmonics not within the resonance regions in the case of the sequence /wʊ/.

In these data, initial /y/ had a steady state, in which the frequency of the third formant was much greater than that for any simple vowel nucleus. The point, however, at which the transition to the following vowel began was at a considerably lower position in frequency. Thus the third formant of /y/ performs a rapid dip in frequency before rising back to the third-formant position of the vowel. The position in time of the frequency minimum of the third formant was thus considered the point of onset of the following vowel. This cue is most easily determined for vowels with a high third-formant frequency. Figure 2 contains illustrations of initial /y/. The steady state associated with the initial /y/ is characterized by a high third formant and a relatively weak intensity of the harmonics between the resonances; the minimum in the movement of the third formant from the steady state of /y/ to the following vowel serves as the point of segmentation.

5. Initial and Final /l/ and /r/

Both initial /l/ and /r/ had periods of steady resonances. The onset of a vowel after /l/ was usually unambiguously defined on the narrow-band spectrograms by the sudden change in marking of the harmonics between the various resonances at the change from steady formants to onglide. Initial /r/ often had a slight fricative quality. In addition, the frequency movements of the third formants usually provided a clue for the segmentation.

Final /l/ and /r/ presented particularly difficult problems. Very often the formant movements were quite smooth, and the establishment of a boundary on the basis of broad-band spectrograms was questionable. Intensity curves were helpful in instances where the vowel had an intrinsic energy considerably different from that of /l/ or /r/. In the transition from the vowel nucleus to /l/ a frequency minimum or a relatively rapid rise in the frequency of the third formant was sometimes present and was used as the basis of the segmentation. In the total set of data, the third formant of /l/ had an average frequency value of 2635 cps, and the change from the usually lower third-formant position of the vowel to that of /l/ sometimes involved a well-defined change point. But in a rather large number of instances, the formant movements appeared smooth, there was no significant change in the intensity, and the determination of a boundary had to be accomplished by some other criterion.

It was observed that the fundamental voice-frequency curve employed in each utterance had certain characteristic distributional features. The initial consonant of the word in the frame appeared to determine the occurrence of the peak of the fundamental curve. When the initial consonant was voiced, the peak occurred in the middle of the nucleus of the target word, with a rather smooth glide of the fundamental (usually upward but often down on voiced plosives) during the initial voiced consonant. If the consonant was voiceless, and particularly when the consonant was a voiceless fricative, the peak occurred immediately at the onset of voicing, and the fundamental on the syllable nucleus thereafter decreased. The total drop in pitch normally took place during the vocalic part of the syllable. When the final consonant was voiceless, this might have been expected. But when the final consonant was voiced, the fundamental pitch reached its minimum value by the beginning of the consonant and remained almost completely level for the duration of the consonant. This pattern was observed with very great regularity, and we concluded that in this type of utterance the region where the fundamental has become essentially level may be considered the consonant part.

Figure 3 illustrates the parallelism between such words as *coin* and *coil*, where the fundamental voice frequency was used to determine the boundary between the syllable nucleus and final /l/. The tenth harmonic has been traced in white, and provides a visual representation of the fundamental movement associated with this intonation. Some examples of initial /l/ are also included in Fig. 3 to illustrate that in initial position, the rise in pitch takes place during the pronunciation of the voiced resonant; level fundamental frequency is not a characteristic of all /l/ sounds.

Examples of final /r/ may be found on Fig. 2, where the segmentation has been based on two clues: the steady fundamental frequency associated with final position, and the change in the third-formant frequency. Initial /r/ sounds are represented in Fig. 1. Approximate segmentation may be achieved by comparing the relative markings of the harmonics in the narrow-band spectrogram and by identifying the position at which the third formant begins to rise rapidly in frequency in the broad-band spectrogram.

2. The Palestinian Carrier Forms For Vowel Tokens

The following pages list the carrier forms for the Palestinian vowel tokens. In each carrier form, the analysed vowel is bolded and enlarged. By accident, occasionally only one token of a carrier form was recorded from KS or KG. This means that in such cases only one token of a particular vowel was analysed for one of the speakers.

Some carrier forms are marked with the following symbols:

⌖	the analysed vowel is underlyingly long (for surface short vowels)
⌖	the analysed vowel is underlyingly short (for surface long vowels)
e	the analysed vowel is epenthetic
⊗	the lexical item was not documented for the other dialect

/I/ - Pharyngealisation Harmony Contexts

CONTEXT	CARRIER FORM			
	Abu Shusha dialect FORM	GLOSS	**Jafa dialect** FORM	GLOSS
<u>open syllable</u>				
no trigger	{ˈs**i**.d-o} ⊕	'grandpa'	{ˈs**i**.d-o} ⊕ [1]	'grandpa'
adjacent guttural	{ˈh**ɪ**.bə}	(fem. name)	{ˈh**ɪ**.bə}	(fem. name)
adjacent emphatic	{ˈf̙**ɪ**.ð̙-i}	'empty (masc.sg.)' (Adj)	{ˈf̙**ɪ**.d̙-i}	'empty (masc.sg.)' (Adj)
non-local harmony	{ˈf**ɪ**.lɪm}	'movie'	{ˈf**ɪ**.lɪm}	'movie'
	{ˈtʃ**ɪ**.bɪr}	'he got bigger'	{ˈk**ɪ**.bɪr}	'he got bigger'
	{ˈm**ɪ**.ʃɪt̙}	'comb' (N)	*no form recorded* [2]	
	{ˈʁɪ.l**ɪ**.bə}	'bother' (N)	{ˈʁɪ.l**ɪ**.bə}	'bother' (N)
<u>closed syllable</u>				
no trigger	{ˈfɪ.l**ɪ**m} ⓔ	'movie'	{ˈfɪ.l**ɪ**m} ⓔ	'movie'
adjacent guttural	{ˈb-**ɪ**ʁ.li}	'he's boiling (something)'	{ˈb-j-**ɪ**ʁ.li}	'he's boiling (something)'
adjacent emphatic	{ˈmɪ.ʃ**ɪ**t̙} ⓔ	'comb'	*no form recorded* [2]	
non-local harmony	{b̙-**ɪ**t̙.-ˈs̙ʊb̙b̙} ⓔ	'she's pouring (something)'	{b̙-**ɪ**t̙.-ˈs̙ʊb̙b̙} ⓔ	'she's pouring (something)'

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[1]Jafa stem-final mid {e} and {o} are similar to [ɛ] and [ɔ], respectively; e.g., Jafa {ˈsi.d-o} [ˈsi.dɔ].

[2]The Jafa form for 'comb' (N) is {mʊ.sʊt̙}.

	{b-ɪt.-ˈmaʃ.ʃɪt}	'she's combing (something)'	{b-ɪt.-ˈmaʃ.ʃɪt}	'she's combing (something)'
	{ˈb-ɪf.tɜħ}	'he's opening (something)'	{ˈb-j-ɪf.tɜħ}	'he's opening (something)'
stem-final	{b-ɪt.-mɛl.ˌli.-l-i-j.ˈjæː-h}	'she's filling it (masc.) for me'	{b-ɪt.-mɛl.ˌli.-l-i-j.ˈjæː-h}	'she's filling it (masc.) for me'
	{ˌt-ɪm.sɜ.ħ-i.-ˈnæː-ʃ}[3]	'(2 fem. sg.) don't wipe us!'	*no form recorded*[4]	
	{lɜ.-ˈħæː.l-i}	'by myself'	{lɜ.-ˈħæːl-i}	'by myself'
	{ʔɪt.-ˌkus.s-i.-ˈɲɐː-ʃ}	'(2 fem. sg.) don't cut us!'	*no form recorded*[5]	
	{tɜ˃ʕ.ˌmi.-ɲ-i-j.ˈjæː-h}	'(2 masc./fem. sg.) feed it (masc.) to me!'	{tɜ˃ʕ.ˌmi.-ɲ-i-j.ˈjæː-h}	'(2 masc./fem. sg.) feed it (masc.) to me!'
	{rɜ˃ʃ.ˈʃæː.ʃ-i}	'my machine gun'	{rɜ˃ʃ.ˈʃæː.ʃ-i}	'my machine gun'

/E/ - Pharyngealisation Harmony Contexts

	Abu Shusha dialect FORM	GLOSS	**Jafa dialect** FORM	GLOSS
open syllable				
no trigger	{ˈʤe.b-ə}	'pocket'	{ˈʤe.be}	'pocket'
adjacent guttural	*no form recorded*		*no form recorded*	
adjacent emphatic	*no form recorded*		*no form recorded*	

[3]In Abu Shusha and Jafa, the 2 subj. prefix /t-/ is frequently elided in forms which begin with /t/; e.g., this form is underlyingly /t-tÆʕmI-nI/.

[4]Jafa has one form for '(2 masc./fem. sg.) don't wipe us!': {ˈla.-t-ɪm.ˌsɜħ.-nə}.

[5]Jafa has one form for '(2 masc./fem. sg.) don't cut us!': {ˈla.-ɪt.-ˌʔus.-ɲə}.

non-local harmony	{ˈ**kɛ**.l-ɜt}	'she fried (something)'	{ˈ**ʔɛ**.l-ɜt}	'she fried (something)'
<u>closed syllable</u>				
no trigger	{mɜ.-ˌ**mɛl**.l-e.-ˈnæː-ʃ}	'we didn't fill (something)'	{ˈma.-**mɛl**.ˌl-e.-nə}	'we didn't fill (something)'
adjacent guttural	*no form recorded*		*no form recorded*	
adjacent emphatic	*no form recorded*		*no form recorded*	
non-local harmony	*no form recorded*		*no form recorded*	
<u>stem-final</u>	{mɜ.-ˌmɛl.l-**e**.-ˈnæː-ʃ}⊕	'we didn't fill (something)'	{ˈma.-mɛl.ˌl-**e**.-nə}⊕	'we didn't fill (something)'
	{mɜ.-ˌʃɜχ.χ-**e**.-ˈnæː-ʃ}⊕	'we didn't urinate/defecate'	{ˈma.-ʃɜχ.ˌχ-**e**.-nə}⊕	'we didn't urinate/defecate'
	{mɜ.-ˌʁɜl.l-**e**.-ˈnæː-ʃ}⊕	'we didn't boil (something)'	{ˈma.-ʁɜ.ˌl-**e**.-nə}⊕	'we didn't boil (something)'
	{m̙ɜ˃.-ˌn̙ɜ˃t̙.t̙-**e**.-ˈn̙ɐː-ʃ}⊕	'we didn't jump'	{ˈma.-n̙ɜ˃t̙.ˌt̙-**e**.-nə}⊕	'we didn't jump'
	{m̙ɜ˃.-ˌt̙ɜ˃ʕ̙.m̙-**e**.-ˈn̙ɐː-ʃ}⊕	'we didn't feed (someone/something)'	{ˈma.-t̙ɜ˃ʕ̙.ˌm̙-**e**.-nə}⊕	'we didn't feed (someone/something)

/Æ/ - Pharyngealisation Harmony Contexts

	Abu Shusha dialect FORM	GLOSS	**Jafa dialect** FORM	GLOSS
<u>open syllable</u>				
no trigger	{ˈs**æ**.mi}	(masc. name)	{ˈs**æ**.mi}	(masc. name)
adjacent guttural	{ˈh**a**.n-ə}⊕	'here'	*no form recorded* [6]	
adjacent emphatic	{ˈm̙**ɑ**.r̙ə}	'woman, wife'	{ˈm̙**ɑ**.r̙ə}	'woman, wife'

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[6]The Jafa form for 'here' is {hoːn}.

non-local harmony	{ˈsa.mɪr}	(masc. name)	{ˈsa.mɪr}	(masc. name)
	{ˈka.ʃɜ˃ṛ}	'he flaked (something) off'	{ˈʔa.ʃɜ˃ṛ}	'he flaked (something) off'
	{ˈma.sɜ.ħ-ə}	'he wiped it (masc.)'	{ˈma.sə.ħ-o}	'he wiped it (masc.)'
<u>closed syllable</u>				
no trigger	{ʃamm}	'Shem'	{ʃamm}	'Shem'
adjacent guttural	{fɜt.ˈħ-at.-l-i}	'she opened (something) for me'	{fɜt.ˈħ-at.-l-i}	'she opened (something) for me'
adjacent emphatic	{ˌsɜtʃ.tʃɜ˃.ˈṛ-ʌṭ.-ḷ-i}	'she closed (something) for me'	{ˌsɜk.kɜ˃.ˈṛ-ʌṭ.-ḷ-i}	'she closed (something) for me'
non-local harmony	{ʕɜd.ˈdaṭ.-ḷ-i}	'she counted for me'	{ʕɜd.ˌdaṭ.-ḷ-i}	'she counted for me'
	{ˌṭaịj.j̣ɜ˃.ˈḅ-ʌṭ.-ṇi}	'she made me become well'	{ˌṭaịj.j̣ɜ˃.ˈḅ-ʌṭ.-ṇi}	'she made me become well'
	{ˈmaʃ.ʃɜ˃.ṭ-ɜ˃ṭ}	'she combed (something)'	{ˈmaʃ.ʃɜ˃.ṭ-ɜ˃ṭ}	'she combed (something)'
<u>stem-final</u>	*no form recorded*		*no form recorded*	

/Æ/ - Uvularisation Harmony Contexts

	Abu Shusha dialect FORM	GLOSS	**Jafa dialect** FORM	GLOSS
<u>no emphatic</u>	{ˈsæ.mi}	(masc. name)	{ˈsæ.mi}	(masc. name)
	{ˈha.n-ə}⌖	'here'	*no form recorded* [6]	
	{ˈma.sɜ.ħ-ə}	'he wiped it (masc.)'	{ˈma.sə.ħ-o}	'he wiped it (masc.)'
	{ʃamm}	'Shem'	{ʃamm}	'Shem'

	{ˈs**a**.mɪr}	(masc. name)	{ˈs**a**.mɪr}	(masc. name)
	{fɜt.ˈħ-**a**t.-l-i}	'she opened (something) for me'	{fɜt.ˈħ-**a**t.-l-i}	'she opened (something) for me'
	{ʕɜd.ˈd**a**t̙.-l̙-i}	'she counted for me'	{ʕɜd.ˌd**a**t̙.-l̙-i}	'she counted for me'
<u>blocked</u>	{ˈm**a**ʃ.ʃɜ˃.t̙-ɜ˃t̙}	'she combed (something)'	{ˈm**a**ʃ.ʃɜ˃.t̙-ɜ˃t̙}	'she combed (something)'
	{ˈk**a**.ʃɜ˃r̙}	'he flaked (something) off'	{ˈʔ**a**.ʃɜ˃r̙}	'he flaked (something) off'
<u>emphatic</u>	{ˈm̙**ɑ**.r̙ə}	'woman, wife'	{ˈm̙**ɑ**.r̙ə}	'woman, wife'
	{ˌsɜtʃ.tʃɜ˃.ˈr̙-**ʌ**t̙.-l̙-i}	'she closed (something) for me'	{ˌsɜk.kɜ˃.ˈr̙-**ʌ**t̙.-l̙-i}	'she closed (something) for me'
	{ˌt̙aij̙.j̙ɜ˃.ˈb̙-**ʌ**t̙.-n̙i}	'she made me become well'	{ˌt̙aij̙.j̙ɜ˃.ˈb̙-**ʌ**t̙.-n̙i}	'she made me become well'

/O/ - Pharyngealisation Harmony Contexts

	Abu Shusha dialect FORM	GLOSS	**Jafa dialect** FORM	GLOSS
<u>open syllable</u>				
no trigger	{ˈm**o**.nə}	(fem. name)	{ˈm**o**.nə}	(fem. name)
adjacent guttural	*no form recorded*		*no form recorded*	
adjacent emphatic	*no form recorded*		*no form recorded*	
non-local harmony	*no form recorded*		*no form recorded*	
<u>closed syllable</u>				
no trigger	*no form recorded*		*no form recorded*	
adjacent guttural	*no form recorded*		*no form recorded*	
adjacent emphatic	*no form recorded*		*no form recorded*	
non-local harmony	*no form recorded*		*no form recorded*	

	Abu Shusha FORM	GLOSS	Jafa FORM	GLOSS
<u>stem-final</u>	{ˈsi.d-**O**}	'grandpa'	{ˈsi.d-**O**}	'grandpa'
	{ˈχal.t-**O**}	'maternal auntie'	{ˈχal.t-**O**}	'maternal auntie'
			{ˈn̙ʌt̙.t̙-**O**}[7]	'they (masc.) jumped'
			{ˈma.-b-ɪj.-t̙ɜ˃ʕ̙.ˌm̙-**O**.-n̙ə}	'they (masc.) don't feed us'
			{ˈma.-b-ɪj.-r̙ɜ˃ʃ.ˌħ-**O**.-nə}	'they (masc.) don't give us a cold'
			{ˈma.-b-j-ɪf.tɜ.ˌħ-**O**-l.-nə}	'they (masc.) don't open (something) for us'

/U/ - Pharyngealisation Harmony Contexts

	Abu Shusha dialect FORM	GLOSS	**Jafa dialect** FORM	GLOSS
<u>open syllable</u>				
no trigger	{ˈd**U**.d-ə}⌖	'worm'	{ˈd**U**.d-e}⌖	'worm'
adjacent guttural	{ʃ**U**.ˈhuː}⊗	'what?!'	*no form recorded*	
adjacent emphatic	{ʃ**U**.ˈr̙uːk̙}	'sunrise'	{ʃ**U**.ˈr̙uːʔ̙}	'sunrise'
non-local harmony	{ˈk**U**.tʊb}	'books'	{ˈk**U**.tʊb}	'books'
<u>closed syllable</u>				
no trigger	{ˈkʊ.t**U**b}ⓔ	'books'	{ˈkʊ.t**U**b}ⓔ	'books'

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[7]The 3 masc. pl. subj. suffix is /-U/ in Abu Shusha, /-O/ in Jafa. For the Abu Shusha cognates of the Jafa carrier forms for stem-final /O/, see the carrier forms for stem-final /U/.

adjacent guttural	{ˈsʊ.χ**ʊ**n}	‘hot (masc. sg.)’ (Adj)	{ˈsʊ.χ**ʊ**n}	‘hot (masc. sg.)’ (Adj)
adjacent emphatic	{ḅ-ɪṭ.-ˈṣ**ʊ**ḅḅ}	‘she’s pouring (something)’	{b-ɪṭ.-ˈṣ**ʊ**ḅḅ}	‘she’s pouring (something)’
non-local harmony	{ˈs**ʊ**tʃ.tʃɜ˃ṛ}	‘sugar’	{ˈs**ʊ**k.kɜ˃ṛ}	‘sugar’
	{m**ʊ**f.tɜ.ˈħ-eːn}	‘two keys’	{m**ʊ**f.tɜ.ˈħ-eːn}	‘two keys’
<u>stem-final</u>	{mɛl.ˈl-eː.-t**u**}	‘you (masc. pl.) filled (something)’	*no form recorded*	
	{bɪ.-ˈʁɛl.b-**u**}	‘they (masc.) bother (something)’		
	{ˈṇʌṭ.ṭ-**u**}	‘they (masc.) jumped’		
	{ḅɪ.-ˌṭɜ˃ʕ̣.ṃ-**u**.-ˈṇɐː-ʃ}	‘they (masc.) don’t feed us’		
	{ḅɪ.-ˌṛɜ˃ʃ.ħ-**u**.-ˈnæː-ʃ}	‘they (masc.) don’t give us a cold’		
	{ˌb-ɪf.tɜ.ħ-**u**-l.-ˈnæː-ʃ}	‘they (masc.) don’t open (something) for us’		

/Iː/ - Pharyngealisation Harmony Contexts

	Abu Shusha dialect FORM	GLOSS	**Jafa dialect** FORM	GLOSS
<u>open syllable</u>				
no trigger	{sə.ˈf**i**ː.nə}	‘boat’	{sə.ˈf**i**ː.ne}	‘boat’
adjacent guttural	{ˈtħ**i**ː.n-ə}	‘tahini’	{ˈtħ**i**ː.n-e}	‘tahini’
adjacent emphatic	{ṇ.ˈð̣**i**ː.ḟ-ə}	‘clean (fem. sg.)’ (Adj)	{ṇ.ˈḍ**i**ː.f-e}	‘clean (fem. sg.)’ (Adj)
non-local harmony	{χɜ.ˈf**i**ː.f-ə}	‘weak (fem. sg.)’	{χɜ.ˈf**i**ː.f-e}	‘weak (fem. sg.)’

	{ṭau.ˈwịː.ḷ-ə}	‘tall (fem. sg.)’	{ṭɑ.ˈwiː.l-e}	‘tall (fem. sg.)’
	{ṛɜ˃.ˈʃiː.d-ə}	(fem. name)	{ṛɜ˃.ˈʃiː.d-ə}	(fem. name)
<u>closed syllable</u>				
no trigger	{tiːn}	‘figs’	{tiːn}	‘figs’
adjacent guttural	{tħiːn}	‘flour’	{tħiːn}	‘flour’
adjacent emphatic	{ṇ.ˈð̣iːf̣}	‘clean (masc. sg.)’ (Adj)	{ṇ.ˈḍiːf}	‘clean (masc. sg.)’ (Adj)
non-local harmony	{χɜ.ˈfiːf}	‘weak (masc. sg.)’	{χɜ.ˈfiːf}	‘weak (masc. sg.)’
	{ṭau.ˈwịːḷ}	‘tall (masc. sg.)’	{ṭɑ.ˈwiːl}	‘tall (masc. sg.)’
	{ṛɜ˃.ˈʃiːd}	(masc. name)	{ṛɜ˃.ˈʃiːd}	(masc. name)
<u>stem-final</u>	{ˈfiː.-nə}⌖	‘with us’	{ˈfiː.-nə}⌖	‘with us’
	{bɪ̣-ṭ.-ḳuṣ.ˈṣ-iː.-ṇə}⌖	‘you (fem.sg.) are cutting us’	{bɪ̣-ṭ.-ʔ̣uṣ.ˈṣ-iː.-nə}⌖	‘you (fem.sg.) are cutting us’
	{ṭɜ˃ʕ̣.ˈṃiː.-ṇi}⌖	‘(2 masc./fem. sg.) feed me!’	{ṭəʕ̣.ˈṃiː.-ni}⌖	‘(2 masc./fem. sg.) feed me!’
	{bɪ-t.-fɜr.ˈʃ-iː.-hɪn}⌖	‘you (fem.sg.) are furnishing them (fem.)’	{bɪ-t.-frɪ.ˈʃ-iː.-hʊm}⌖	‘you (fem.sg.) are furnishing them (masc./fem.)’
	{b-t-ìm.sɜ.ˈħ-iː.-nə}⌖	‘you (fem.sg.) are wiping us’	{b-t-ìm.sɜ.ˈħ-iː.-nə}⌖	‘you (fem.sg.) are wiping us’
	{bɪ.-t-ɪʁ.ˈl-iː-h}⌖	‘you (fem.sg.) are boiling it (masc.)’	{bɪ.-t-ɪʁ.ˈl-iː-h}⌖	‘you (fem.sg.) are boiling it (masc.)’

/Eː/ - Pharyngealisation Harmony Contexts

	Abu Shusha dialect FORM	GLOSS	**Jafa dialect** FORM	GLOSS
open syllable				
no trigger	{bə.ˈb-**eː**.n-i}	'my two doors'	{bə.ˈb-**eː**.n-i}	'my two doors'
adjacent guttural	{ˌmʊf.tɜ.ˈħ-**eː**.n-i}	'my two keys'	{ˌmʊf.tɜ.ˈħ-**eː**.n-i}	'my two keys'
adjacent emphatic	{mɪʃ.ˈt̝-**eː**.n̝-i}	'my two combs'	{mʊʃ.ˈt̝-**eː**.n-i}	'my two combs'
non-local harmony	{s̝ɛ.ˈf̝-**eː**.n̝-i}	'my two summers'	{s̝ɛ.ˈf̝-**eː**.n-i}	'my two summers'
	{fɜ.rɪʃ.ˈt-**eː**.n-i}	'my two mattresses'	{fɜ.rɪʃ.ˈt-**eː**.n-i}	'my two mattresses'
	{ħɜ.bi.ˈb-**eː**.n-i}	'my two beloveds'	{ħɜ.bi.ˈb-**eː**.n-i}	'my two beloveds'
closed syllable				
no trigger	{bə.ˈb-**eː**n}	'two doors'	{bə.ˈb-**eː**n}	'two doors'
adjacent guttural	{ˌmʊf.tə.ˈħ-**eː**n}	'two keys'	{ˌmʊf.tɜ.ˈħ-**eː**n}	'two keys'
adjacent emphatic	{mɪʃ.ˈt̝-**eː**n̝}	'two combs'	{mʊʃ.ˈt̝-**eː**n}	'two combs'
non-local harmony	{s̝ɛ.ˈf̝-**eː**n̝}	'two summers'	{s̝ɛ.ˈf̝-**eː**n}	'two summers'
	{fɜ.rɪʃ.ˈt-**eː**n}	'two mattresses'	{fɜ.rɪʃ.ˈt-**eː**n}	'two mattresses'
	{bɜʕ.ˈd**eː**n}	'later'	{bɜʕ.ˈd**eː**n}	'later'
stem-final	{mɛl.ˈl-**eː**.-tu}	'you (masc. pl.) filled (something)'	{mɛl.ˈl-**eː**.-to}	'you (masc. pl.) filled (something)'

{n̙ɜ˃t̙.ˈt̙-**eː**.-t̙u}	‘you (masc. pl.) jumped’	{n̙ɜ˃t̙.ˈt̙-**eː**.-to}	‘you (masc. pl.) jumped’
{t̙ɜ˃ʕ̙.ˈm̙-**eː**.-t̙u}	‘you (masc. pl.) fed (someone/something)’	{t̙ɜ˃ʕ̙.ˈm̙-**eː**.-to}	‘you (masc. pl.) fed (someone/something)’
{ʃɜχ.ˈχ-**eː**.-tu}	‘you (masc. pl.) urinated/defecated’	{ʃɜχ.ˈχ-**eː**.-to}	‘you (masc. pl.) urinated/defecated’
{ʕɜ.ˈl**eː**-h}	‘on it (masc.)’	{ʕɜ.ˈl**eː**-h}	‘on it (masc.)’

/Æː/ - Pharyngealisation Harmony Contexts

	Abu Shusha dialect FORM	GLOSS	**Jafa dialect** FORM	GLOSS
<u>open syllable</u>				
no trigger	{ˈsn**æː**.n-i}	‘my teeth’	{ˈsn**æː**.n-i}	‘my teeth’
adjacent guttural	{lɜ.-ˈħ**æː**.l-i}	‘by myself’	{lɜ.-ˈħ**æː**.l-i}	‘by myself’
non-local harmony	{nɜʕ.ˈs**æː**.n-ə}	‘sleepy (fem. sg.)’	{nɜʕ.ˈs**æː**.n-e}	‘sleepy (fem. sg.)’
	{ɾ̙ɜ˃ʃ.ˈʃ**æː**.ʃ-i}	‘my machine gun’	{ɾ̙ɜ˃ʃ.ˈʃ**æː**.ʃ-i}	‘my machine gun’
<u>closed syllable</u>				
no trigger	{sn**æː**n}	‘teeth’	{sn**æː**n}	‘teeth’
adjacent guttural	{tɪm.ˈs**æː**ħ}	‘crocodile’	{tɪm.ˈs**æː**ħ}	‘crocodile’
non-local harmony	{nɜʕ.ˈs**æː**n}	‘sleepy (masc. sg.)’	{nɜʕ.ˈs**æː**n}	‘sleepy (masc. sg.)’
	{ɾ̙ɜ˃ʃ.ˈʃ**æː**ʃ}	‘machine gun’	{ɾ̙ɜ˃ʃ.ˈʃ**æː**ʃ}	‘machine gun’
<u>stem-final</u>	{ʔə.ˈʤ-**æː**.-ni}⌖	‘he came to me’	{ʔə.ˈʤ-**æː**.-l-i}⌖	‘he came to me’

	{b̙ɪ.-k̙ʊs̙.ˌs̙-.l̙-ɜ˃.k̙-ɪj.ˈjæː-h}⊕	‘he’s cutting it (masc.) for you (masc. sg.)’	{bɪ.-ʔ̙ʊs̙.ˌs̙-.l̙-ɜ˃.k̙-ɪj.ˈjæː-h}⊕	‘he’s cutting it (masc.) for you (masc. sg.)’
	{ʁɜ.ˈl-æː.-l-i}⊕	‘he boiled (something) for me’	{ʁɜ.ˈl-æː.-l-i}⊕	‘he boiled (something) for me’

/Æː/ - Uvularisation Harmony Contexts

	Abu Shusha dialect		**Jafa dialect**	
	FORM	GLOSS	FORM	GLOSS
no emphatic	{ˈsnæː.n-i}	‘my teeth’	{ˈsnæː.n-i}	‘my teeth’
	{lɜ.-ˈħæː.l-i}	‘by myself’	{lɜ.-ˈħæː.l-i}	‘by myself’
	{nɜʕ.ˈsæː.n-ə}	‘sleepy (fem. sg.)’	{nɜʕ.ˈsæː.n-e}	‘sleepy (fem. sg.)’
	{snæːn}	‘teeth’	{snæːn}	‘teeth’
	{tɪm.ˈsæːħ}	‘crocodile’	{tɪm.ˈsæːħ}	‘crocodile’
	{nɜʕ.ˈsæːn}	‘sleepy (masc. sg.)’	{nɜʕ.ˈsæːn}	‘sleepy (masc. sg.)’
	{ʔə.ˈʤ-æː.-ni}⊕	‘he came to me’	{ʔə.ˈʤ-æː.-l-i}⊕	‘he came to me’
	{ʁɜ.ˈl-æː.-l-i}⊕	‘he boiled (something) for me’	{ʁɜ.ˈl-æː.-l-i}⊕	‘he boiled (something) for me’
blocked	{r̙ɜ˃ʃ.ˈʃæː.ʃ-i}	‘my machine gun’	{r̙ɜ˃ʃ.ˈʃæː.ʃ-i}	‘my machine gun’
	{b̙ɪ.-k̙ʊs̙.ˌs̙-.l̙-ɜ˃.k̙-ɪj.ˈjæː-h}⊕	‘he’s cutting it (masc.) for you (masc. sg.)’	{bɪ.-ʔ̙ʊs̙.ˌs̙-.l̙-ɜ˃.k̙-ɪj.ˈjæː-h}⊕	‘he’s cutting it (masc.) for you (masc. sg.)’
	{r̙ɜ˃ʃ.ˈʃæːʃ}	‘machine gun’	{r̙ɜ˃ʃ.ˈʃæːʃ}	‘machine gun’
emphatic	{ˈs̙m̙ɐː.t̙-i}	‘my rash’	{ˈs̙m̙ɐː.t̙-i}	‘my rash’

{ʕ̣ɜ̣˃.ˈṭ-ɐː.-ṇi}⊕	'he gave (something) to me'	{ʕ̣ɜ̣˃.ˈṭ-ɐː.-ṇi}⊕	'he gave (something) to me'
{ṭɜ̣˃ʕ̣.ˈṃ-ɐː.-ṇi}⊕	'he fed me'	{ṭɜ̣˃.ʕ̣.ˈṃ-ɐː.-ṇi}⊕	'he fed me'
{ṇ.ˈð̣ɐːf̣}	'clean (masc. pl)'	{ṇ.ˈdɐːf}	'clean (masc. pl.)'
{ṭẉɐːḷ}	'tall (masc. pl.)'	{ṭwɐːl}	'tall (masc. pl.)'

/Oː/ - Pharyngealisation Harmony Contexts

	Abu Shusha dialect FORM	GLOSS	**Jafa dialect** FORM	GLOSS
open syllable				
no trigger	{ʔə.kə.ˈmOː.n-i}	'my Akamōn (brandname pain killer)'	{ʔə.kə.ˈmOː.n-i}	'my Akamōn (brandname pain killer)'
adjacent guttural	{ˈṛOː.ḥ-i}	'my spirit'	{ˈṛOː.ḥ-i}	'my spirit'
adjacent emphatic	{ṃɜ̣˃.ˈṭOː.ṛ-i}	'my motorcycle'	{ṃɜ̣˃.ˈṭOː.ṛ-i}	'my motorcycle'
non-local harmony	{ħɜ.ˈðOː.l-ə}⊗	'those (fem.)'	*no form recorded*[8]	
closed syllable				
no trigger	{ʔə.kə.ˈmOːn}	'Akamōn (brandname pain killer)'	{ʔə.kə.ˈmOːn}	'Akamōn (brandname pain killer)'
adjacent guttural	{ṛOːḥ}	'spirit'	{ṛOːḥ}	'spirit'
adjacent emphatic	{ṃɜ̣˃.ˈṭOːṛ}	'motorcycle'	{ṃɜ̣˃.ˈṭOːṛ}	'motorcycle'
non-local harmony	{ħɜ.ˈðOːl}	'those (masc.)'	{ħɜ.ˈdOːl}	'those (masc./fem.)'

[8]Jafa has one form for 'those (masc./fem.)': {ħɜ.ˈdoːl}.

<u>stem-final</u>	*no form recorded*		*no form recorded*	

/Uː/ - Pharyngealisation Harmony Contexts

	Abu Shusha dialcet FORM	GLOSS	**Jafa dialect** FORM	GLOSS
<u>open syllable</u>				
no trigger	{ʤə.ˈmuː.s-ə}	'female moose'	{ʤə.ˈmuː.s-e}	'female moose'
adjacent guttural	{ʔɜ.ˈχuː.-i}⌖	'my brother'	{ʔɜ.ˈχuː.-i}⌖	'my brother'
adjacent emphatic	{f̙ɜ˃k̙.ˈk̙uː.s̙-ə}	(a type of cucumber)	{f̙ɜ˃ʔ̙.ˈʔ̙uː.s-e}	(a type of cucumber)
non-local harmony	{mə.ri.ˈuː.l-ə}⊗	'bib'	*no form recorded*	
	{ħɜ.ˈnuː.n-ə}	'caring (fem. sg.)' (Adj)	{ħɜ.ˈnuː.n-e}	'caring (fem. sg.)' (Adj)
<u>closed syllable</u>				
no trigger	{duːd}	'worms'	{duːd}	'worms'
adjacent guttural	{mɜʃ.ˈʁuːl}	'busy (masc. sg.)'	{mɜʃ.ˈʁuːl}	'busy (masc. sg.)'
adjacent emphatic	{mə.ri.ˈuːl}	'apron'	{mə.ri.ˈuːl}	'apron'
non-local harmony	{ħɜ.ˈnuːn}	'caring (masc. sg.)' (Adj)	{ħɜ.ˈnuːn}	'caring (masc. sg.)' (Adj)
<u>stem-final</u>	{ʃə.ˈf-uː-h}⌖	'they saw it (masc.)'	{ʃə.ˈf-uː-h}⌖	'they (masc.) saw it (masc.)'
	{b̙ɪ.-k̙ʊs̙.ˈs̙-uː-h̙}⌖	'they (masc.) are cutting it (masc.)'	{bɪ-j.-ʔ̙ʊs̙.ˈs̙-uː-h}⌖	'they (masc.) are cutting it (masc.)'

{b̙ɪ.-t̙ɜ˃ʕ̙.ˈm̙-uː-ʃ}⊕[9]	'they (masc.) don't feed (someone/something)'
{bɪ.-fɜr.ˈʃ-uː-ʃ}⊕	'they (masc.) don't furnish (something)'
{b-ìm.sɜ.ˈħ-uː-ʃ}⊕	'they (masc.) don't wipe (something)'
{b-ɪʁ.ˈl-uː-ʃ}⊕	'they (masc.) aren't boiling (something)'

[9]The Jafa cognates for this and the next three Abu Shusha carrier forms for stem-final /Uː/ are: {ˈma.-b-ɪj.-ˌt̙ɜ˃ʕ̙.m̙-u}, {ˈma.-ˌb-j-ɪf.rɪ.ʃ-u}, {ˈma.-ˌb-j-ɪm.sɜ.ħ-u}, and {ˈma.-ˌb-j-ɪʁ.l-u}.

Appendix IV: Salish Language Classification

The classification of Salish languages below is based on Kinkade (1991), van Eijk (1987:viii-x), and p.c. from M.D. Kinkade, Susan Blake, and Donna Gerdts. Extinct languages or dialects are marked with '*'; slashes separate alternate labels for the same language or dialect.

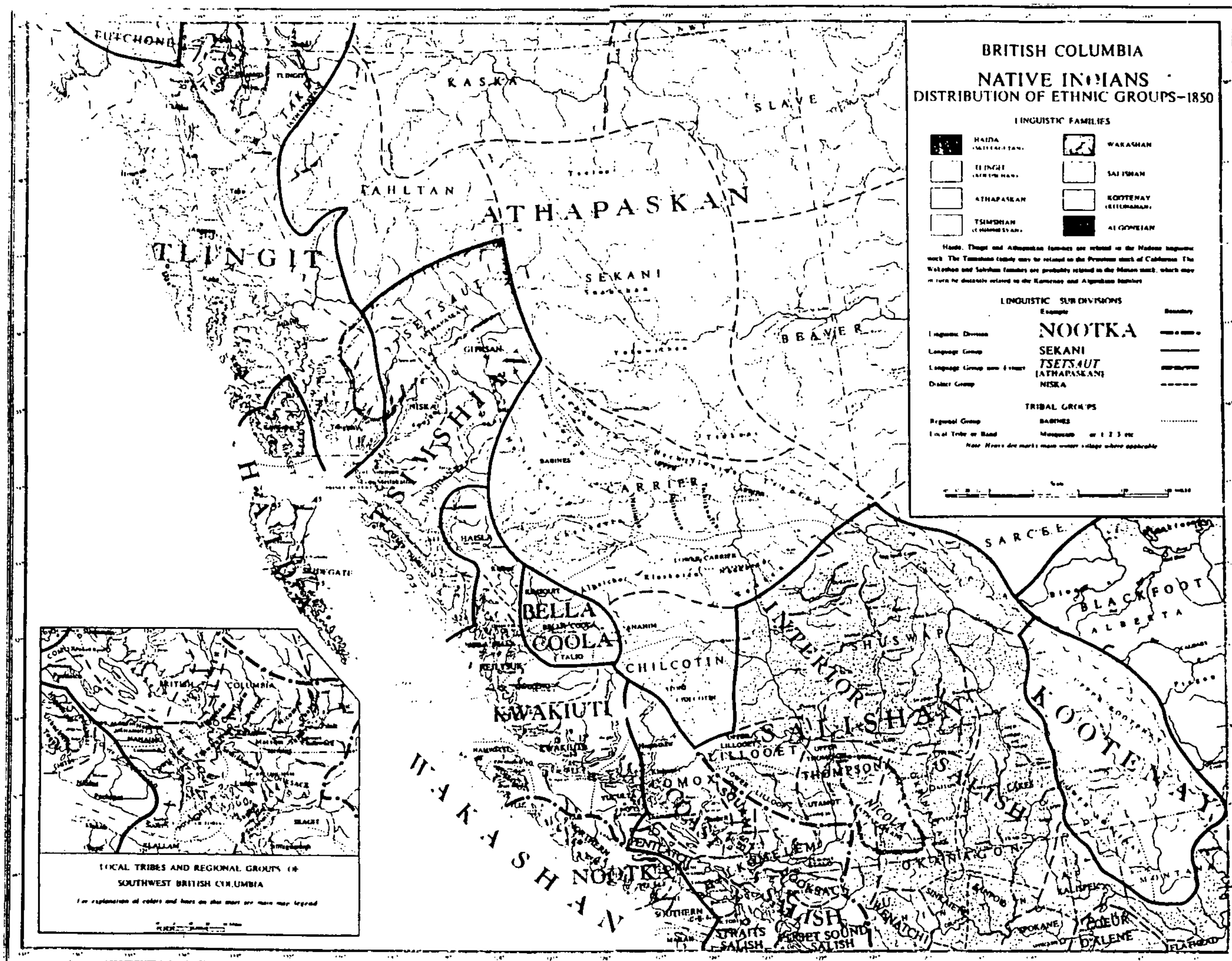
Division	Branch	Language	Major Dialect	Minor Dialect
Bella Coola	——	Nuxalk/Bella Coola	——	——
Central	——	Comox	ʔayʔaǰuθəm (Mainland Comox)	Sliammon
				Klahoose
				Homalco
			Island Comox*	——
		Pentlatch*	——	
		Sechelt/Seshelt	——	——
		Squamish	——	——
		Halkomelem	Upriver Halkomelem/Sto:lo	Tait
				Chilliwack River
				Chehalis
			Downriver Halkomelem	Katzie
				Musqueam
				Kwantlen*
			Island Halkomelem	Nanaimo
				Chemainus
				Cowichan
	Straits	Klallam	——	——
		Lkungen/Northern Straits	Saanich	——
			Sooke*	——
			Lummi	——
			Songish/Songees*	——
			Samish	——
			Semiahmoo*	——
		Nooksack	——	——
		Lushootseed/Puget Salish	Northern Lushootseed	Upper Skagit
				Lower Skagit Snohomish

			Southern Lushootseed	Skykomish
				Snoqualmie
				Duwamish
				Muckleshoot
				Puyallup
				Nisqually
				Sahewamish
		Twana/Skokomish*	——	——
Oregon	——	——	——	Tillamook*
		——	——	Siletz*
Tsamoan	Inland	Upper Chehalis	——	Satsop
				Oakville Chehalis
				Tenino Chehalis
		Cowlitz*	——	——
	Maritime	Lower Chehalis*	——	Northern
				Southern
		Quinault*	——	——
Interior	Northern	St'át'imcets/Lillooet/ Lí l'wat'ul	——	Upper St'át'imcets/Upper Lillooet/Fountain
				Lower St'át'imcets/ Lower Lillooet/ Mount Currie
		NLa'kapmx/Thompson	——	——
		Shuswap	Eastern Shushwap	Enderby
				Athalmer
			Western Shushwap	Canim Lake
				Deadman's Creek
				Kamloops
	Southern	Okanagan	Northern Okanagan	Head of the Lakes
				Okanagan
			Southern Okanagan	Colville
				San Poil - Nespelen
				Southern Okanagan
				Methow
		Columbian	——	Nxa'amxcin/Moses Columbian
				Wenatchi/ Peskwaus
				Chelan
		Kalispel	Spokane	——
			Kalispel	——
			Flathead	——
		Coeur d'Alene	——	——

Appendix V: Salish Language Map

Resources Map 12, British Columbia Natural Resources Conference, 1956[1]

REPRODUCED BY PERMISSION OF THE ROYAL BRITISH COLUMBIA MUSEUM, VICTORIA, B.C



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[1]There is now also a sizeable Lower St'át'imcets speech community in Mission, B.C., the general location of a previous residential school at the foot of St'át'imcets territory.

Appendix VI: The St'át'imcets Carrier Forms For Vowel Tokens

The carrier forms for the St'át'imcets vowel tokens are listed below. In each form, the analysed vowel is bolded and enlarged. Occasionally only one token of a carrier form was recorded from LC or LN; for such forms, only one token of a particular vowel was analysed for one of the speakers.

Certain carrier forms are marked with '⊗', which means that the lexical item was not documented for the other dialect.

/I/ - Pharyngealisation Harmony Contexts

CONTEXT	CARRIER FORM			
	Lower dialect FORM	GLOSS	**Upper dialect** FORM	GLOSS
no trigger				
no postvelar	{ ʔæmæ-ɰ̜ʷ**i**l'x}	'to get better, to recover (e.g., from a sickness)'	{ t͡ɬ'æm**i**n}⊗	'wool, fur'
	{ tʃ**i**-tʃ-l-uʃæʔ}	'fresh fruit'	{ tʃ**i**-tʃ-l-uʃæʔ}	'fresh fruit'
immediately preceding a laryngeal	{ xʷʔɑɹ̩-kæt**i**ʔ}	'not at all'	{ xʷʔɑɹ-kæt**i**ʔ}	'not at all'

immediately following a laryngeal	{ ʔæmh-**i**n’æk}	‘good gun’	*no form recorded*	
immediately following a guttural	{ ʁ**i**ʃ}	‘to shrink’	{ ʁ**i**ʃ}	‘to shrink’
	{ ʁ**i**ʃ-in’}	‘to shrink something (tr.)’		
immediately following an emphatic	{ ʁətʃ̙-k̙**i**n-upʔ-æm}	‘to lead horses by tying them to the tail of the horse in front’	{ ʁətʃ̙-k**i**n-upʔ-æm}	‘to lead horses by tying them to the tail of the horse in front’
	{ k̙’**i**ɬil}	‘to run’	{ k̙’**i**ɬil}	‘to run’
<u>trigger</u>				
immediately preceding a guttural	{ ɬɪ-’-ʁ’} [ɬɛʔ**ɛ**ʁ’]	‘to scatter (e.g., people leaving frm a gathering)’	{ ɬɪ-’-ʁ’} [ɬɛʔ**ɛ**ʁ’]	‘to scatter (e.g., people leaving from a gathering)’
immediately preceding an emphatic	{m**ɪ**x̙æɬ}	‘black bear’	{m**ɪ**x̙æɬ}	‘black bear’
	{tʃ’k̙ʷʔ**ɪ**k̙ʷ}	‘salmon stretcher’	{tʃ’ɔk̙ʷʔ**ɪ**k̙ʷ}	‘salmon stretcher’

/Æ/ - Pharyngealisation Harmony Contexts

	Lower dialect FORM	GLOSS	**Upper dialect** FORM	GLOSS
<u>no trigger</u>				
no postvelar	{ kæ-ʔæmhæ-ɬk**æ**n-æ}	‘I’ve become better’	{ kæ-ʔæmhæ-ɬk**æ**n-æ}	‘I’ve become better’

	{xʷʔɑɹ̣-k**æ**tiʔ}[1]	'not at all'	{t͡ɬ'**æ**min}⊗	'wool, fur'
immediately preceding a laryngeal	{k**æ**-ʔæmhæ-ɬkæn-æ}	'I've become better'	{k**æ**-ʔæmhæ-ɬkæn-æ}	'I've become better'
	{t͡ɬ'p**æ**ʔ}	'marrow'	{t͡ɬ'p**æ**ʔ}	'marrow'
immediately following a laryngeal	{kæ-ʔ**æ**mhæ-ɬkæn-æ}	'I've become better'	{kæ-ʔ**æ**mhæ-ɬkæn-æ}	'I've become better'
	{kæ-ʔæmh**æ**-ɬkæn-æ}	'I've become better'	{kæ-ʔæmh**æ**-ɬkæn-æ}	'I've become better'
immediately following a guttural	*no form recorded*		{ʃ-ʁ**æ**ɹ-xæl}	'something that one has piled up'
<u>trigger</u>				
immediately preceding a guttural	*no form recorded*		*no form recorded*	

[1]This word, which contains emphatic /ɹ̣/ {ɹ̣}, was inadvertently used as a carrier form for no postvelar /Æ/ (also as a carrier form for /Æ/ in the no emphatic context, as seen from the list of carrier forms for /Æ/ - uvularisation harmony contexts). However, the tokens of /Æ/ which occurred in this word are perceptually {æ} and cluster in the F_1 - F_2 plane with tokens of /Æ/ which occurred in words containing no postvelar; see the vowel graphs for St'át'imcets /Æ/ in chapter 3.

/Æ/ - Uvularisation Harmony Contexts

	Lower dialect FORM	GLOSS	**Upper dialect** FORM	GLOSS
<u>no trigger</u>				
immediately following an emphatic	{mɪx̙**æ**ɬ}	'black bear'	{mɪx̙**æ**ɬ}	'black bear'
	{mɑk̙**æ**ʔ}	'snow'	{mɑk̙**æ**ʔ}	'snow'
preceding an emphatic with intervening non-laryngeal	{ʔ**æ**tʃʼx̙-ən}	'to see something, someone (tr.)'	*no form recorded*	
other no trigger forms = forms with no emphatic in the word	{ k**æ**-ʔæmhæ-ɬkæn-æ}	'I've become better'	{ k**æ**-ʔæmhæ-ɬkæn-æ}	'I've become better'
	{ kæ-ʔ**æ**mhæ-ɬkæn-æ}	'I've become better'	{ kæ-ʔ**æ**mhæ-ɬkæn-æ}	'I've become better'
	{ kæ-ʔæmh**æ**-ɬkæn-æ}	'I've become better'	{ kæ-ʔæmh**æ**-ɬkæn-æ}	'I've become better'
	{ kæ-ʔæmhæ-ɬk**æ**n-æ}	'I've become better'	{ kæ-ʔæmhæ-ɬk**æ**n-æ}	'I've become better'
	{ t͡ɬʼp**æ**ʔ}	'marrow'	{ t͡ɬʼp**æ**ʔ}	'marrow'
	{ xʷʔɑɹ̙-k**æ**tiʔ}	'at all'	{ t͡ɬʼ**æ**min}⊗	'wool, fur'
			{ ʃ-ʁ**æ**ɹ-xæl}	'something that one has piled up'
<u>trigger</u>				
immediately preceding an emphatic	{m**ɑ**k̙æʔ}	'snow'	{m**ɑ**k̙æʔ}	'snow'
	{xniɹʼ**ɑ**ɹ̙ʼ}	'gooseberry bush'		

preceding an emphatic with intervening phonetic laryngeal	{mitʃɑ-'-ḳ} [mitʃɑʔḳ]	'to assume a sitting position'	{mitʃɑ-'-ḳ} [mitʃɑʔḳ]	'to assume a sitting position'

The epenthetic vowel - Pharyngealisation Harmony Contexts

	Lower dialect FORM	GLOSS	**Upper dialect** FORM	GLOSS
<u>no trigger</u>				
no postvelar	{ʃəx-ʃəx}	'partly crazy'	{ʃəx-ʃəx}	'partly crazy'
	{punɬəp}	'Rocky Mountain juniper'	{punɬəp}	'Rocky Mountain juniper'
	{kɵɰʷæʔtu}	(fem. name)	{kɵɰʷæʔtu}	(fem. name)
immedately preceding a laryngeal	*no form recorded*		*no form recorded*	
immedately following a laryngeal	{ʃ-p'iʔ-əl'ɰʷæʃ}	'squeezed in the middle'	*no form recorded*	
immediately following a guttural	{ʁətʃ̣-ḳin-upʔ-æm}	'to lead horses by tying them to the tail of the horse in front'	{ʁətʃ̣-ḳin-upʔ-æm}	'to lead horses by tying them to the tail of the horse in front'
	{ʁətʃ-ən}	'to tie something (intr., tr.)'	{ʁətʃ-ən}	'to tie something (intr., tr.)'
	{ʁʷɵl-ən}	'to burn something, set something on fire (intr., tr.)'		
<u>trigger</u>				
immediately preceding a guttural	{mɜ-'-ʁ}	'(breaking) daylight'	{mɜ-'-ʁ}	'(breaking) daylight'

	{ tʃ**ɜ**ʁ-ən}	‘to rip, tear something (tr.)’

The epenthetic vowel - Uvularisation Harmony Contexts

	Lower dialect		**Upper dialect**	
	FORM	GLOSS	FORM	GLOSS
	form	gloss	form	gloss
<u>no trigger</u>				
immediately following an emphatic	{ ḳ**ə**ɬ-ən}	‘to put something away, tobury something (tr.)’	{ ḳ**ə**ɬ-ən}	‘to put something away, to bury something (tr.)’
			{ʔætʃ’x̣-**ə**n}	‘to see something, someone (tr.)’
preceding an emphatic with intervening non-laryngeal	{ ʁ**ə**tʃ̣-ḳin-upʔ-æm}	‘to lead horses by tying them to the tail of the horse in front’	{ ʁ**ə**tʃ̣-ḳin-upʔ-æm}	‘to lead horses by tying them to the tail of the horse in front’
all other contexts = forms with no emphatic in the word	{ ʃ**ə**x-ʃəx}	‘partly crazy’	{ ʃ**ə**x-ʃəx}	‘partly crazy’
	{ punɬ**ə**p}	‘Rocky Mountain juniper’	{ punɬ**ə**p}	‘Rocky Mountain juniper’
	{ k**ɵ**ɰʷæʔtu}	(fem. name)	{ k**ɵ**ɰʷæʔtu}	(fem. name)
	{ m**ɜ**-’-ʁ}	‘(breaking) daylight’	{ m**ɜ**-’-ʁ}	‘(breaking) daylight’
	{ ʁ**ə**tʃ-ən}	‘to tie something (intr., tr.)’	{ ʁ**ə**tʃ-ən}	‘to tie something (intr., tr.)’
	{ ʃ-p’i′**ə**ʔ-l’ɰʷæʃ}	‘squeezed in the middle’		
	{ ʁʷ**ɵ**l-ən}	‘to burn something, set something on fire (intr., tr.)’		
	{ tʃ**ɜ**ʁ-ən}	‘to rip, tear something (tr.)’		

<u>trigger</u>				
immediately preceding an emphatic	{ ʔɔx̙ʷʔun}	‘to cough’	{ ʔɔx̙ʷʔun}	‘to cough’
			{ k̙ʌ̙lɰʷɪ̙l’x}	‘to get spoiled (e.g., meat, potatoes), to break down (car, wagon)’
preceding an emphatic with intervening phonetic laryngeal	*no form recorded*		*no form recorded*	

/U/ - Pharyngealisation Harmony Contexts

	Lower dialect FORM	GLOSS	**Upper dialect** FORM	GLOSS
<u>no trigger</u>				
no postvelar	{ p**u**nɬəp}	‘Rocky Mountain juniper’	{ p**u**nɬəp}	‘Rocky Mountain juniper’
	{ tʃi-tʃ-ɬ-**u**ʃæʔ}	‘fresh fruit’	{ tʃi-tʃ-ɬ-**u**ʃæʔ}	‘fresh fruit’
immedately preceding a laryngeal	{ ʔ**u**-ʔ-ʃæʔ}	‘egg’	{ ʔ**u**-ʔ-ʃæʔ}	‘egg’
immedately following a laryngeal	{ ʔ**u**-ʔ-ʃæʔ}	‘egg’	{ ʔ**u**-ʔ-ʃæʔ}	‘egg’
immediately following a guttural	{ ʁʷ**u**j’t}	‘to sleep’	{ ʁʷ**u**j’t}	‘to sleep’
	{ ʁʷ**u**j’t-itʃ’æʔ}	‘pajamas, nightie’	{ ʁʷ**u**j’t-itʃ’æʔ}	‘pajamas, nightie’

immediately following an emphatic	{ ʔʊ-’-x̙ʷ-**u**ʃæʔ}	‘to peel fruit (intr., tr.)’	*no form recorded*
	{ x̙ɹ̙**u**m}	‘big, large, great, important’	
<u>trigger</u>			
immediately preceding a guttural	{ ʃ-tʃ**ʊ**ʁʷ}	‘stripe’	*no form recorded*
immediately preceding an emphatic	*no form recorded*		*no form recorded*

Appendix VII: St'át'imcets Word List

Below is a list of the St'át'imcets forms cited in chapter 3. The list does not include forms which were cited only from van Eijk (1985) or (1987). (Forms cited only from the two van Eijk volumes were presented in chapter 3 in the North American transcription.) The list includes the carrier forms for the St'át'imcets acoustic study.

The data below are presented in underlying, surface, and phonetic form. The phonetic transcriptions include lowered vowel height and the excrescent vowel. The van Eijk orthography of each form is also given, after van Eijk (1995). Unless otherwise noted, the data are in the Lower dialect.

		Underlying Form	Surface Form	Phonetic Form	Orthography
1.	'a bunch of fruit trees'	/k̙ʷU ‿# k̙'ʷl-Æɹ̙'/	{ k̙ʷu ‿# k̙'ɵʷl-ɑɹ̙'}	[k̙ʷo ‿# k̙'ʷɵlɑɹ̙']	qwu-q'weláz'
2.	'bad'	/k̙l̙/	{ k̙ʌl̙}	[k̙ʌl̙]	qvl̲
3.	'bitter'	/tx̙/	{ tʌx̙}	[tʌx̙]	tex
4.	'black bear'	/mIx̙Æɬ/	{mɪx̙æɬ}	[mɛx̙æɬ]	mí xalh
5.	'brass'	/kʷl̙-It/	{kʷəl̙-it}	[kʷəl̙ət]	kwl̲it

6.	‘(breaking) daylight’	/GLOT, mʁ/	{ mɜ-’-ʁ’}	[mɜʔɜʁ’]	mé7eg’
7.	‘burned forest, any area where a fire went through’	/ʃ-p’Æʁ’/	{ ʃ-p’aʁ’}	[ʃp’aʁ’]	sp’ag’
8.	‘canoe’	/t͡ɬ’lÆɹ̙’/	{ t͡ɬ’lɑɹ̙’}	[t͡ɬ’lɑɹ̙’]	tl’laz’
9.	‘constipation’	/n-k’Æx-Æɬtʃ’Æʔ/	{ n-k’æx-æɬtʃ’æʔ}	[nk’æxæɬtʃ’æʔ]	nk’ácalhts’a7
10.	‘cranky (child),fussing’	/GLOT, kIx̙/	{ kɪ-’-x̙}	[kɛʔx̙]	kii7x
11.	‘downstream area’	/RED, n-kʷUtʃÆ/	{ n-kʷu-kʷtʃæ}	[nkʷukʷtʃæ]	nkwúkwtsa
12.	‘drunk’	/ʃ-k̙jÆx̙/	{ ʃ-k̙jɑx̙}	[ʃk̙jɑx̙]	sqyax
13.	‘each one, every one’	/RED, GLOT, ɹ̙Iʁ’/	{ ɹɪ-’-ɹʁ’}	[ɹiʔɹɜʁ’]	zî7zeg’
14.	‘egg’	/RED, ʔUʃÆʔ/	{ ʔu-ʔ-ʃæʔ}	[ʔuʔʃæʔ]	7ú7sa7
15.	(exclamation, used to urge a storyteller to continue his story)	/ʔIʔÆj/	{ ʔiʔæj}	[ʔiʔæj]	7i7áy
16.	(fem. name)	/kwÆʔtU/	{ kəɰʷæʔtu}	[kəɰʷæʔtu]	kewá7tu
17.	‘finger’	/x̙ʷUl-ÆkÆʔ/	{ x̙ʷul-ækæʔ}	[x̙ʷolækæʔ]	xwuláka7
18.	‘fish, (any kind of) salmon’	/tʃ’Uk̙ʷÆɹ̙’/	{tʃ’ʊk̙ʷɑɹ̙’}	[tʃ’ɔk̙ʷɑɹ̙’]	ts’úqwaz’
19.	‘fourteen’	/k̙’m’p # ɰʷI ‿# x̙ʷʔUtʃIn/	{ k̙’əm’p # ɰʷi ‿# x̙ʷʔutʃin}	[k̙’əm’p # ɰʷi ‿# x̙ʷʔotʃin]	q’em’p wi xw7útsin
20.	‘fresh fruit’	/RED, tʃIl̥-UʃÆʔ/	{ tʃi-tʃ-l-uʃæʔ}	[tʃitʃluʃæʔ]	tsitslúsa7
21.	‘good for nothing, useless (persons, horses, etc.)’	/RED, k̙l̙/	{ k̙ʌ-k̙ʌl̙ }	[k̙ʌk̙ʌl̙]	qvqvl̲
22.	‘good gun’	/ʔÆmÆ-In’Æk/	{ ʔæmh-in’æk}	[ʔæmhin’æk]	7amhí n’ak
23.	‘gooseberry bush’	/xnIɹ̙ˀ-Æɹ̙’/	{xniɹ’-ɑɹ̙’}	[xniɹ’ɑɹ̙’]	cní z’az’

24.	'green, yellow'	/kʷl̙-Iʔ/	{kʷəl̙-iʔ}	[k̙ʷəlei̯ ʔ]	kwl̲ii7
25.	'handsome (in face)'	/ʔÆmÆ-Us/	{ʔæmh-us}	[ʔæmhus]	7ámhus
26.	'hat'	/k̙mUt/	{k̙əmut}	[k̙əmut]	qmut
27.	'huckleberry'	/mxÆɹ̙/	{ məxɑɹ̙}	[məxɑɹ̙]	mecáz'
28.	'I've become better'	/kÆ-ʔÆmÆ-ɬkÆn-Æ/	{ kæ-ʔæmhæ-ɬkæn-æ}	[kæʔæmhæɬkænæ]	ka-7ámhalhkan-a
29.	'leaf'	/ptʃkɬ/	{pətʃkəɬ}	[pətʃkəɬ]	pétskelh
30.	'light, bright'	/RED, mÆʁ/	{ mɜʁ-maʁ}	[mɜʁəmaʁ]	megmág
31.	'loose (objects, also ways of behaviour)'	/RED, ʃIʁʷ/	{ ʃəʁʷ-ʃɪʁʷ}	[ʃəʁʷʃɛʁʷ]	segwsí gw
32.	'lynx'	/tʃk̙ʷ-ÆnÆʔ/	{ t̙ʃk̙ʷ-ænæʔ}	[t̙ʃk̙ʷænæʔ]	tsqwána7
33.	'marrow'	/t͡ɬ'pÆʔ/	{ t͡ɬ'pæʔ}	[t͡ɬ'pæʔ]	tl'pa7
34.	'mouth'	/tʃUtʃIn/	{ tʃutʃin}	[tʃutʃin]	tsútsin
35.	'night'	/ʃItʃt/	{ ʃitʃt}	[ʃitʃt]	sitst
36.	'not at all'	/xʷʔÆɹ̙-kÆtIʔ/	{xʷʔɑɹ̙-kæti?}	[xʷʔɑɹ̙kætiʔ]	cw7aoz-káti7
37.	'otter'	/lhÆtʃ'/	{ ləhætʃ'}	[ləhætʃ']	leháts'
38.	'pajamas, nightie'	/ʁʷUj't-Itʃ'Æʔ/	{ ʁʷuj't-itʃ'æʔ}	[ʁʷoj'titʃ'æʔ]	gwuy'tí ts'a7
39.	'pale, fading, faded'	/GLOT, pʁ/	{pɜ-'-ʁ'}	[pɜʔɜʁ']	pé7eg'
40.	'partly crazy'	/RED, ʃx/	{ ʃəx-ʃəx}	[ʃəxʃəx]	sécsec
41.	'pig' (Chinook Jargon borrowing)	/kʷUʃ̙U/	{kʷʊʃ̙u}	[kʷɔʃ̙o]	kwos̲ó
42.	'really, very much; to be in the way'	/ʃ-tx̙ʷ/	{ ʃ-tɔx̙ʷ}	[ʃtɔx̙ʷ]	stexw

43.	'Rocky Mountain juniper'	/pUn-ɬp/	{ punɬ-əp}	[punɬəp]	púnlhep
44.	'room, spaces in between things'	/RED, lÆʁ'ʷ/	{ ləʁʷ-laʁ'ʷ}	[ləʁʷlaʁ'ʷ]	legwlág'w
45.	'rose'	/ḳḷ'ḳ/	{ḳʌḷ'ḳ}	[ḳʌḷ'ḳ]	qvl̲'q
46.	'salmon head'	/x̣ʷUm-ḳÆʔ/	{x̣ʷum-ḳæʔ}	[x̣ʷomḳæʔ]	xwúmqa7
47.	'salmon stretcher'	/tʃ'ḳʷʔIḳʷ/	{tʃ'ḳʷʔɪḳʷ}	[tʃ'ḳʷʔɛḳʷ]	ts'qw7iiqw
48.	'sick, ill'	/ʔÆḷʃ̣-m/	{ʔaḷʃ̣-əm}	[ʔaḷʃ̣əm]	áol̲s̲em
49.	'sleep'	/ʁʷUj't/	{ ʁʷuj't}	[ʁʷoj't]	gwuy't
50.	'small rainbow trout'	/RED, ʁItʃ-ḳʃ/	{ ʁi-ʁ'-tʃ-ḳʃ}	[ʁei̯ ʁ'tʃḳʃ]	gig'tsqs
51.	'snow'	/mÆḳÆʔ/	{maḳæʔ}	[maḳæʔ]	máqa7
52.	'sockeye (salmon)'	/x̣ʷÆʔʃ/	{x̣ʷæʔʃ}	[x̣ʷæʔʃ]	xwa7s
53.	'something that one has piled up'	/ʃ-ʁÆɹ̣-xÆl/	{ ʃ-ʁaɹ̣-xæl}	[ʃʁaɹ̣xæl]	sgázcal
54.	'squeezed in the middle'	/s-p'Iʔ-l'wÆs/	{ ʃ-p'iʔ-əl'ɰʷæʃ}	[ʃp'iʔəl'ɰʷæʃ]	sp'i7el'wás
55.	'stick' (N)	/mUlx/	{mulx}	[mulx]	mulc
56.	'stingy'	/n-ʃ-p'x̣Iḷ'/	{n-ʃ-p'x̣ɪḷ'}	[nʃp'x̣ɛḷ']	nsp'xiil̲'
57.	'stripe'	/ʃ-tʃUʁʷ/	{ ʃ-tʃuʁʷ}	[ʃtʃoʁʷ]	stsugw
58.	'strong, healthy, vigorous'	/RED, ʁl/	{ ʁəl-ʁəl}	[ʁəlɜʁəl]	gélgel
59.	'supernatural being, powerful spirit'	/hIʔ/	{hiʔ}	[hiʔ]	hi7
60.	'the hat (absent, known)' (Upper dialect)	/nÆ ‿# ḳmUt-Æ/	{ næ ‿# ḳəmut-æ}	[næ ‿# ḳəmutæ]	na qmúta

61. ‘the tooth (absent, unknown)’	/nI ‿# ʁItʃ-mn/	{ ni ‿# ʁitʃ-mn}	[ni ‿# ʁei̯ tʃmən]	ni gí tsmen
62. ‘three’	/kÆɬÆʃ/	{kæɬæʃ}	[kæɬæʃ]	kalhás
63. ‘to arrive here’	/t͡ɬ’Ik̝ /	{ t͡ɬ’ɪk̝}	[t͡ɬ’ɛk̝]	tl’iiq
64. ‘to arrive (over there)’	/tʃIxʷ/	{tʃixʷ}	[tʃixʷ]	tsicw
65. ‘to assume a sitting position’	/mItʃÆ’k̝/	{ mitʃɑ’k}	[mitʃɑʔk̝]	mí tsa7q
66. ‘to be unfriendly to some-one (tr.)’	/k̝l̝-k̝l̝-nUxʷ-mIn/	{ k̝ʌl̝-k̝ʌl̝-nuxʷ-min}	[k̝ʌl̝k̝ʌl̝nuxʷ min]	qvlqvlnúcwmin
67. ‘to bleed’	/GLOT, tʃIʁ’ʷ/	{tʃɪ-’-ʁ’ʷ}	[tʃɛʔɛʁ’ʷ]	tsí 7ig’w
68. ‘to burn something, set something on fire (intr., tr.)’	/ʁʷl-n/	{ ʁʷəl-ən}	[ʁʷələn]	gwélen
69. ‘to cave in, to get caved in’	/ɬtʃ̝/	{ɬʌtʃ̝}	[ɬʌtʃ̝]	lhvts
70. ‘to cough’	/ʔx̝ʷʔUn/	{ ʔɔx̝ʷʔun}	[ʔɔx̝ʷʔon]	éxw7un
71. ‘to drool, slobber (e.g., like cows)’	/RED, n-ʃÆl̝’-tʃ/	{n̝-ʃɑl̝’-l̝’-ətʃ}	[n̝ʃɑl̝’l̝’ətʃ]	nsáol’l’ets
72. ‘to fart audibly’	/kÆ-p’Uʔ-Æ/	{kæ-p’uʔ-æ}	[kæp’uʔæ]	ka-p’ú7-a
73. ‘to get better, to recover (e.g., from a sickness)’	/ʔÆmÆ-ɰʷIl’x/	{ ʔæmæ-ɰʷil’x}	[ʔæmæɰʷil’x]	7amawí l’c
74. ‘to get spoiled (e.g., meat, potatoes), to break down (car, wagon)’	/k̝l̝-ɰʷIl’x/	{ k̝ʌl̝-ɰʷɪ̝l’x}	[k̝ʌ̝lɰʷɛl’x]	qvlwií l’c
75. ‘to get stuffed, to eat too much’	/mk̝’/	{ mʌk̝’}	[mʌk̝’]	meq’
76. ‘to go for a walk’	/RED, mÆt-k̝/	{mæ-m’-t-ɜk̝}	[mæm’tɜk̝]	mám’teq

77.	'to go (not always in a specified direction)'	/t͡ɬ'Æk/	{ t͡ɬ'æk }	[t͡ɬ'æk]	tl'ak
78.	'to have a nightmare, to sleepwalk'	/RED, k̙ʷÆx̙/	{ k̙ʷɑ-k̙ʷ-x̙ }	[k̙ʷɑk̙ʷx̙]	qwaqx
79.	'to hide something (intr., tr.)'	/lʁʷ-n/	{ ləʁʷ-ən }	[ləʁʷən]	légwen
80.	'to hit (as a bush to make the berries fall off)'	/t͡ɬ'xʷ-xÆl/	{ t͡ɬ'əxʷ-xæl }	[t͡ɬ'əxʷxæl]	tl'ecwcál
81.	'to keep still, to sit still without moving'	/t͡ɬ'l-Il'x/	{ t͡ɬ'l-il'x }	[t͡ɬ'lil'x]	tl'lil'c
82.	'to lay something down (intr., tr.)'	/kItʃ-In'/	{kitʃ-in'}	[kitʃin']	kí tsin'
83.	'to lead horses by tying them to the tail of the horse in front (intr.)'	/ʁtʃ-k̙In-Upʔ-Æm/	{ ʁətʃ-k̙in-upʔ-æm }	[ʁətʃk̙enupʔæm]	getsqinúp7am
84.	'to peel fruit (intr., tr.)'	/GLOT, ʔUx̙ʷ-UʃÆʔ/	{ ʔʊ-'-x̙ʷ-uʃæʔ }	[ʔɔʔx̙ʷoʃæʔ]	ú7xwusa7
85.	'to punch someone, hit someone with the fist (intr. tr.)'	/tUp-Un'/	{tup-un'}	[tupun']	túpun'
86.	'to put down a container with the opening turned upwards, to put it upright (tr.)'	/tʃk̙-n/	{ tʃʌk̙-ən }	[tʃʌk̙ən]	tséqen
87.	'to put something away,to bury something (tr.)'	/k̙ɬ-n/	{ k̙əɬ-ən }	[k̙əɬən]	qélhen
88.	'to rip, tear something (tr.)'	/tʃʁ-n/	{ tʃɜʁ-ən }	[tʃɜʁən]	tségen
89.	'to rot, get rotten'	/GLOT, nÆk̙/	{ nɑ-'-k̙ }	[nɑʔk̙]	na7q'
90.	'to run'	/k̙'IɬIl/	{ k̙'iɬil }	[k̙'ei̯ ɬil]	q'í lhil
91.	'to scatter (e.g., people leaving from a gathering)'	/GLOT, ɬIʁ/	{ ɬɪ-'-ʁ' }	[ɬɛʔɛʁ']	lhí 7ig'

92.	'to see something, someone (tr.)'	/ʔÆtʃ'x̣-n/	{ʔætʃ'x̣-ən}	[ʔætʃ'x̣ən]	7áts'xen
93.	'to serve food to someone (tr.)'	/n-ɬUḳʷ-xIt/	{ n-ɬʊḳʷ-xit}	[nɬɔḳʷxit]	lhúqwcit
94.	'to shrink'	/ʁIʃ/	{ ʁiʃ}	[ʁeḭ ʃ]	gis
95.	'to shrink something (tr.)'	/ʁIʃ-In'/	{ ʁiʃ-in'}	[ʁeḭ ʃin']	gi´sin'
96.	'to sleep'	/ʁʷUj't/	{ ʁʷuj't}	[ʁʷoj't]	gwuy't
97	'to smoothen something (wood) by shaving it (intr.)'	/ʔUx̣ʷ-xÆl/	{ʔʊx̣ʷ-xæl}	[ʔɔx̣ʷxæl]	7úxwcal
98.	'to stab all over'	/RED, tʃIḳ-In'/	{ tʃʌḳ-tʃɪḳ-in'}	[tʃʌḳtʃɛḳeḭ n']	tsvqtsi´qin'
99.	'to stab someone (tr.)'	/tʃIḳ-In'/	{ tʃɪḳ-in'}	[tʃɛḳeḭ n']	tsi´qin'
100.	'to stick out from something (e.g., from a pocket or a house)'	/ʃ-pḷxʷ/	{ ʃ-pʌḷxʷ}	[ʃpʌḷxʷ]	spvḻcw
101.	'to tie something (intr., tr.)'	/ʁtʃ-n/	{ ʁətʃ-ən}	[ʁətʃən]	gétsen
102.	'to tie something, someone'	/ɹ̣Uʃ-Un'/	{ɹuʃ-un'}	[ɹuʃun']	zúsun'
103.	'to untie something, to turn an animal loose (tr.)'	/tIʁ'ʷ-In'/	{ tɪʁ'ʷ-in'}	[tɛʁ'ʷeḭ n']	ti´g'win'
104.	'to walk, go on foot'	/mÆt-ḳ/	{mæt-ḳ}	[mætḳ]	matq
105.	'to warn someone, tell someone to be careful (intr., tr.)'	/ɹ̣Uh-n/	{ ɹuh-ən}	[ɹuhən]	zúhen
106.	'until it got tangled up'	/t͡ɬ'U # ḳ'tʃ'-p/	{ t͡ɬ'u # ḳ'ətʃ'-əp}	[t͡ɬ'u # ḳ'ətʃ'əp]	tl'u q'i´tsep
107.	'water'	/ḳʷUʔ/	{ ḳʷuʔ}	[ḳʷoʔ]	qwu7

108.	‘water inhabited by *hi7*’	/hIʔ-Ætk̩ʷÆʔ/	{hiʔ-ætk̩ʷæʔ}	[hiʔætk̩ʷæʔ]	hi7átqwa7
109.	‘when evening comes’	/ʔI ‿# ʁÆpÆʃ/	{ ʔi ‿# ʁæpæʃ}	[ʔi ‿# ʁæpæʃ]	7i gápas
110.	‘wind-dried salmon’	/tʃ’ɰʷÆn/	{ tʃ’ɰʷæn}	[tʃ’ɰʷæn]	ts’wan
111.	‘wool, fur’ (Upper dialect)	/t͡ɬ’ÆmIn/	{ t͡ɬ’æmin}	[t͡ɬ’æmin]	tl’ámin
112.	‘you (sg.)’	/ʃ-nUɰʷÆ/	{ʃ-nuɰʷæ}	[ʃnuɰʷæ]	snúwa
113.	‘(young) boy’	/RED, tɰʷt/	{ təɰʷə-ɰʷ-ɰ’ʷət}	[təɰʷəɰʷəɰ’ʷət]	twéww’et

Glossary

(The definitions below are as proposed or adopted in this thesis.)

AIRSTREAM MECHANISM: movement of a body of air for speech, corresponding to Catford's (1977) 'initiation' function. Airstream mechanisms are characterised according to (i) which body of air is moved: pulmonic (the air in the lungs), glottalic (the air in the pharynx), or velaric (the air in the oral cavity); (ii) the direction of movement: egressive (upward/outward) or ingressive (downward/inward).

ALIGNMENT: a phonological term referring to the coincidence of categories at constituent edges. Imposed by Alignment constraints (McCarthy and Prince (1993b)), e.g., ALIGN-L([RTR], NUC) ('The left edge of every [RTR] is aligned with the left edge of a NUC.').

ARTICULATION: the posture or movement of some articulator (i.e., of the lips, tongue tip/blade, tongue back, or tongue root) in an overall vocal tract configuration or sequence thereof, by which some articulatory constriction is produced.

ARTICULATOR THEORY: a theory of segmental representation which assumes that phonological features are defined in articulatory terms and are in a hierarchical ordering which directly reflects the anatomy of the vocal tract.

COMBINATORIAL SPECIFICATION: a procedure of segmental derivation (Archangeli and Pulleyblank (1994a)) which assumes that, for a given language: (i) active features freely combine; (ii) all combinatorially possible feature sets are instantiated (i.e., are realised as segments in the langauge) unless ruled out by the grammar.

CONSTRAINT: a phonological term referring to a formal restriction of the grammar.

CORRESPONDENCE: a relation between two structures, such as input and output forms, which allows an evaluation of faithfulness (McCarthy and Prince (1995)).

EMPHATIC: Phonological definition - a segment specified for secondary-[DOR] and secondary-[RTR].

Articulatory definition - a segment, e.g., [t̙], which is produced with secondary uvular and secondary pharyngeal articulation (except for dorsal emphatics, e.g., [k̙], which are produced with the articulation of a primary uvular, e.g., [q]).

EPENTHETIC VOWEL: a vowel inserted into a phonological form in the input-output mapping.

EXCRESCENT VOWEL: a vowel inserted in the phonetics.

FORMANT: a vocal tract resonance which is displayed on a spectrogram as a relatively broad (< ~300 Hz) band of energy.

GESTURE: a movement by an organ of the larynx or of the vocal tract.

GROUNDED: phonetically-based.

GUTTURAL: Phonological definition - a segment specified for primary-[RTR] or for primary-[DOR] and secondary-[RTR].

Articulatory definition - a segment which is produced with a primary articulation in the postvelar region of the vocal tract.

HARMONY: phonological feature sharing. Segments can undergo a harmony or be neutral to it.

MORA: the representation of a unit of prosodic weight.

NEUTRAL: with respect to some harmony, the term for segments which do not undergo the harmony. Neutral segments are either transparent or opaque.

NUCLEUS: in Nuclear/Moraic Theory (Shaw (1992, 1993)), the representation of the prosodic constituent which functions as the head of a syllable.

OPAQUE: with respect to some harmony, the term for neutral segments which do not undergo the harmony and which block its progression in the phonological string.

PHARYNGEALISATION: secondary tongue root retraction.

PHARYNGEALISED: Phonological definition - specified for secondary-[RTR].
Articulatory definition - produced with secondary tongue root retraction.

PHONETIC FORM: the phonological surface form (without its word-internal morpheme boundaries) with phonetic properties added to it. The transcription of a phonetic form is enclosed in square brackets ('[ ]').

POSTVELAR: Phonological definition - a segment specified for primary- or secondary-[RTR].
Articulatory definition - a segment which is wholly or partly articulated in the postvelar region of the vocal tract (Bessell and Czaykowska-Higgins (1991)).

PRIMARY UVULAR: Phonological definition - a segment specified for primary-[DOR] and secondary-[RTR] (but not also secondary-[DOR]).
Articulatory definition - a segment which is produced with primary uvular and secondary pharyngeal articulation.

PROSODIC: the term for properties which relate to the suprasegmental phonology, involving formal units such as mora, nucleus, and syllable.

RETRACTED: produced with retraction of the tongue root or with retraction of the tongue back and tongue root.

SEGMENTAL: the term for properties which relate to the feature hierarchy.

SPECTROGRAM: a two-dimensional graphic representation of energy distribution in a three-dimensional acoustic space defined by the variables time, frequency, and amplitude. In a standard spectrogram, time is represented on the abcissa, frequency on the ordinate, and amplitude by darkness of display.

SURFACE FORM: the underlying phonological form with all predictable phonological properties added to it. The transcription of a surface form is enclosed by the braces '{ }'.

TRANSPARENT: with respect to some harmony, the term for neutral segments which do not undergo the harmony and which do not block its progression in the phonological string.

UNDERLYING FORM: the phonological form consisting of only unpredictable phonological properties. The transcription of an underlying form is enclosed by slashes ('/ /').

UVULARISATION: secondary tongue back retraction (with concomitant secondary tongue root retraction).

UVULARISED: Phonological definition - a segment specified for secondary-[DOR] and secondary-[RTR].

Articulatory definition - produced with secondary tongue back retraction (and concomitant secondary tongue root retraction).

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