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The Role of the Syllable Contact Law-Semisyllable (SCL-SEMI) in the Coda Clusters of Najdi Arabic and Other Languages

Reham Alhammad
University of Wisconsin-Milwaukee

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by

Reham Alhammad

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ABSTRACT

THE ROLE OF THE SYLLABLE CONTACT LAW-SEMISYLLABLES (SCL-SEMI) IN THE CODA CLUSTERS OF NAJDI ARABIC AND OTHER LANGUAGES

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Reham Alhammad

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Under the Supervision of Professor Anne Pycha

Final consonants in Arabic are semisyllables; that is, moraic unsyllabified segments that are attached to the prosodic word (Kiparsky, 2003). If this is the case, optional vowel epenthesis in Najdi Arabic final clusters cannot be attributed to violations of the Sonority Sequencing Principle, because sonority restrictions apply within syllables only. In a new perspective, this dissertation argues that the existence of vowel epenthesis in Najdi coda clusters that have rising sonority, and its absence in clusters that have a falling sonority, are instead due to violations of the Syllable Contact Law (SCL), where sonority must drop between syllable codas and the following onset. It specifically argues that SCL is further divided into two sub-constraints where it not only applies across two syllables (SCL-SYLL), but also across syllables and the following unsyllabified semisyllable (SCL-SEMI). The new constraint SCL-SEMI is shown to be operative in other languages and dialects of Arabic, as well, including German, Slovak, English and Jordanian Arabic. Optionality of vowel epenthesis when words are produced in isolation vs. followed by a vowel-initial suffix is accounted for by adopting the Reversible Ranking Strategy introduced by Lee (2001) where the two constraints DEP-IO and SCL-

SEMI are reversed following this ranking: *CCC, MAX-IO, ONSET >> ALIGNR>> DEP-IO, SCL-SEMI >> SCL-SYLL, *CXCOD. In addition, a psycholinguistic study is conducted to test the perception and production of ten Najdi speakers to observe whether they epenthesized a vowel into nonsense words with final rising-sonority clusters. It also investigates the generalizability of the semisyllable consistutent, by asking whether Najdi listeners will assign semisyllable status to any unsyllabifiable consonant, even those occurring in nonsense words. Results show that most participants apply their preferred vowel epenthesis pattern to nonesense words, which reflects their implicit knowledge of this pattern. Results also show a harmony effect where inserted vowels copy stem vowels.

To

my parents

my husband, Meshari

and my beloved daughter, Areen

بسم الله الرحمن الرحيم

" وَقُلْ رَبِّ زِدْنِي عِلْمًا "

"and say,O My Lord! increase me in knowledge"
Qura'an, 20:114

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Last but not least, very special thanks go to my parents, for their unconditional love, support, understanding, and wise words.

Chapter One: Introduction

1. Introduction.

The existence of coda clusters in Standard Arabic as well as in many other dialects of Arabic including Najdi, a dialect spoken in the central region of Saudi Arabia, have led many linguists to claim that clusters in examples like [sˀabr] ‘patience’, [qasˀr] ‘palace’, [masˀr] ‘Egypt’, and [nisr] ‘eagle’ are not sonority-based because they show violations to the well-known Sonority Sequencing Principle (SSP), which is stated in (1.1) (Altamimi & Shboul, 2013; Geirut, 1999; Ingham, 1994; Kenstowicz, 1986; Watson, 2002).

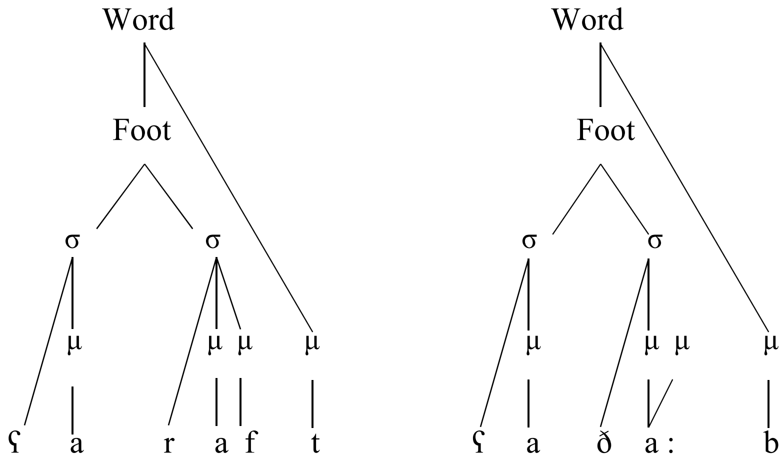
(1.1) Sonority Sequencing Principle (SSP):

> “a. In every syllable, there is exactly one peak of sonority, contained in the nucleus.
> b. Syllable margins exhibit a unidirectional sonority slope, rising toward the nucleus.”

(Parker, 2002:8)

A well justified solution to the problem of sonority violations in Arabic is found in Kiparsky (2003) where he argues that final consonants in CV<u>CC</u> syllables in Arabic are not part of the final syllable; instead, they constitute semisyllables. These semisyllables are attached to the prosodic word immediately. Thus, super heavy syllables CVCC and CVVC are identified as heavy CVC, and CVV, respectively. This explains why we only have CVCC and CVVC forms word finally, but never word medially in Arabic. This also supports the claim that the maximal possible syllable structure in Arabic is bimoraic:

(1.2)



‘I knew’ ‘torture’

According to Kiparsky, the correct syllabification of the two words presented in (1.2) are as follows: (ʕa)(raf)$\mathbf{t}_{\mu}$ (ʕa)(ða:)$\mathbf{b}_{\mu}$, respectively; where the final consonants [t] and [b] are left unsyllabified. These unsyllabified segments are immediately attached to the prosodic word instead of the closest prosodic constituent, which is the syllable node (σ). Hayes (1995) also shows that final consonants in Arabic have special behavior. He explains that the reason why sometimes CVC syllable structure loses stress word-finally and attracts it elsewhere is that final consonants in some languages, including Arabic, are invisible.

The Najdi data presented in this study are interesting in that it optionally allows vowel epenthesis in CVCC words where the coda cluster has a rising sonority, and prohibits such insertion when the cluster has a falling sonority. For example, words like [bint] ‘girl’ and [darb] ‘way’, with falling sonority towards the syllable boundary, prohibit the insertion of vowels to break up the cluster in coda position; that is, *[binit], and *[darib] are not acceptable. On the other hand, words with rising sonority in coda position like [nisr] ‘eagle’ and [ʕagl] ‘mind’ allow vowel epenthesis to break up the cluster as in [nis(i)r] and [ʕag(i)l] ‘mind’, respectively. Kiparsky provides a good argument that final consonants in many dialects of Arabic, including Najdi, are not part of final syllables. If this is the case, however, the optionality of vowel epenthesis in Najdi is problematic; that is, if final consonants are outside the syllable boundary, why is there a difference in vowel epenthesis in Najdi? In other words, optionality in vowel epenthesis in the final clusters indicates that there are some restrictions imposed on final segments, and these restrictions are not due to the SSP. Providing an answer to this question is the key problem that is addressed in this dissertation.

Following Kiparsky's perspective combined with the fact that SSP only applies within syllables, this difference in vowel epenthesis cannot be attributed to to SSP. Thus, I argue in this dissertation that vowel epenthesis in Najdi coda clusters CVCC should not be explained as a solution to violations of the SSP, but as violations of the closely related principle: the *Syllable Contact Law (SCL),* instead:

(1.3) Syllable Contact Law (SCL) (Murray & Vennemann, 1983)

"Sonority must drop between syllable codas and the following onsets."

In the literature to date, the SCL is known to apply across syllables only; that is, it applies on the final coda and the onset of the following syllable as in the English word (dim)(ple) where the sonority drops across syllables from a nasal coda to the following onset stop (Murray and Vennemann, 1983).

I claim that Najdi data provided in this study shows that SCL can also apply across a syllable and the following semisyllable that is left unsyllabified. Thus, words like [sˀabr], [masˀr], and [nisr] are syllabified as: (sˀab)r_{μ}, (masˀ)r_{μ}, and (nis)r_{μ} where the approximant [r] is left out of the syllables. This leads to the assumption that SSP can no longer be applicable since it only works within syllables. As a result, I suggest that the only way to explain vowel epenthesis in these words: (sˀabi)r_{μ}, (masˀi)r_{μ}, and (nisi)r_{μ} is due to the fact that rising sonority between codas of these words and the unsyllabified segment [r] violates a new constraint: SCL-SEMISYLLABLES (SCL-SEMI), where sonority is banned from rising across a syllable and the following semisyllable segment. This indicates that SCL is operative in the dialect, but with different rankings; hence, optionality emerges. In other words, I propose that SCL in Najdi is divided into two sub-constraints:

- SCL-AcrossSyllables (abbreviated as SCL-SYLL): *Sonority is banned from rising across two syllables.*
- SCL-Semisyllables (abbreviated as SCL-SEMI): *Sonority is banned from rising across syllables and the following semisyllables.*

In this regard, I show that SCL-SEMI outranks SCL -SYLL: SCL-SEMI >> SCL-SYLL. To address the issue of optionality in vowel epenthesis in Najdi, such that words can either be produced with a cluster: (sˀab)r_{μ}, (masˀ)r_{μ}, and (nis)r_{μ}, or with a vowel inserted between the two consonants: (sˀa.bi)r_{μ}, (ma.sˀi)r_{μ}, and (ni.si)r_{μ}. I further introduce the following constraint ranking:

(1.4) *CCC, MAX-IO, ONSET >> ALIGNR>> DEP-IO, SCL-SEMI >> SCL-SYLL, *CXCOD.

This dissertation is organized as follows. Chapter two is a background about sonority and SCL, and it also sheds light on the notion of the unsyllabified segments with all their different terms in the literature. Chapter three presents Najdi data and highlights the issue of optionality. Chapter four presents a full OT analysis of optionality in Najdi vowel epenthesis. Chapter five covers the process of vowel epenthesis and vowel identity in Najdi. Chapter six shows that the new constraint SCL-SEMI is operative in a diverse set of languages besides Najdi. Chapter seven provides a psycolinguistic study to test the perception and production of ten Najdi speakers to observe whether they epenthesized a vowel into nonsense words with final rising-sonority clusters, and to test the generalizability of the semisyllable consistutent. Finally, Chapter eight concludes the dissertation.

Chapter Two: Background

This chapter provides a background about two important principles in Phonology: the Sonority Sequencing Principle (SSP), and the Syllable Contact Law (SCL). In particular, it discusses how SSP has been introduced in the literature as a possible explanation to the vowel epenthesis process that takes place in some Arabic dialects. The chapter also sheds light on the notion of the unsyllabified segments and differentiates between their various terms. Moreover, it highlights the key argument of the study, which is based on the idea of semisyllables in Arabic as introduced in Kiparsky (2003).

1. Literature Review.

1.1 Sonority Violations.

Arabic is a language where the well-known SSP in coda cluster position does not seem to hold. Geirut (1999) supports this by claiming that the existence of reversals in the –CC coda clusters of Modern Standard Arabic (MSA) doubt on the long-standing assumption of the explanatory adequacy of SSP cross-linguistically.

Similarly, in their study, Altamimi and Shboul (2013) show that coda clusters in MSA are not sonority-based. They examine the phonotactics of coda consonant clusters using five hundred words of the syllable structure CVCC and show that words are categorized into three groups according to the sonority: words that obey the SSP (42%), words that violate the SSP (49%), and plateaus (9%) (i.e., clusters have the same sonority). They conclude that SSP should not be a reliable phonological predictor for the sequencing of clusters in MSA coda clusters. Similar to MSA, the data of this study show that Najdi coda clusters in CV<u>CC</u> can exhibit a rising sonority.

Moreover, Ibrahim (2012) shows that in Kuwaiti and Iraqi Arabic, vowel epenthesis is motivated when final consonant clusters do not conform to the SSP, as shown in the following example (cited from Ibrahin, 2012):

(2.1) Final consonant clusters in Kuwaiti and Iraqi Arabic violate the SSP

a. **Kuwaiti Dialect:**

Input		**Output**
/ħa**dr**/	'under'	[ħa.dir]
/sˀa**br**/	'patience'	[sˀa.bur]
/ħi**sn**/	'beauty'	[ħi.sin]
/ra**gm**/	'number'	[ra.gum]

b. Iraqi Dialect:

Input		**Output**
/ku**br**/	'size'	[ku.bur]
/ʃu**ɣl**/	'work'	[ʃu.ɣul]
/di**hn**/	'oil'	[di.hin]
/mi**θl**/	'like'	[mi.θil]

All words in (2.1) violate the SSP by exhibiting *Reverse Sonority* where peripherals are more sonorous than preceding consonants. Such clusters are prohibited in Kuwaiti and Iraqi dialects of Arabic. Therefore, epenthesis takes place to break up the cluster and to satisfy the SSP.

Moreover, Medinah Arabic, a dialect spoken in the Western region of Saudi Arabic, is similar to Najdi in which clusters are broken up by an epenthetic vowel when sonority rises towards syllable boundary. Aljarrah (1993) attributes this vowel epenthesis to the role that SSP plays in the dialect. Consider the following words:

(2.2) Final consonant clusters in MHA violate SSP (Cited from Aljarrah (1993)).

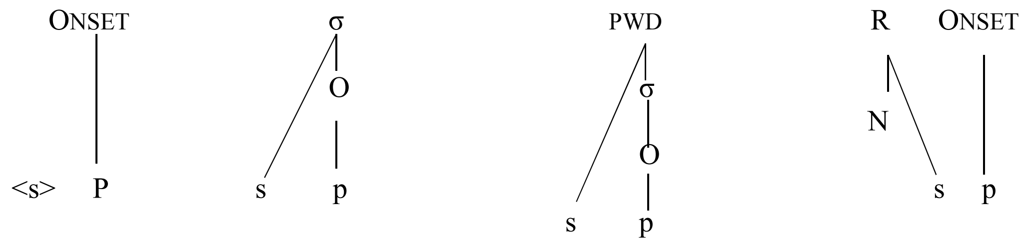
a. /ħibr/	ħibir	'ink'
b. /ʤism/	ʤisim	'body'
c. /rubʕ/	rubuʕ	'quarter'
d. /ħukm/	ħukum	'decision'
e. /faħm/	faħam	'coal'
f. /baħr/	baħar	'sea'
g. /ħabl/	ħabil	'robe'
h. /ʔakl/	ʔakil	'food'
i. /gasʕr/	gasʕur	'palace'

Just like other Arabic dialects, final consonants in Medinah Arabic are semisyllables. Thus, they fall outside the syllable domain on which SSP applies. I argue that vowel epenthesis in (2.2) is one way to avoid violating SCL-SEMI across a syllable and the following unsyllabified segment, similar to the case observed in Najdi.

Other dialects of Arabic also show the same pattern where the explanatory adequacy of SSP does not seem to hold. Watson (2002), for instance, examines the behavior of SSP in complex coda clusters of San'ani Arabic and finds 30% instances of sonority reversals.

Many interesting explanations to the violations of SSP are introduced in the phonological literature. One explanation is attributed to *Extracyllabicity*, where consonants that seem problematic are assumed to be out of the syllable. Steriade (1982) claims that one way to explain the special behavior of the English voiceless fricative [s] in words like *stop* and *sport,* where the onset clusters violate the SSP, is by classifying [s] as extraprosodic: that is, [s] does not belong to any higher structure, but is nevertheless protected from being deleted (2.3). Other linguists have proposed different treatments of the voiceless fricative [s] in English, most commonly: [s] does not belong to the onset of the following consonant cluster, but is attached to the syllable directly, instead (2.4) (Van der Hulst, 1984); [s] is attached to the prosodic word immediately (2.5) (Goldsmith, 1990); [s] is a coda of an empty-headed syllable (2.6) (Kaye, 1992):

(2.3) Extraprosodic: (2.4) Licensed by σ: (2.5) Licensed by PWD: (2.6) Coda:



These four examples are similar to one another in which they all demonstrate extrametricallity of [s]. No matter where [s] belongs, it is always left outside of the syllable.

In some Slavic languages, sonorants are syllabic, but they show a special behavior when they occur at word edges where they violate the SSP. For example, Russian sonorants become nonsyllabic word-initially: *mgla ‘mist’,* and *rta ‘mouth’* (one syllable). In addition, Czech word-initial liquids are nonsyllabic, but they become syllabic when preceded by a consonant: *rty ‘lips’, rvat ‘pull’* (one-syllable), *zr.no ‘corn’, sr.dce ‘heart’, vl.na ‘wool’, vi.chr ‘wind’,* and *bra.tr ‘brother* (two syllables) (Rubach and Booij, 1990).

Moreover, Bye (1997) shows that Estonian and Saami syllables are biomoraic, and their superheavy syllables pose a problem to the syllabification process, as they become trimoraic. Bye argues that semisyllables offer a solution to this problem by treating the third mora after the bimoraic core as an unsyllabified mora, and suggests that the unsyllabified mora is freestanding.

Interestingly, semisyllables (i.e., unsyllabified moras) are not restricted to consonants only. Vowels can also show similar behavior. In languages where ONSET constraints dominate LICENSE-μ, which requires moras to be affiliated with syllables, onsetless syllables are avoided by treating onsetless nucleus as semisyllables. These are referred to as *degenerate syllables*. Several studies have claimed that onsetless initial vowels have a special prosodically status; that is, they are not syllables (Downing, 1998; Mutaka & Hyman, 1990; Odden, 1995).

Kiparsky (2003) also suggests that final consonants in coda clusters in many Arabic dialects are semisyllabes; that is, moras which are unaffiliated with syllables and adjoined to higher prosodic constituents, and thus should not be counted as parts of the final syllable. Kiparsky classifies Arabic dialects into three categories: VC dialects, CV dialects, and C-dialects where all three types differ mainly on the syllabification patterns and in the licensing of semisyllables. Semisyllables arise where a constraint LICENSE-μ, which requires all moras to be licensed by syllables, is outranked by markedness constraints on the form of syllables and feet. In Arabic, syllables must consist of two moras only, and the FOOT-BIN constraint requires that foot size does not exceed two syllables.

Kiparsky suggests that in order to avoid violating the Prosodic Licensing principle introduced by Itô (1986, 1989), which requires that every segment must be assigned to a higher-level prosodic constituent, a mora that cannot be attached to a syllable should be attached to the lowest possible superordinate prosodic category. In Arabic, assignment of an unsyllabified mora to the next higher category (foot) would violate the undominated constraints on foot size. Thus, he assumes that moras are attached to the prosodic word immediately, which is not subject to any size constraints.

None of the previous studies, at least to my knowledge, have considered SCL as a possible explanation to the violations of sonority restrictions in Najdi and similar languages.

1.2 The Unsyllabified Segments.

Studies in different areas have used various terms to refer to the notion of unsyllabified segments. Such terms include *Extraprosodicity* or *Floatingness* (Autosgmental theory), *Extrametricality* (Metrical theory of stress), *Extrasyllabicity* (Syllable Structure theories), and *Semisyllables* (Kiparsky, 2003). This section sheds light on the notion of these unsyllabified segments and on their importance in accounting for the different behavior of certain segments within a language. It specifically discusses the nature of such segments, differentiates between their various terms, and shows some cues to their existence.

In defining the term *Extraprodicity*, “extra” means outside and the second part relates to “prosody” which is a term used in Suprasegmental Phonetics and Phonology to indicate a variation in pitch, loudness, tempo and rhythm (Crystal, 1985). Prosodicity, then, refers to the hierarchical structure above the segment, which might include tonal tiers, syllables, feet, words, and so on. Combining the two parts yields the meaning of outside hierarchical structure; that is, some constituents (autosegments, syllables, feet, etc.) may not count for the purpose of assigning prosodic structure and thus, are treated as extraprosodic. Prosodic segments are assumed to be limited to the edges of words.

The other term *Extrametricality* is first introduced in the metrical analysis by Liberman and Prince (1977) and has been developed later by other linguists, including but not limited toHayes (1979); Archangeli (1984); and Pulleybank (1986). The basic idea of extrametrical segments is similar to that of extraprosodic segments. In Extrametricality, some constituents (whether consonants, vowels, syllables, feet, etc.) are systematically ignored in the computation of stress patterns (Selkirk, 1984). Hayes (1979) restricts the number of elements that belong to this category of extrametricality and proposes that extrametrical segments are located at the periphery of the domain of the stress rules following the rule in (2.6) (x is some phonological constituent and ---] indicates the edge domain which is usually the word):

(2.7) x < x > / -----] D where < > = [+extrametrical]

Hayes explains that the feature extrametricality attaches to constituents and causes stress rules to treat these extrametrical segments as invisible entities. He further introduces the Convention of

Stray Adjunction (CSA) to integrate the extrametrical segments into the prosodic structure. Stray adjunction ensures that stray segments that are left out of the metrical structure layer are attached to the next adjacent constituent as metrically weak members. Such attachment causes these adjoined segments to be phonetically realized and protect them from being deleted by the other universal convention of Stray Erasure (see Steriade, 1982; Itô, 1986, 1989).

Extrametricality, with all its different terms, provides a logical explanation to the special behavior of domain final-position CVC syllables with regard to syllable weight. In particular, the behavior of CVC structures as stress-attracting in non-final position, but stress-rejecting in final position in many languages, including Arabic, can be attributed to final consonant extrametricality. Hayes (1982) argues that final consonants in CVC syllables are syllabified as codas, but at the same time are marked as extrametrical.

The third term, *Extrasyllabicity*, means that segments are licensed through Extraprocodicity. It is basically described as the same process of Extraprocodicity (see (Steriade,1988) in her analysis of [s] in Sanskrit). Scheer (2004: 420) argues that extrasyllabicity "may be detected by the simple fact that the syllabification algorithm is unable to parse a given sequence."

Kiparsky (2003) uses the term "*Semisyllables*", in his analysis of some Arabic dialects, to refer to these unsyllabifid segments in final position. Since the main claim in this dissertation is based on Kiparsky's argument of semisyllables in Arabic, a description of Kiparsky's view is introduced in details below (for the sake of consistency, the term '*semisyllables'* will be adopted in this dissertation to refer to the unsyllabified segments in Najdi).

1.2.1 Kiparsky (2003).

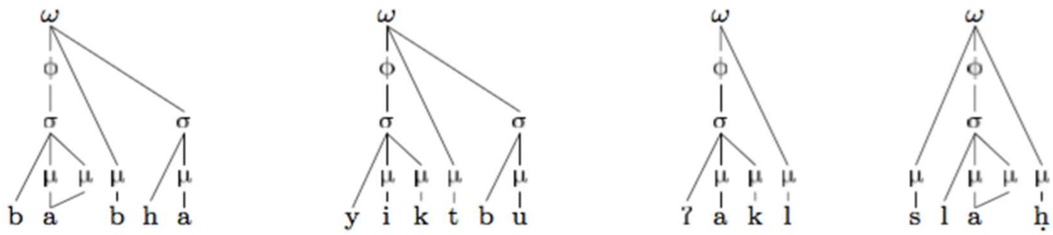
Kiparsky argues that final consonants in coda clusters in many Arabic dialects fall outside the syllable domains. He used the term *'semisyllables'*– that is, moras which are unaffiliated with syllables and adjoined to higher prosodic constituents, to refer to these segments.

Semisyllables arise where a constraint LICENSE-μ, which requires all moras to be licensed by syllables, is outranked by markedness constraints on the form of syllables and feet. In Arabic, syllables must consist of two moras only, and FOOT-BIN constraint requires that foot size does not exceed two syllables.

Kiparsky suggests that in order to avoid violating the Prosodic Licensing principle introduced by Itô (1986, 1989), which requires that every segment must be assigned to a higher-level prosodic constituent, a mora that cannot be attached to a syllable should be attached to the lowest possible superordinate prosodic category. In Arabic, assignment of an unsyllabified mora to the next higher category (foot) would violate the undominated constraints on foot size. Thus, he assumes that moras are attached to the prosodic word immediately, which is not subject to any size restrictions. Kiparsky classifies Arabic dialects into three categories: VC dialects, CV dialects, and C-dialects where all three types differ mainly on the syllabification patterns and in the licensing of semisyllables.

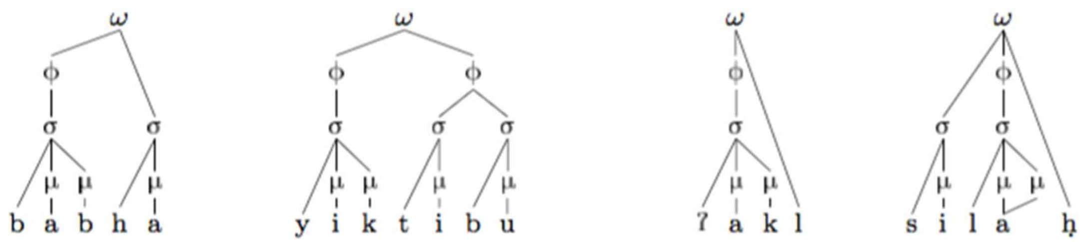
According to Kiparsky, the three categories of dialects differ in their treatment of semisyllables. VC and C-dialects allow semisyllables to occur where these semisyllables carry a mora that is attached to the prosodic word immediately to avoid violating highly ranked constraints that impose syllable and foot well-formedness. CV dialects, on the other hand, allow no semisyllables at any level. CVCC and CVVC syllables occur in CV dialects in final position only where the final consonants do not carry moras and are attached to the prosodic word; the crucial difference here is in the assignment of μ of the unsyllabified segment:

(2.8) Semisyllables in VC- and C-dialects: (Cited from Kiparsky, 2003)



‘her door’ ‘they write’ ‘food’ ‘weapon’

(2.9) In CV-dialects, moras must be affiliated with syllables:



‘her door’ ‘they write’ ‘food’ ‘weapon

Kiparsky’s analysis provides some evidence for a constraint-based version of Lexical Phonology where the syllable structure of the dialects differs in the ranking of LICENSE -μ in the word-level phonology. In the VC- and C-dialects, it is outranked by a number of FAITHFULNESS constraints (of both MAX and DEP type), by the markedness constraints FOOT-BIN, LICENSE-SEGMENT, and by REDUCE (which minimizes the number of light syllables) while in CV-dialects, LICENSE -μ dominates these constraints (for more details about the nature of these constraints, please refer to Kiparsky, 2003).

Kiparsky lists number of dialects and specific features for every category (for details, see Appendix A). Of particular interest here is his claim that in C-dialects, the second consonant in a CV<u>CC</u> coda cluster is a semisyllable; that is, a segment with an unsyllabified mora that is attached immediately to the prosodic word. In other words, such segments are not part of the final syllable and thus are not subject to sonority restrictions.

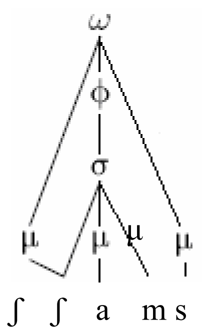
In his paper, Kiparsky does not include Najdi as a C-dialect; however, Alghizzi (2013) does. Alghizzi claims that all features that categorize C-dialects in Kiparsky's perspective are found in Najdi, and thus he concludes that Najdi must belong to this specific category. Some of these features include: A) C-dialects allow phrase-final clusters CC to occur unrestrictedly and they can be broken up by epenthetic vowels. Najdi also allows final CC that can be broken up by a vowel as in: [baħr] 'sea', [ʔism] 'name' become [baħ(a)r], and [ʔis(i)m], respectively. B) C-dialects allow phrase initial CC- clusters as a result of deleting the vowel in between the two cluster consonants. This is also true about Najdi where words like [<u>kt</u>abt] ~ [k(i)tabt] 'I wrote' and [<u>ʃr</u>abt] ~ [ʃarabt] 'I drank' are grammatically accepted. C) C-dialects delete high vowels after geminates. Najdi also exhibits the same behavior where the high vowel [i] in the singular forms [jisallim] 'he greets' and [jixarrib] 'he destroys' are deleted after geminates when verbs indicate plurality, as in [jisallmu:n] 'they greet' and [jixarrbu:n] 'they destroy'. D) Medial -CCC- clusters are allowed in C-dialects. Alghizzi claims that Najdi also allows[1] medial CCC in words like [jimdħu:n] 'they are praising' and [jimzħu:n] 'they are kidding'. E) C-dialects allow initial geminates as a result of an assimilation process. Similarly, Najdi allows initial geminates after the assimilated form of the article 'il' that assimilates to the first consonant of the geminate as in: [il-sala:m] → [ʔis-sala:m] 'peace' that is heard in rapid speech as 'ssala:m' (output) rather than 'is-sala:m' (input).

In fact, initial geminates constitute fairly direct evidence for the unsyllabified moras in Kiparsky's analysis. The assimilation of the article [ʔil] with the first sound of the words 'sun' and 'sin' in [ʔiʃ-ʃams] and [ʔið-ðanb] will render [ʃʃams], and [ððanb] in fast speech,

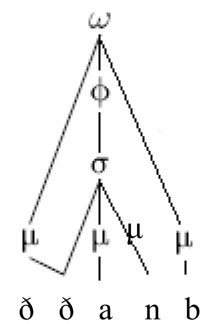
[1] I personally, produce these verbs with a vowel inserted between the last two consonants CCiC jimdiħu:n and jimziħu:n, but I don't think this would affect the classification of Najdi as a C-dialect because in Kiparsky (2003), he mentions that in the North African C-dialects, three-consonant cluster are either retained without epenthesis: (yilbsu, yiktbu), or produced with an inserted vowel on one or the other side of the middle consonant yıkatbu, yıktabu, and this does not eliminate this dialect from the C-dialects' category.

respectively, where the distribution of moras assigned to these segments differs depending on the location of the geminates: in word initial position, the first consonants [ʃ] and [ð] of the geminate bear moras that are attached to the prosodic word immediately as semisyllables while the second [ʃ] and [ð] bear no moras as they form the onset of the following vowels, and thus, are attached to the syllable instead (2.10):

(2.10) (a)

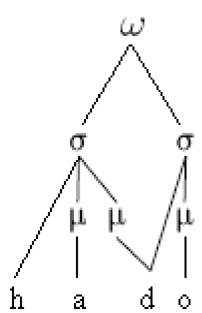


(b)

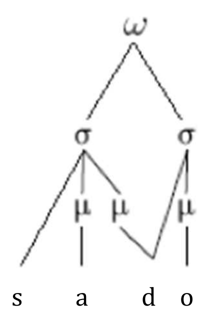


According to the moraic theory, moras can be either attached to the prosodic word (w) or to the foot (Φ) depending on whether or not they add weight. Medial geminates in Najdi, on the other hand, show different behavior where the first segment of the geminate acts as the coda of the previous syllable and the second segment forms the onset of the following syllable. Consider the following representations for the words [had.do] 'they destroyed sth', [saddo] 'they blocked', and [sˀallu] 'pray.imperative': (geminates d, and l are affiliated with two positions):

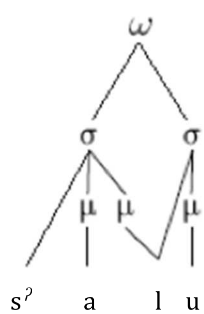
(2.11) (a)



(b)



(c)



The existence of initial geminates in VC- and C-dialects and its absence in CV dialects clearly shows its correlation with the distribution of initial clusters where the first segments are semisyllables in the VC- and C-dialects, but are excluded in CV- dialects; that is, CV- dialects allow no initial CC- clusters, as well.

One limitation of these unsyllabified segments, however, is that they go against theories of syllabic well-formedness and violate the Prosodic Licensing principle. Itô argues that all phonological units must belong to higher prosodic structures; that is, they must be prosodically licensed where segments are attached to syllables, syllables are attached to metrical feet, and feet are attached to phonological words or phrases.

Btoosh (2006) also reviews challenges that semisyllables undergo. He explains that semisyllables are appropriate to account for unlicensed segments; however, their existence violates the Strict Layer Hypothesis (SL): a prosodic constituent in a domain is to be properly contained in a domain of the next higher level (Selkirk, 1984). This hypothesis is introduced in Optimality Theory (OT) as the following constraint:

(2.12) SL: A prosodic constituent of level C immediately dominates only constituents of the level C-1.

Btoosh claims that if it were not for semisyllables, marginal segments would remain unlicensed. These unlicensed segments, if they remain unlicensed, are subject to consonant deletion, which might be favored over the assignment of semisyllables. However, this analysis is not satisfactory because many languages, including Arabic, prohibit deletion of segments due to their high ranking of the MAX-C-IO constraint, in which input consonants must have output correspondents. Abu Mansour (1995) also confirms that, in Arabic, consonants are not subject to deletion for any reason.

Following Kiparsky (2003) and Algizzi (2013), we conclude then that Najdi belongs to the C-dialects and thus Najdi final consonants in coda clusters are semisyllables. As typically formulated in previous work on the SSP, sonority restrictions cannot be imposed on these semisyllables. As a result, the only possible explanation for the vowel epenthesis that occurs in Najdi is the SCL, which applies across syllables. Considering the fact that semisyllables do not form syllables by themselves, I further suggest that SCL should also apply across a syllable and the following semisyllable segment. In other words, I claim that SCL is operative in Najdi, but in a new perspective where it is divided into two sub-constraints: SCL-SYLL (the traditional constraint) and SCL-SEMI (a newly suggested constraint).

2. The Syllable Contact Law (SCL):

Since SCL is crucial to understand the analysis of Najdi data in this dissertation, it is important to discuss the basics of this constraint before introducing the Najdi data in the following chapter. This section reviews how SCL works, and provides two examples of languages where it is operative.

SCL is a constraint that requires adjacent segments to differ by a certain number of steps on the sonority hierarchy. For this constraint to be effective, sonority must drop between two syllables. No language requires sonority to rise across syllables; between a coda and a following onset favoring, for example, [at.la] over [al.ta].

The *sonority distance* between the coda and the following onset matters, and it can be counted based on the sonority hierarchy of the language. Most languages follow the hierarchy suggested by Clements (1990) where obstruents are the least sonorous, and glides are the highest in sonority (2.13).

(2.13) Obstruents < Nasals < Laterals < Glides

Sonority steps can be minimal (zero or one step) or maximal (up to three or four steps). In general, the more sonority falls, the better the sequence, and the more it raises, the worse the sequence. For the hierarchy in (2.13), flat sonority occurs when the sonority distance between the codas and the following onsets is zero. This is observed in words like [kab.dah] ‘kidney’ and [rux. sˀah] ‘license’ because the two clusters belong to the same category; sonority rises by one step in words like [nam.lah] ‘ant’ and [far.wah] ‘heavy coat’ because each segment of the cluster belongs to a different adjacent category; sonority rises by two steps in words like [ʕag.rab] ‘scorpion’ and [ʕam.ja] ‘blind girl’ because each segment of the cluster belongs to two different non-adjacent categories; and by three steps in words like [xaʃ.jah] ‘fear’ and [nis.wah] ‘women’. Sonority scales are language-specific and the sonority distance is affected by the sonority scale adopted for the language. For example, in (2.13) Clements (1990) groups both stops and fricatives in one category (obstruents) while in many other languages, the two classes are different. Consider the following hierarchy:

(2.14) Stops < Fricatives < Nasals < Laterals < Glides

The sonority scale in (2.14) shows a different sonority distance between two categories than found in (2.13). Following the scale in (2.14), the distance between the coda and the following onset in [ʕag.rab] ‘scorpion’ is no longer two, but three, as we have two separate categories between stops and laterals in the hierarchy.

Understanding the sonority distance is important to justify the role of SCL in some languages. In Kazakh, a Turkic language, sonority distance between the coda and the onset is crucial for explaining alternations. In Kazakh, suffixes with initial consonants must desonorize following codas of flat or rising sonority: /kol-lar/ ‘hands’→ [kol.**d**ar], and /murin-lar/ ‘noses’ → [mu.rin.**d**ar]. However, when these suffixes follow vowels or codas of higher sonority, no desonorization takes place: [al.ma.**l**ar] ‘apples’ and [ki.jar.**m**a] ‘cucumber-INT’ (Davis,1998).

Languages differ in how much sonority must fall across two syllables. Kazakh requires that sonority must fall without setting a level for the drop. On the other hand, Sidamo, an Afro-

Asiatic language, requires that across two syllables, sonority must fall by two sonority steps. If sonority rises between the coda and the following onset, metathesis is applied to satisfy SCL, as in /hu**tʃ-n**anni/ → [hu**n-tʃ**anni] ‘they pray’, and /ha**s-n**emmo/ → [ha**n-s**emmo] ‘we look for’. When sonority drops less than two steps or is flat, gemination is deployed, instead, as in, /a**f-t**inonni/ → [a**f-f**inonni] ‘you have seen’, and /fu**l-n**emmo/ → [fu**l-l**emmo] ‘we go out’. (Moreno, 1940), as cited in Gouskova, 2004).

The Najdi data of this study do not set a degree for sonority rising. Flat sonority and rises up to three sonority steps occur between both syllables and semisyllables (2.15), and between syllables and other syllables (2.16) (the sonority scale in (2.14) is adopted for Najdi):

(2.15) Sonority rise in Najdi: *Across syllables and semisyllables*

a. Flat sonority (Zero)	**b. One step**	**c .Two steps**	**d. Three steps**
/ʕi**g.d**/ ‘necklace’	/xu**b.z**/‘bread’	/ba**tˤ.n**/ ‘tummy’	/ʕa**g.l**/ ‘mind’
/sa**m.n**/ ‘butter’	/ra**m.l**/ ‘sand’	/ʁa**s.l**/, ‘washing’	/sˤa**d.r**/’chest’

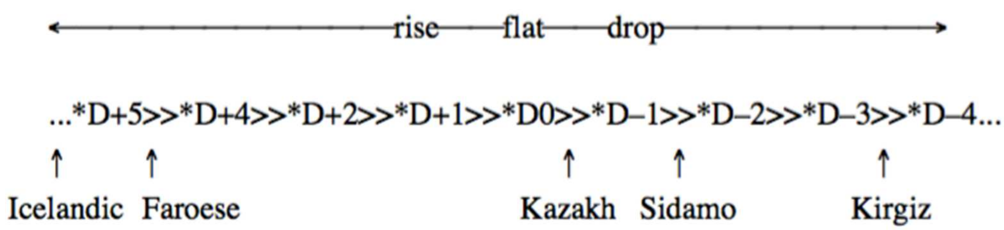
(2.16) Sonority rise in Najdi: *Across two syllables*

a. Flat sonority (Zero)	**b. One step**	**c .Two steps**	**d. Three steps**
/ka**b.d**ah/ ‘kidney’	/na**m.l**ah/ ‘ant	/na**x.l**ah/ ‘palm tree’	/xa**ʃ.j**ah/ ‘fear’
/fu**s. ħ**ah/ ‘break’	/ba**s.m**ah/ ‘smile’	/la**b.n**ah/ ‘cheese’	/ʕu**tˤ.l**ah/ ‘vacation'

Vowel epenthesis applies to words in (2.15) to break up the rising sonority across syllables and the following semisyllables in Najdi: [ʕig(i)d], [xub(u)z], batˤ(i)n/, and [ʕag(i)l], etc., but not in words in (2.16) where sonority rises across two syllables: *[kab(i)dah], *[nam(a)lah], *[nax(a)lah], and *[xaʃ(a)jah] ‘fear’, etc. Thus, I propose that SCL is operative in Najdi with the following ranking: SCL-SEMI >> SCL-SEYLL. This ranking justifies why SCL must not be violated in (2.15), but is violable in (2.16).

Some linguists attempt to explain the role of SCL using a much more complex analysis of Optimality Theory (OT), with different rankings of constraints. Gouskova (2004), for example, introduces *Relational alignment,* which derives relational scales from harmonic scales. The difference between the two scales is that the harmonic scale relates prominence to position while the relational scale shows the relative harmony of different sequences of such positions; that is, the more marked the elements, the more marked their relation. Gouskova claims that SCL is a relational constraint because it is defined as a hierarchy derived from the same scales that form constraints on the sonority of onsets and codas. She shows SCL as a hierarchy of constraints with various sonority distances where languages differ in their selections of cutoff points for acceptable SCL:

(2.17) Languages select different cutoff points for acceptable syllable contact (Gouskova, 2004)



Gouskova argues that SCL applies categorically, not gradiently, where there is a specific threshold of coda-onset sonority distance that triggers a repair strategy.

Vowel epenthesis is one solution to SCL violations. However, other languages use different repair strategies for ill-formed heterosyllabic sequences such as deletion, assimilation, and metathesis (Seo, 2011). In the following section, I discuss some cases of SCL violations in two different languages with various repair strategies to obey the SCL.

2. 1 The Role of SCL in Other Languages.

2.1.1 SCL in Mbelime

In Mbelime, a Gur language (Niger-Congo) spoken in Northwestern Benin, the SCL plays an important role in syllable structures across word boundaries when aspectual suffixes are added to verb roots. SCL is an undominated constraint in this language and violations of this constraint is treated by applying vowel epenthesis. Mbelime's syllable structure is very restricted; thus, when vowel epenthesis results in adding one extra segment to the syllable structure, root segments are deleted to obey SCL and to comply with the permissible syllable structure of Mbeline. The decision as to which segment to be removed is made based on other markedness constraints. Sonority plays a great role in determining permissible syllable templates in this language. The sonority scale in Mbelime is based on effects related to SCL:

(2.18) Sonority hierarchy of Mbelime

Natural class	**Sonority**
Low and mid vowels	highest
High vowels	↑
Glides	↕
Nasals	↓
Obstruents	lowest

The ranking of high vowels below low and mid vowels explains the reason why the high vowel, not the low or mid vowel, is deleted to conform to permissible syllabic templates, as in the word: /cuɔn-na/ → [cɔn.na] 'be.in.pocket'.

Permissible verb templates in Mbelime are: CV(V), $C_1VX.C_2V$ [X= V, C_2, N], CV.CV.CV. Onsets are obligatory and verbs must end in a vowel. Codas must consist of a consonant that is homorganic to the following onset, and the two consonants share a place of articulation node (2.19). If the two segments are not homorganic, total assimilation process takes place.

(2.19) C]σ C

Place x

X

Evidence for the role of SCL in this language comes from the phonological changes that verb roots undergo when CV suffixes are added to the stem. Here is a summary of the changes that take place to avoid violating the SCL in Mbelime:

- **Obstruent-Obstruent sequence (sonority plateau):** Plateaus, where sonority is flat across syllables, are considered violations to the SCL in Mbelime. That is, for SCL to be satisfied, sonority must not rise or be flat across two syllables. When a sequence of two obstruents appears in Mbelime, epenthesis and shortening of first syllable occur instead. This usually requires deletion of some segments in the root to comply with the permissible syllable structure of Mbeline. For example, in a CVNC root that ends with an obstruent and is attached to an obstruent-initial suffix, as in [bɛ̄n̄**k-t**á] 'be closed', the nasal [n] is deleted and a vowel is inserted to break up the plateau sequence resulting in CV.CV.CV word: /bɛ̄n̄k-tá/ → [bɛ̄.**kī.t**á] 'be.closed'. In a CVVC root, a vowel is deleted instead, resulting in a CV.CV.CV word: /yèè**t-k**í/ → [yè.tì.kí] 'refuse'. The choice of which vowel to be deleted is subject to other constraints and sonority level where vowels of lowest sonority are deleted from the verb root.

- **Obstruent –Nasal sequence (sonority rise):** When an obstruent-final verb root is attached to a nasal-initial suffix, a violation of SCL occurs where sonority rises across word boundary (i.e., between coda of the final syllable in the root and onset of the attached suffix). Two processes take place: vowel epenthesis to obey the SCL, and shortening of first syllable via deletion of a nasal of the verb root to comply with the allowed syllable structure of the langugae, as in: /bɛ̄n̄**k-n**á/ → [bɛ̄.kī.ná] 'be.closed'

• **Nasal- Obstruent sequence (sonority fall):** This sequence shows a falling sonority where the SCL is obeyed. As a result, no changes take place except that the nasal assimilates in place of articulation to the following obstruent, as in: /ká<u>**m-s**</u>i/ → [ká<u>**n.s**</u>i] 'make.cheese'

2.1.2 SCL in Korean.

Korean nasalization and lateralization have been known to pose a problem in the literature as they are applicable in some examples and are excluded from others. Examples (2.20) through (2.23) below show alternations involving nasalization and lateralization. Consider the following examples (all examples are cited from Davis and Shin, 1999).

In (2.20), when an oral stop is followed by a nasal stop, as a result of morpheme concatenation, the oral stop assimilates to the following consonant and changes to a nasal stop.

(2.20) Obstruent-Nasalization (a stop nasalizes before a nasal)

	Input	Output	Gloss
a.	/si**p**-nyən/ –	[si**m**.nyən]	'ten years'
b.	/pa**t**^{h}+noŋsa/ –	[pa**n**.noŋ.sa]	'(dry) field farming'
d.	/ku**k**-min/ –	[ku**ŋ**.min]	'the nation'

In example (2.21) when the lateral [l] is preceded by a coronal nasal, the coronal nasal stop undergoes lateralization resulting in a geminate [l].

(2.21) n-lateralization (/n/ becomes a lateral when immediately before a lateral)

	Input	Output	Gloss
a.	/no**n**-li/	– [nol.li]	'logic'
b.	/ta**n**-lan/	– [tal.lan] •	'happiness'
c.	/sa**n**-lim/	– [sal.lim]	'mountain'

However, when the lateral [l] is preceded by a non-coronal nasal stop, the lateral [l] nasalizes to [n], as in (2.22).

(2.22) l-nasalization ([l] becomes nasalized when after a non-coronal nasal)

	Input	Output	Gloss
a.	/kam-**l**i/	– [kam.ni]	‘supervision’
b.	/sam-**l**yu/	– [sam.nyu]	‘third rate’
c.	/cəŋ-**l**i/	– [cəŋ.ni]	‘arrangement’

Example (2.23) below shows another case of assimilation where the coronal [t] assimilates to the following lateral [l] when the two consonants come together over a morpheme boundary resulting in a geminate lateral [l].

(2.23) Lateralization of coronal-liquid sequences

	Input	Output	Gloss
a.	/tikɨt+liɨl/	– [ti.kɨl.li.ɨl]	‘the letter’

While examples (2.20) through (2.23) show clear instances of manner assimilation (i.e., one consonant assimilates to the lateral or nasal feature of the neighboring consonant), the following example (2.24) is completely unpredictable where a sequence of a non-coronal stop followed by a lateral [l] is nasalized despite the fact that the feature [nasal] is absent in the triggering environment:

(2.24) Nasalization of (non-coronal) obstruent-liquid sequences

	Input	Output	Gloss
a.	/pə**p-l**i/	– [pəm.ni]	‘principle of law□’
b.	/ca**p-l**ok/	– [cam.nok]	‘a miscellany’
c.	/kyə**k-l**i/	– [kyəŋ.ni]	‘separation’
d.	/pa**k-l**am/	– [paŋ.nam]	‘exhibition’

Another interesting behavior of consonants in Korean is observed in the following examples. Examples (2.25) through (33) show a lack of nasalization and lateralization despite the existence of nasals and laterals in the input.

(2.25) Sequence of a nasal followed by an obstruent

	Input	Output	Gloss
a.	/kun-**t**æ/	– [kun.tæ]	‘army’
b.	/kam-**k**i/	– [kam.ki] or [kaŋ.ki]	‘flu’
c.	/toŋ-**t**ɨŋ/	– [toŋ.tɨŋ]	‘equality’

(2.26) Sequence of a lateral followed by an obstruent

	Input	Output	Gloss
a.	/kal-**k**u/	– [kal.ku]	‘desire’
b.	/kal**p**i/	– [kalpi]□	‘ribs□’
c.	/kal**t**æ/	– [kalt’æ]	‘reed’

(2.27) Sequence of a lateral followed by a (non-coronal) nasal

	Input	Output	Gloss
a.	/ka**l-m**aŋ/	– [kal.maŋ]	‘desire’
b.	/pa**l-m**yəŋ/	– [pal.myəŋ]	‘invention’
c.	/ca**l+m**ot/	– [cal+mot]	‘fault’

What motivates the difference in these examples? Davis and Shin (1999) argue that the reason why lateralization and nasalization apply in (2.20)-(2.23), but not in (2.25)-(2.27) is due to the role that the *Syllable Contact Law* plays in the language. They explain that in (2.20)-(2.23), the SCL is violated by having a rising sonority across the syllable boundary in the underlying form. As a result, nasalization and lateralization apply to obey the SCL by preventing sonority from rising over a syllable boundary. On the other hand, the consonant sequences in the input of examples (2.25) through (2.27) have a falling sonority across the syllable boundary; that is, SCL is not violated. Thus, there is no motivation for any alternation to occur. Davis and Shin (1999) claim that SCL is an undominated constraint in Korean that must never be violated. This argument is unique as it shows that SCL has solved the problem that many linguists have proposed in the literature. They are not the first to suggest that SCL is the motivating force behind such alternations in Korean, but they are the first to directly formalize the role that SCL plays in the language.

3. Conclusion.

This chapter provides an overview about the Sonority Sequencing principle and how it is used as a solution to the vowel epenthesis process that is found in some Arabic dialects. For example, the rising sonority in final clusters of Kuwaiti dialect requires vowel epenthesis to break up the rising sonority and to obey SSP, as in /ħadr/ → [ħadir]. Similarly, the chapter discusses the importance of the Syllable Contact Law and the role it plays in forming syllables. Vowel epenthesis can also be used as a repair tool to break up rising sonority across two syllables and to obey SCL. For example, in Mbelime, vowels are inserted to break up the flat sonority of Plateaus when a sequence of two obstruents appear, as in /yèèt-kí/ → [yè.tì.kí] 'refuse'. Moreover, this chapter introduces the notion of semisyllables and differenciates between their various terms in the literature. Most importantly, it highlights the claim made by Kiparsky (2003) on which semisyllables exist in Arabic final consonants.

Chapter Three: Najdi Data

This chapter introduces the new constraint SCL-SEMI and discusses its importance in accounting for optionality in vowel epenthesis in Najdi final clusters. In analyzing Najdi data, I am employing both the traditional SCL-SYLL, which prevents sonority from rising across two syllables, and the newly suggested constraint SCL-SEMI, which prevents sonority from rising across a syllable and the following semisyllable.

The Najdi data presented in this chapter show coda clusters that have both falling and rising sonority towards the syllable boundary. Words of all possible consonant combinations with different manner of articulations are observed and listed to better understand the behavior of the SCL in this dialect. The primary informant of the Najdi data presented in this dissertation is the author, who is a native speaker of this particular variety. Ten other native speakers of Najdi were also consulted and asked to produce some forms when needed.

1. Data and Discussion.

The discussion of examples starts with words that have falling sonority with no vowel insertion, followed by examples where the coda cluster has a rising sonority across the syllable boundary and the following semisyllables. An observation of cases where vowels are inserted to avoid violating the SCL-SEMI is then introduced and discussed. The three Najdi vowels that are of interest here are: the low back vowel [a], the high front vowel [i], and the high back vowel [u]. All the words provided in the data are nouns (N) of the structure CV.C(V)C. Ten to fifteen examples are provided for each pattern to include as many environments with different consonant combinations as possible.

(3.1) <u>Words where coda clusters in CVCC have falling sonority:</u>

/(dar)$s_μ$/	‘lesson’
/(bin)$t_μ$/	‘girl’
/(dar)$b_μ$/	‘road’
/(gir)$d_μ$/	‘monkey’
/(kan)$z_μ$/	‘treasure’
/(kal)$b_μ$/	‘dog’
/(daʕ)$k_μ$/	‘scrubbing’
/(xal)$f_μ$/	‘behind’
/(ʕak)$s_μ$/	‘opposite’
/(qam)ħ$_μ$/	‘wheat’
/(ʕil)$m_μ$/	‘science’
/(ʁar)$s_μ$/	‘planting’
/(ʃar)$x_μ$/	‘crack’
/(gar)ʃ$_μ$/	‘coin’

The words in (3.1) show a falling sonority between the final consonants in syllables (indicated in bimoraic syllables (CV**<u>C</u>**)), and the following semisyllables that are left unsyllabified. All these words obey the SCL-SEMI, which requires a falling sonority between the coda of the first syllable and the following semisyllable. As a result, they are grammatical and do not require vowels to be inserted to break up the cluster. In fact, interestingly, for the words in (3.1), insertion of a vowel to break up the cluster is ungrammatical because there is no motivation for the insertion; that is, the constraint SCL-SEMI is already satisfied. Consider the following example:

(3.2) Vowels may not be inserted when the SCL-SEMI is satisfied:

*/dar(i)s/
*/bin(i)t/
*/dar(a)b/
*/gir(i)d/
*/kan(a)z/
*/kal(i)b/
*/daʕ(i)k/
*/xal(i)f/
*/ʕak(i)s/
*/qam(a)ħ/
*/ʕil(i)m/
*/ʁar(i)s/
*/ʃar(i)x/
*/gar(a)ʃ/

I assume that since there is no violation of the SCL-SEMI, as the sonority is dropping between syllables and the following semisyllables, vowel epenthesis is not required in these cases and thus, is ungrammatical in the dialect.

Similarly, Kenstowicz (1986) observes coda clusters of some Bedouin Jordanian Arabic lexical items of the structure CV**CC**. He concludes that in this dialect, lexical items where the SSP has a falling sonority towards the syllable boundary do not undergo vowel epenthesis to break up the cluster, as in words like [bint] 'girl' and [dars] 'lesson', but vowel epenthesis is observed when coda clusters have a rising sonority instead, as in the word [ħiml] 'load' which is pronounced as [ħimil].

Moreover, Abdul-Karim (1980) observes vowel epenthesis in Lebanese Arabic and claims that it is obligatory when the peripheral consonants are more sonorous than consonants that are closer to the nucleus in order to obey the SSP, as in /ʔism/ → [ʔisim] 'name' and /ʔibn/ → [ʔibin] 'son'. Such vowel insertion is absent when the final cluster conforms to SSP.

The data of this study also show that when the sonority falls towards the syllable boundary, no vowel is inserted to break up the coda cluster, as example (3.1) shows. However, when the sonority rises towards a syllable boundary, a vowel may be inserted to break up the cluster, as shown in (3.3) below. I claim that in both dialects, Najdi and Bedouin Jordanian Arabic, vowel epenthesis avoids violations of SCL-SEMI, where (ħi.mi)(l) is preferred over (ħim)(l).

(3.3) <u>Words where coda clusters have rising sonority:</u>

/(ħuk)m_μ/	'decision'
/(faħ)m_μ/	'coal'
/(qasˤ)r_μ/	'palace'
/(ħam)l_μ/	'pregnancy'
/(tˤaħ)n_μ/	'grinding'
/(sˤad)r_μ/	'chest'
/(ʁas)l_μ/	'washing'
/(ʃak)l_μ/	'shape'
/(ʕaq)l_μ/	'mind'
/(ram)l_μ/	'sand'
/(xat)m_μ/	'stamp'
/(daʕ)m_μ/	'support'
/(ðah)r_μ/	'back'
/(ʕuð)r_μ/	'excuse'
/(lak)m_μ/	'boxing'

Unlike example (3.2), the insertion of vowels to break up the coda clusters in (3.4) is perfectly grammatical because there is a motivation for their insertion; that is, insertion crucially avoids violation of SCL-SEMI.

(3.4) <u>Vowels are optionally inserted when the SCL-SEMI is violated:</u>

/(ħu)(kum)/	'decision'
/(fa)(ħam)/	'coal'
/(qa)(sˤir)/	'palace'
/(ħa)(mil)/	'pregnancy'
/(tˤa)(ħin)/	'grinding'
/(sˤa)(dir)/	'chest'
/(ʁa)(sil)/	'washing'
/(ʃa)(kil)/	'shape'
/(ʕa)(qil)/	'mind'
/(ra)(mil)/	'sand'
/(xa)(tim)/	'stamp'
/(da)(ʕim)/	'support'
/(ða)(har)/	'back'
/(ʕu)(ðir)/	'excuse'
/(la)(kim)/	'boxing'

One feature of C-dialects in Kiparsky (2003) is that they allow coda clusters that have a rising sonority at the syllable boundary. This is clearly true about Najdi as indicated in example (3.3). All words in (3.3) show a rising sonority in the coda cluster where the least sonorous segment is closer to the nucleus of the syllable. These words show violations of SCL-SEMI because the sonority rises from the coda of the first syllable (shown in parenthesis) to the following semisyllable. According to Kiparsky, such clusters allow vowels to be inserted to break up the cluster. Ingham (1994) also talks about the possibility of vowel insertion in such cases in Najdi Arabic where he explains that in Arabic, when coda clusters violate the Sonority Principle by having a rising sonority, a vowel is inserted as a repair tool to avoid such violations. He provides examples where sometimes, a vowel is inserted in Najdi only to avoid having the least sonorous segment precede a more sonorous one at the syllable boundary. Consider the following example:

(3.5) /ma.sˤur/ 'egypt' (Cited from Ingham, 1994)

In this example, Ingham claims that the high back vowel [u] is inserted between the last two segments to break up the complex coda cluster where the first consonant [sˤ] is less sonorous than the liquid [r] resulting in a rising sonority towards a syllable boundary while a falling sonority is predicted following the SSP. My alternative claim is that vowel insertion in Najdi is a way to avoid violations of SCL-SEMI.

Interestingly, the insertion of vowels in words with rising sonority in Najdi coda clusters is optional. Although Kiparsky does not talk about the possible optionality in vowel epenthesis, Najdi shows that such vowel insertion is optional depending on whether the words are produced in isolation or are followed by a vowel-initial word; that is, when the words in (3.3) are produced in isolation, vowels may be inserted between the two coda clusters, as in (3.4).

However, when the words in (3.3) are followed by a vowel-initial suffix, no vowel insertion takes place, as in [ħukm$_{μ}$ il.maħkamah] 'the court's decision', [faħm il.mazraʕah] 'the farm's coal', and [qas^{ʕ}r il.malik] 'the king's palace', *[ħukum$_{μ}$ il.maħkamah], etc. In sum, when words with clusters that violate the SCL-SEMI are produced in isolation, a preference towards inserting a vowel to break up the cluster and obey the SCL-SEMI constraint is observed. On the other hand, when these words are followed by another word that starts with a vowel, no vowel insertion takes place. The only difference between the two situations is that when words are produced in isolation, violation of SCL is expressed as a rising sonority across a syllable and its moraic semisyllable consonant – i.e., violation of *SCL-Semisyllables* – while when words are followed by a vowel-initial suffix, the violation occurs across a syllable and another syllable of the following word – i.e., violation of *SCL-AcrossSyllables (SCL-SYLL).*

If vowel insertion in Najdi occurs to avoid violating the SCL-SEMI as in (3.4), then it should apply generally in the dialect. However, the data shows that it does not; that is, when words are produced in isolation, vowel epenthesis applies to satisfy the SCL-SEMI, but such vowel epenthesis does not take place when target words are followed by another word that starts with a vowel: [ħukm$_{\mu}$ il.maħkamah], and [qasˤr il.malik]. This is where a need to suggest two sub-constraints of SCL arises. In other words, one way to justify the insertion of vowels here is attributed to the role that SCL plays in the dialect: SCL-SEMI >> SCL-SYLL.

I propose the following analysis. In the two examples [(ħuk)m$_{\mu}$] and [(qasˤ)r$_{\mu}$], words are produced with clusters that violate the SCL-SEMI by having a rising sonority across the codas [k] and [sˤ] and the following unsyllabified segments, [m$_{\mu}$], and [r$_{\mu}$], respectively. Thus, vowel epenthesis is possible as a repair tool to satisfy SCL-SEMI, which is ranked higher than SCL-SYLL in the dialect.

Violations of the other sub-constraint, SCL-SYLL, are observed when words in (3.3) are followed by another word that starts with a vowel. The syllabification of the first word is affected where the semisyllables in [(faħ)m$_{\mu}$ il.mazraʕah], and [(qasˤ)r$_{\mu}$ il.malik] join the following syllable as the onset of the following vowel of the article [il]: [(faħ).(mil).mazraʕah] and [(qasˤ).(ril).malik]. This movement is attributed to the top ranked constraint ONSET, which requires syllables to have onsets (Prince and Smolensky, 2004). Thus, semisyllables join the following onsetless vowels to form their onsets and satisfy this constraint. This movement, however, comes with a cost. It violates the SCL constraint, which requires that sonority must not rise across two syllables. The violation is observed in the rising sonority from the fricative codas of the first syllables (faħ) and (qasˤ) to the onsets [m] and [r] in the second syllables: (mil) and (ril), respectively. However, violating SCL-SYLL is less harmful than violating ONSET as the latter is considered a top ranked constraint in the dialect. (A detailed OT analysis is provided in Chapter four).

In these cases, besides the important role that the constraint ONSET plays in the dialect, the violation now is across two syllables violating the other sub-constraint, SCL-SYLL, where one segment is the coda and the other is the onset of the following vowel. I assume that violations of the first type, SCL-SEMI, is more fatal due to the higher ranking of SCL-SEMI compared to the second type, SCL-SYLL, as in (faħ)(mil) mazraʕah, and thus, requires a repair tool to solve the violation. This repair strategy is the vowel epenthesis in Najdi.

Btoosh (2006) supports this idea by emphasizing that in Arabic, codas at both morpheme boundaries and across word boundaries resyllabify as the onset of the following onsetless syllables. He further elaborates that such process is blocked when the following word begins with a consonant. This entails that ONSET is a top ranked constraint in the Arabic language.

The process of moving semisyllables to join either the following or preceding syllables is common in some languages. For example, the process of *Syntactic Doubling* in Italian (Chierchia 1986, Nespor and Vogel 1986) treats clusters that violate SSP differently from those that obey it. In this language, a single onset or well-behaved onset cluster geminates when preceded by a word ending in an open stressed syllable. Extrasyllabic consonants, on the other hand, do not show similar behavior (they do not geminate). Instead, these extrasyllabic segments move to close the preceding syllable. For example, in the two examples /palto **p**ulito/ → [palto **pp**ulito] and /avra **tr**o/ → [avra **ttr**o], onsets are geminated because they obey SSP. However, in /gia **st**anco/ → *[gia **sst**anco], the onset cluster violates the SSP by not showing a rising sonority towards the nucleus; thus, [s] is treated as extrasyllabic and is not allowed to geminate (examples are cited from Cho and King, 2003).

Further support for the violation of the constraint SCL-SYLL in Najdi is seen in the following examples (3.6)-(3.9).

(3.6) ħaf.l 'party'
nam.l 'ants'
nax.l 'palm trees'
ras.m 'drawing'
ʁas.l 'washing'

Final consonants in all words in (3.6) are semisyllables. These words are either produced with clusters: [ħaf.l] and [nam.l], or have a vowel inserted between the two clusters: [ħafil] and [namil], respectively. When these words are attached to the vowel-initial suffix *-ah,* which indicates feminine subjects, the semisyllables are re-syllabified as onsets of the following vowel (3.7). This re-syllabification process is one way to avoid violating SCL-SEMI.

(3.7) ħafl-ah → (ħa**f)(l**ah) 'party'
naml-ah → (na**m)(l**ah) 'ant
naxl-ah → (na**x)(l**ah) 'palm tree'
rasm-ah → (ra**s)(m**ah) 'painting'
ʁasl-ah → (ʁa**s)(l**ah) 'washing' (once)

After resyllabification, however, the words in (3.7) have rising sonority across codas of the first syllables and onsets of the second syllables. These words are grammatical although they violate the constraint SCL-SYLL. Insertion of vowels to break up the rising sonority and satisfy the SCL-SYLL in Najdi is not allowed, as shown in (3.8) below. This suggests a low ranking of this constraint in the dialect.

(3.8) *(ħa**f)(a)(l**ah) 'party'
*(na**m)(a)(l**ah) 'ant
*(na**x)(a)(l**ah) 'palm tree'
*(ra**s)(i)(m**ah) 'painting'
*(ʁa**s)(a)(l**ah) 'washing' (once)

Another piece of evidence that shows violations to the constraint SCL-SYLL in Najdi is found in the second word of the example: [faħm$_{\mu}$ il.mazraʕah] where the word (maz)(ra)(ʕah$_{\mu}$) violates the

SCL in having a rising sonority from the coda of the first syllable [z] to the onset of the following syllable [r] while a falling sonority is expected, instead. Other examples of this type are listed in (3.9).

(3.9) (ma**s)(r**aħ) 'theater'
(ma**t)(ħ**af) 'museum'
(ma**d)(x**al) 'entrance'

Unlike the words in (3.7), example (3.9) shows words that are not attached to any affixes, but still violate the SCL across two syllables: codas of first syllables and onsets of second syllables. My explanation is that such violation is acceptable because SCL-SYLL constraint is ranked lower than SCL-SEMI in the dialect; SCL-SYLL << SCL-SEMI.

One limitation, however, of the newly suggested ranking SCL-SEMI >> SCL-SYLL is that it does not account for optionality in vowel epenthesis in Najdi. This is where the need to introduce FAITHFULNESS constraints arises. To better account for optionality in vowel epenthesis in Najdi, a detailed analysis of constraints and their ranking based on Optimality Theory (OT) is introduced in the following chapter.

2. Conclusion.

To sum up, Najdi Arabic, as a C-dialect, treats final consonants in CVCC as semisyllables – that is, moraic unsyllabified segments that are attached to the prosodic word. The main claim in this study is that vowel epenthesis to break up the rising sonority in the coda clusters of Najdi CVCC exemplifies one way to satisfy a new interpretation of the *Syllable Contact Law*, that is, across a syllable and its unsyllabified semisyllable. A preference towards avoiding such violation is detected in the optionality of vowel insertion to break up the cluster when target words are produced in isolation vs. when target words are followed by a vowel-initial word. To account for the role of SCL in Najdi, the following ranking is suggested: SCL-SEMI >> SCL-SYLL.

Chapter Four: Optionality in Vowel Epenthesis in Najdi.

This chapter provides a background about optionaliy, and shows exapmles where two forms are interchangeable within one dialect/language. Three different stratigies are introduced in the literature to deal with optionality: *Tied Ranking* (Broihier, 1995), *Re-Ranking* (Kager, 1999), and *Reversible Ranking* (Lee, 2001). I show that *Reversible Ranking* is the best strategy to account for optionality in vowel epenthesis that takes place in Najdi Arabic. In doing so, I discuss this within the frame of Optimality Theory (OT), introduced by (Prince and Smolensky, 1991). I claim that the two constraints to be reversed in Najdi are: DEP-IO and SCL-SEMI following this constraint ranking: *CCC, MAX-IO, ONSET >> ALIGNR>> DEP-IO, SCL-SEMI >> SCL-SYLL, *CXCOD.

OT is a linguistic model claiming that interaction between conflicting sets of constraints results in the observed forms of languages. OT treats grammars as systems that map inputs (underlying representations) to outputs (surface realizations). This theory is based on three basic components: 1) GEN, the candidate set: takes an input, and lists all possible outputs, or candidates. 2) CON: universal constraint component that provides the criteria used to decide between candidates, and 3) EVAL: takes the candidate set from GEN, evaluates it using some constraint hierarchy, and chooses the optimal member as the output of the grammar. OT assumes that these three components are universal, and that languages differ in the ranking of these constraints; each language has its own constraint ranking. OT constraints have two types: *Faithfulness* constraints, which require that outputs match the inputs, and *Markedness* constraints, which impose requirements on the structural well-formedness of the output (McCarthy and Prince, 1995).

1. Literature Review on Optionality.

1.1 Optionality vs. Variation: Are they the same?

Lee (2001) argues that optionality or (Kager's (1999) free variation) and variation differ on the basis of their different input-output mappings. Variation is due to differences of region or speech group while optionality is due to intra-speaker free choice of speech style. He further relates the difference to different input-output mapping relationships following the advent of the input-output correspondence schema of McCarthy and Prince (1995). Variation reflects one-to-one mapping between input and output, (4.1)(a), while optionality reflects a one-to-many mapping relationship, (4.1)(b): (as cited in (Lee, 2001))

(4.1) Formal Distinction: Variation vs. Optionality

a. Variation (from different dialects or speech groups)

/Input i/ → (via a tableau of ranking $_1$) → Output $_1$ → Dialect I

↘ (via a tableau of ranking $_2$) → Output $_2$ → Dialect II

b. Optionality (from an individual speaker's free choice)

/Input i/ → (via a tableau of ranking $_3$) → Output $_1$

↘ Output $_2$] Speaker 1

In rule-based grammar, such a distinction has not been formally acknowledged. Thus, variation has been explained using rules and their different ordering as reported in many studies (such as Kiparsky 1968; Vennemann 1972; Calabrese 1989, and others). Other studies have used the term *variation* to refer to phonological change from regional or speech group differences, speech style and individual speaker optionality (such as Bolozky 1977; Morris 1998; and Kager 1999).

According to the distinction between variation and optionality introduced by Lee (2001), variation has been dealt with by applying rule addition, rule loss, rule ordering, and rule inversion. Chambers and Trudgill (1980) assume that a single underlying form with different outputs is posited for a number of related dialects. Phonological differences then arise from the rule's ordering among these dialects. An example of such relationship is found in Northern Greek dialects (as cited in Chambers and Trudgill 1980:47).

Table 1**:** Dialectal variation of [ðikósmu] 'my own'

	Macedonia	Thessaly	Epirus	Euboea
UR	/ðikósmu/	/ðikósmu/	/ðikósmu/	/ðikósmu/
Rules	(A) ðkosm (B) θkozm (C) θkozim	(A) ðkosm (B) θkozm (C) θkozim (D) θkozum	(A) ðkosm (C) ðkosim (B) θkosim	(A) ðkosm (C) ðkosim (B) θkosim (D) θkosum
SR	[θkozim]	[θkozum]	[θkosim]	[θkosum]

Rule (A): High vowel loss: unstressed [i] and [u] are lost.
Rule (B): Voicing Assimilation: voiceless stops become voiced before voiced stops; voiced stops become voiceless before voiceless stops.
Rule (C): Vowel epenthesis: when the final consonant of a word-final consonant clusteris nasal, an [i] is inserted before the nasal.
Rule (D): Rounding: [i] becomes [u] before a following labial consonant.

Table 1 shows that all four dialects start with the same input form and end up with a different output form. Note that all these dialects share the same rules, and differ only in their relative ranking. Macedonia and Thessaly have the same rules A through C, but Thessaly differs by the addition of rule D, rounding. The other two dialects, Epirus and Euboea have the opposite order of rules B and C compared to the previous two dialects. Euboea also differs from Epirus by the addition of one rule, rounding. In a rule-based model, such phonological differences in dialects of the same language are attributed to dialect-specific rule orderings.

Speech style optionality, on the other hand, has been dealt with by the presence/absence of optional rules (Bolozky 1977; Hasegawa 1979; and Kim-Renaud 1987). Multiple outputs are often a result of different speech styles (careful vs. casual) or tempos (fast vs. slow). For example, fast speech leads to reduction, deletion, merging, and assimilation to facilitate the articulatory transition in less time. One example of optionality in fast speech is found in voicing assimilation in Modern Hebrew. In fast speech, Hebrew obstruent clusters obligatory assimilate in voicing, but optionally if the first segment of the cluster is a voiceless fricative or affricate (example is cited from Bolozky, 1977: 219).

(4.2) Tempo-driven voicing assimilation in Modern Hebrew (Bolozky 1977: 219)

yi**df**ok ~ yi**tf**ok	'he will knock'
zkenim ~ **sk**enim	'old ones (pl.)'
pzila ~ **bz**ila	'squinting'
yi**ʃb**or ~ yi**ʒb**or	'he will break'
yi**fg**oʃ ~ yi**vg**oʃ	'he will meet'

Another example of optionality, as a result of intra-speaker variation, is observed in Korean glide formation. In fast speech, when two vowels are adjacent at a syllable boundary, one vowel of the cluster changes to become a glide, as shown in (4.3): (example is cited from Kim-Renaud, 1987)

(4.3) Optional nature of glide formation (Kim-Renaud 1987)

[au-nim] ~ [awnim]	'younger sibling (hon.)
[po-i-ni] ~ [poyni]	'can you see it'
[se-u-ja] ~ [sewja]	'let's set up …'
[cu-əra] ~ [cwəra]	'give (imp.)'

In sum, rule-based grammar account for dialectal variation by using rules and their different orderings while intra-speaker optionality is accounted for by the presence or absence of optional rules due to speech-tempo or speech-style.

Lee (2001) points out that OT fails to show that variation and optionality have different input-output mapping processes. He elaborates that OT fails to account for optionality in outputs because of its strict dominance ranking system where constraints are ranked in a fixed order. OT reflects a one-to-one mapping where a single input form is mapped onto one and only one optimal output form. In other words, OT allows no more than one optimal output on the surface.

How then should we account for the presence of optionality, as found in Najdi and other langauges? Lee follows Kager (1999) in rejecting the idea of multiple constraint hierarchies. Kager argues that optional forms are similar to each other and multiple constraint hierarchies fail to show such relationship. He, instead, prefers a single hierarchy for similar optional output forms. Thus, Lee (2001) introduces a solution that can handle both optimal forms within one evaluation process. Before discussing Lee's suggested solution to the problem of optionality (intra-speaker optionality) vs. variation (intra-speaker variation), I will review two of the ranking strategies that are introduced in the literature to deal with the notion of variation in phonology: *Tied ranking*, and *Re-ranking.*

1) **Tied ranking:** This concept is developed by Broihier (1995) where he argues that when two constraints are not crucially ranked in OT, they are treated as if there were one single constraint (indicated as constraint B equals constraint C: B=C). When candidates X and Candidate Y in an OT tableau have the same number of violations of all other ranked constraints, and both violate only one pair of the tied constraints, B or C in Table 2, or both violate the same pair, either B Table 3 or C Table 4, at the end of the evaluation process, both candidates X and Y are chosen as optimal candidates because they are equal in violating or satisfying the tied constraints:

Table 2: Tied Ranking- condition 1

	A	B = C	D
☞ X		*	*
☞ Y		*	*
Z	*!		*

Table 3: Tied Ranking- condition 2

	A	B	=	C	D
☞ X		*			*
☞ Y		*			*
Z	*!				*

Table 4: Tied Ranking- condition 3

	A	B	=	C	D
☞ X				*	*
☞ Y				*	*
Z	*!				*

Lee (2000) argues against Tied Ranking in explaining optionality properly. His argument is based on the idea that Tied Ranking does not predict optionality when other low-ranked constraints below the tied constraints play a role in the evaluation process. In other words, when two competitive constraints have a different number of violation marks in the constraint below the tied constraint, the candidate that does not violate the low constraint will fare better than the one that does (if that lower constraint plays a role in the evaluation process), as shown in Table 5:

Table 5: Violation of the constraint below the tied constraints

	A	B	=	C	D
X			*		*!
☞Y				*	
Z	*!				

In Table 5**,** candidate Y wins because it has fewer violation marks compared to candidate X, especially when the constraint D plays a crucial role in the evaluation. A serious problem that Tied Ranking faces is that, in numerous cases, optional output forms violate lower ranked constraints. This argument is further supported by Y. Lee (1997) in his analysis of Korean glide formation where Tied Ranking wrongly predicts optionality. In Korean, /po+a/ 'to see' has two forms on the surface: [po.a] and [pwa:]. In order to satisfy the ONSET constraint, /po+a/ becomes [pwa:] where the onsetless vowel issue is solved. However, the new form violates another constraint: *COMPLEXONSET, no complex onset is allowed. The process of glide formation is not obligatory in Korean. Thus, if we assume that the two constraints are tied, Onset=*ComplexOnset, then multiple output forms will appear on the surface:

Table 6: Tied constraints in Korean

/po + a/	ONSET	=	*COMPLEX
a. ☞ pwa:			*
b. ☞ po.a	*		

However, if another constraint that plays a crucial role in the evaluation is introduced in the ranking and it falls below the tied ranking, only one form will be the optimal due to fewer violations. In the following tableau, Table 7, candidate (b) looks more faithful to the underlying input form where the two vowels remain the same. It obeys the ASSOCIATION-μ constraint where each vowel is associated to one mora. As a result, candidate (a) never becomes optimal because it has one additional violation compared to (b). This entails that only one candidate wins the competition, and that is candidate (b), which is contrary to the fact about glide formation in Korean.

Table 7: Wrong prediction about Glide Formation in Korean

/po + a/	ONSET = *COMPLEX	ASSOCIATION- μ
a. ? pwa:	*	*!
b. ☞ po.a	*	

2) **Re-Ranking** (also known as Free Ranking [Kager, 1999] or Floating Constraints [Nagy and Reynolds, 1997]) is based on two different rankings where one ranking produces one output form and the other ranking produces a different output form. Under this ranking strategy, multiple optimal forms from the same underlying input arise from two different tableaus with

two different rankings. Any two constrains can be re-ranked no matter where they stand: remote or adjacent. Re-Ranking differs from Tied Ranking in that it requires two tableaus; that is, a single tableau does not produce multiple forms. Lee (2001) explains that this type of ranking strategy can account for dialectal differences where the two outputs represent one dialect each; that is, the ranking A>>C>>D represents one output form in Dialect1, and A>>D>>C represents another output from in Dialect2. An important note here is that the two forms are not interchangeable within a single dialect. A good example where this strategy works is observed in the consonant cluster reduction in Korean. For example, Korean deletes a consonant in a CC cluster when the cluster is attached to a consonant-initial suffix (M. Lee, 1998).

(4.4) Korean CC reduction (M. Lee 1998)

	Seoul dialect		**Kyungsang dialect**			
(l)k	ilk+ta	→ [ik.t’a]	l(k)	ilk+ ta	→ [il. t’a]	‘to read’
(l)p	pa:lp+ta	→ [pa:p.t’a]	l(p)	pa:lp+ ta	→ [pa:l.t’a]	‘to tread on’
$(l)p^h$	ilp^h+ta	→ [ip.t’a]	$l(p^h)$	ilp^h+ ta	→ [il.t’a]	‘to recite’

Example (4.4) shows that when Korean roots with final clusters are attached to a consonant-initial suffix (-ta), two different Korean dialects behave differently regarding the cluster reduction: Seoul dialect deletes coronal sonorants (l) while Kyungsang deletes non-coronal obstruents. The process can be better explained by the interaction of two Max-feature constraints: MAX-F (SON), which requires any [sonorant] input to be realized in the output, and MAX-F (Dor), which requires any [Dorsal] input to be realized in the output and MAX-F (LAB), which requires any [Labial] input to be realized in the output. The ranking of these constraints is what determines the final output in either dialect; that is, in Seoul Korean, MAX-F(DOR) and MAX-F(LAB) outrank MAX-F(SON), as shown in Table 8 while in Kyungsang Korean, the opposite ranking is observed: MAX-F(SON) outranks MAX-F(DOR) and MAX-F(LAB), as shown in Table 9. Consider the following tableaus as cited in M. Lee (1998):

Table 8: Seoul dialect: /lk/ → [k] via Max-F (Dor) >> Max-F (Son)

/lk/	MAX-F (DOR)	MAX-F (LAB)	MAX-F (SON)
l	*!		
☞ k			*

Table 9: Kyungsang dialect: /lk/ → [l] via Max-F (Son) >> Max-F (Dor)

/lk/	MAX-F (SON)	MAX-F (DOR)	MAX-F (LAB)
☞ l		*	
k	*!		

Table 8 and Table 9 show that different rankings result in two different output forms: a single input [lk] corresponds to multiple outputs [l] and [k]. Each output corresponds to a crucial re-ranking (one-to-one mapping). Lee (2001) argues that Re-Ranking cannot be used to explain optionality within one dialect where two outputs are optimal in the same tableau because Re-Ranking requires two tableaus with two different rankings and the two optimal forms must not be interchangeable within a single dialect. However, he shows that Re-Ranking is the best strategy to account for variation across dialects.

1.2 Solution to the Optionality Phenomena.

Lee (2001) distinguishes between optionality and variation and argues that optionality is best dealt with by invoking a new ranking strategy: Reversible Ranking (explained in 1.2.1) while variation is best analyzed using Re-Ranking (in Kagers', 1999). Lee further supports his argument by: 1) relating optionality to two phonological processes that take place in the Korean phonology, Korean Vowel Coalescence, and Glide Formation, and 2) associating variation to other processes: Consonant Cluster Reduction and Vowel Umlaut that occur in two different

Korean dialects (for further details in the nature of these two processes of variation, see Lee [2001])[2].

1.2.1 Reversible Ranking

This ranking strategy is suggested by Lee (2001) and is based on the idea of one-to-many mapping between input and output per tableau; that is, multiple output forms result from a single parallel evaluation. Multiplicity is a result of a speaker's free choice with or without speech style or speech tempo. In Reversible Ranking, one of two constraints dominates the other and vice versa.

Reversible Ranking differs from Tied Ranking in that the dotted line between two constraints in the tableau represents a combination of two crucial rankings: B>>C, and C>>B in the same evaluation. Another crucial difference between the two is that in Reversible Ranking, the role of constraint D, which falls below the two constraints in question, does not crucially matter in the evaluation process:

Table 10: Reversible Ranking (cited from Lee, 2001)

	A	B	C	D
☞ X		*		
☞ Y			*	*
Z	*!			

Table 10 shows that both candidates X and Y are optimal in the same tableau as they both have one violation mark of the two constraints in question, B and C. If the constraint B outranks C, then we get Y as the optimal form. On the other hand, when the ranking is reversed such that C outranks B, we get X as the optimal form. The reversible relationship of these two constraints is represented with a dotted line between B and C. One important condition, however, must be met

[2] Since optionality in Najdi occurs within the same dialect; that is, one-to-many mapping (in Lee's, 2001analysis), I will review the processes that are related to the same issue in Korean, with the exclusion of *Cluster Reduction* and *Vowel Umlaut* that are used to show variation in Korean.

in order for Reversible Ranking to be applied and that is, the two constraints involved, B and C in this example, must be adjacent in ranking in order to be reversible.

Reversible Ranking also differs from Re-Ranking in two aspects: First, two optimal forms are predicted from the same tableau in Reversible Ranking, versus from two different tableaus in Re-Ranking. Second, the reversed constraints must be locally adjacent in Reversible Ranking. Re-Ranking, on the other hand, requires no adjacency; that is, any two constraints can be re-ranked.

In Lee's account, two phonological processes are in favor of Reversible Ranking in Korean: Vowel Coalescence, and Glide Formation.

- **Korean Vowel Coalescence.** This phonological process is invoked to avoid vowel hiatus in Korean; that is, when two vowels are adjacent within or across a morpheme boundary, the two vowels are coalesced and the resulting vowel shares some features of the two. This process is not obligatory. What makes it more complicated is the presence/absence of vowel lengthening.

(4.5) Optionality of Vowel Coalescence (Lee, 2001)

Merger with lengthening

ai	[ai], [æ:]	'baby'
tˈe+ ə	[tˈeə], [tˈe:]	'to detach'
kæ+ ə	[kæə], [kæ:]	'to break'
kæ+i	[kæi], [kæ:]	'to be folded'
pe+ ə	[peə], [pe:]	'to cut'
pe+i	[pei], [pe:]	'to be cut'

Example (4.5) shows an interesting surface multiplicity where all underlying forms in (4.5) have two potential output forms: either the two vowels remain hiatus, or they undergo Vowel Coalescence. Lee (2001) claims that Reversible Ranking can perfectly account for this optional behavior in Korean. He introduces a list of constraints and their appropriate ranking: ONSET, vowel-initial syllables are not allowed; MAX-FEATURE (-[ɨ]), all features that do not characterize [ɨ] must appear on the surface; that is, [+front], [+low], and [+round] (assuming that the vowel [ɨ] is specified in Korean and that it always gets deleted, satisfying Max-F of segments other than [ɨ] is more important); MAX-FEATURE ([ɨ]), features of [ɨ], [+high] and [+back] must appear on the surface; *COMPLEX (NUC), complex nucleus are not allowed; MAX-M, underlying moras should be realized; DEP-SEG, avoid insertion of segments; and MINWD, A prosodic word should be minimally bimoraic. The overall ranking of these constraints is: DEP-SEG, MINWD >> MAX-F (-[ɨ]) >> (ONSET, *COMPLEX (Nuc)) >> MAX-F ([ɨ]), MAX-M. In this ranking, ONSET and *COMPLEX (Nuc) are reversible and play a crucial role in the optional Vowel Coalescence in OT. When the two vowels remain, this means *COMPLEX (Nuc) is ranked higher than ONSET. However, when Vowel Coalescence occurs, ONSET dominates; that is, both ONSET >>*COMPLEX (Nuc), and *COMPLEX (Nuc) >> ONSET are put together in one tableau. Consider the following tableau of the first word in (4.5), [ai] 'baby'. Note that when two or more constraints are separated by a dashed line in an OT tableau, this means that they are equally important in ranking. Dotted lines, on the other hand, indicate that the two constraints in question are reversed, following the Reversible Ranking in Lee (2001).

Table 11: /ai/ → [a.i], [æ:] 'baby' (cited from Lee, 2001)

μμ /ai/	DEP-SEG	MINWD	MAX-F(-[i])	ONSET	*COM (Nuc)	MAX-F([i])	MAX-M
a.☞ a.i				**			
b.☞ æ:				*	*	*	
c. æ		*!		*		*	*
d. a.ti	*!			*			

*Note that dashed lines means that constraints are equally important in ranking while dotted lines indicate the Reversible Ranking (as in Lee, 2001)

Candidates (a) and (b) both win the competition in this tableau. If ONSET >>*COMPLEX (Nuc), then (b) is the optimal form since (a) has one additional violation of ONSET. If, however, *COMPLEX (Nuc) >> ONSET, then (a) is the optimal since the other competitor violates this constraint. Note that candidate (b) also violates MAX-F ([ɨ]) because the features [+back] of [a], and the feature [+high] of [ɨ] are not realized in the output form. An important difference between Reversible Ranking and Tied Ranking here is that violation in (b) of the lower ranked constraint MAX-F ([ɨ]) does not eliminate this candidate, as this low constraint does not play a role in the evaluation process. Candidates (c) and (d) are ruled out because they fatally violate top ranked constraints.

• **Glide Formation.** This phonological process is also applied to solve the problem of vowel clash when two vowels are adjacent within or across a morpheme boundary in Korean. It only takes place when the first vowel of the sequence is high (with the exclusion of [ɨ]) or round. Glide Formation is an optional process in Korean that is related to intra-speaker optionality due to formal vs. casual speech style (Lee.Y, 1993; Kim, 2000) or fast vs. slow speech tempo (Kim-Renaud, 1987). This Glide Formation is interesting because in some cases, it is optional (4.6) while in other cases, it is obligatory (4.7), similar to the optionality in Najdi.

(4.6) Optional Glide Formation

po+a	poa ~ pwa:	'to see'
cu+ə	cuə ~ cwə:	'to give'
ki+ ə	kiə ~ kyə:	'to crawl'
kˈu+ ə	kˈuə ~ kˈwə:	'to dream'

Example (4. 6) shows that when two vowels are adjacent with the first vowel is either high or round, or both, Glide Formation takes place where the less sonorous vowel changes to become a glide. This process is accompanied with a compensatory vowel lengthening where the mora of the changing vowel moves to the following vowel causing it to be longer. Note that Glide Formation in (4.6) is optional and this is clear from having two forms on the surface. Lee (2001) claims that Reversible Ranking can also account for the optionality in Korean Glide Formation in example (4.6) using the same constraints he proposes for Korean Vowel Coalescence. His analysis also involves the interaction of ONSET and * COMPLEX (Nuc) under Reversible Ranking. Consider the following tableau of the first word: po+a : (cited from Lee,2001).

Table 12: /po+a/ → [po.a], [pwa:] 'to see'

μ μ /po + a/	DEP-SEG	MINWD	MAX-F(-/i/)	ONSET	* COMPLEX (Nuc)	MAX-F(/i/)	MAX-μ
a. ☞ pwa:					*		
b. ☞ po.a				*			
c. pwa		*!					*
d. pa(:)			*!		(*)		(*)
e. po:			*!				

In Table 12 two candidates (a) and (b) are optimal and are freely chosen by a single speaker. If ONSET >> *COMPLEX (Nuc), then candidate (a) becomes the winner as it does not violate ONSET. On the other hand, if the ranking is reversed: *COMPLEX (Nuc)>> ONSET, candidate (b) wins because the other competitor violates *COMPLEX (Nuc). The other three candidates are ruled out due to their fatal violations of higher ranked constraints. Candidate (c) is monomoraic while the prosodic word must be biomoraic. Candidates (d) and (e) both violate MAX-F(/ɨ/) where (d) lacks the feature [+round] in the output while (e) lacks the feature [+low].

Glide Formation can also be obligatory, sometimes, as shown in (4.7):

(4.7) Obligatory Glide Formation (Lee, 2001)

meu+ ə	* meuə	mewə	'to fill'
moi+ ə	* moiə	moyə	'to gather'
seu+ ə	* seuə	sewə	'to erect'
c^{h}æu+ ə	* c^{h}æuə	c^{h}æwə	'to lock up'

Example (4.7) shows that the constraint ONSET is violated twice here where every word in (4.7) has two onsetless vowels. For example, [u] and [ə] are onsetless in [meu+ ə]; [i] and [ə] are onsetless in [moi+ ə], and so on. As a result, Glide Formation becomes obligatory in Korean while it is optional in (4.6) because in Table 12 ONSET is violated once. In other words, ONSET can be minimally violated. Consider the following tableau of the word /seu+ə/:

Table 13: /seu+ə/ → [se.wə] 'to erect' (Lee, 2001)

μμ μ /seu + ə/	DEP - SEG	MINWd	MAX-F(-/i/)	ONSET	*COMPLEX (Nuc)	MAX-F(/i/)	MAX-μ
a. se.wə:					*!		
b. ☞ se.wə							*
c. se.u.ə				**!			
d. se:.wə					*!		

In Table 13, both ranking of the reversed constraints: *COMPLEX(Nuc) >> ONSET or ONSET >> *COMPLEX(Nuc) will choose candidate (b) as the winner. Other candidates are eliminated due to their violations of either ONSET or *COMPLEX(Nuc). The crucial role of *COMPLEX(Nuc) and its reversibility with ONSET provide a consistent analysis on both optional and obligatory GF.

In sum, Reversible Ranking provides the best solution to handle surface multiplicity phenomena in the optionality found in Koran Phonology as exemplified by two phonological processes that take place in Korean: Vowel Coalescence and Glide Formation.

2. Optionality Analysis in Najdi (OT perspective).

This section reviews the OT analysis of the optionality problem that is observed in Najdi. Eight OT constraints are involved:

- **SCL-SEMI:** Sonority is banned from rising across syllables and the following semisyllables. (Newly suggested constraint)
- **SCL-SYLL:** Sonority is banned from rising across two syllables.
- ***CXCOD:** No coda clusters. (Markedness)
- **MAX-IO:** Every element in the input has a correspondent in the output (No deletion-Faithfulness)
- **DEP-IO:** Every element in the output has a correspondent in the input. (No insertion-

Faithfulness) (McCarthy and Prince, 1995)

- **ONSET:** syllables must have onsets. (Prince and Smolensky, 2004)
- **ALIGNR:** The right edge of the output must correspond to the right edge of the input
- ***CCC:** a sequence of three consonant clusters is not allowed.

Table 14 shows that candidate (a), [ħukm] 'decision', with the coda cluster wins as the optimal candidate although it has a complex coda. This shows that the constraint *CXCODA which bans the existence of coda clusters must be ranked low in the dialect. Evidence for its low ranking comes from the fact that the winner candidate violates this constraint and still wins the competition. Candidate (b) violates a highly- ranked Faithfulness constraint that prohibits the deletion of any segment in the word, thus it loses. Candidates (c) and (d) both violate a top-ranked FAITHFULNESS constraint as they have one segment ([u] in (c), and [i] in (d)) that does not have a correspondence in the input. As a result, they both have a fatal violation that rules them out of this competition.

Table 14: Input: /ħukm/ → Output: [ħuk.m]

/ħukm/	MAX-IO	DEP-IO	*CXCOD
a. ☞ ħuk.m_{μ}			*
b. ħuk	*!		
c. ħu.kum		*!	
d. ħuk.mi		*!	

If the winner candidate [ħukm] were indeed the only optimal output in the dialect, then we would not have a problem in Najdi as the existence of this form is due to the high ranking of the Faithfulness constraint DEP-IO, which prevents the insertion of new segments in the output. However, what makes the situation more complicated is the optionality in Najdi where the other form that allows vowel epenthesis can also be a possible output in the dialect. Consider the following tableau:

Table 15: Input: /ħukm/ →Outputs: [(ħuk)m] and [ħu.kum].

/ħukm/	ALIGNR	MAX-IO	SCL-SEMI	DEP-IO	*CXCOD
a. ☞ (ħuk)m			*		*
b. ☞ ħu.kum				*	
c. ħuk.mi	*!			*	
d. ħuk		*!			

*Note that dashed lines means that constraints are equally important in ranking while dotted lines indicate the Reversible Ranking (as in Lee, 2001)

Table 15 is an extension of Table 14 where a new constraint is introduced in the ranking: SCL-SEMI. This constraint does not allow sonority to rise across a coda and the following semisyllable. Following Lee (2001), I adopt his theory of Reversible Ranking, which is based on the idea of one-to-many mapping between input and output per tableau; that is, multiple output forms result from a single parallel evaluation. I further support his theory by showing that the analysis of optionality in Najdi data fits very well into his OT optionality analysis.

In Reversible Ranking, one of two constraints dominates the other and vice versa, and the two constraints must be adjacent. The dotted line between two constraints in the tableau represents a combination of two crucial rankings: SCL-SEMI >> DEP-IO, and DEP-IO >> SCL-SEMI in the same evaluation. Another crucial factor in Reversible Ranking is that the role of any constraint that is ranked below the two reversed constraints (namely, *CXCOD) does not crucially matter in the evaluation process. This is true where *CXCOD in Table 15 does not play a role in the evaluation; note that it is violated by the winner candidate itself in all of the tableaus. This also explains why the MAX-IO constraint that eliminates some candidates, in both Table 14 (b) and Table 15 (d), is ranked higher than the two reversed constraints. Moreover, candidate (c) violates DEP-IO just like the winner in (b). As a result, to eliminate this candidate from being an optimal output, we need to introduce a constraint that is both higher than DEP-IO and is violated by this candidate at the same time. Such constraint is ALIGNR, The right edge of the output must correspond to the right edge of the input. This constraint is important to show why the insertion of the vowel after the coda cluster is not an acceptable repair, and that vowels are only allowed to be inserted between cluster consonants. Since this constraint is crucial in eliminating possible candidates, it must be ranked higher than the two reversed constraints; that is, it plays a crucial role in the evaluation process, thus it cannot be ranked below the reversed constraints according to the Reversible Ranking strategy.

Going back to the reversed constraints, I suggest that the two relative constraints to be considered in Najdi are: DEP-IO and SCL- SEMI. Note that the optimal candidates both have one violation mark of the two constraints in question. The idea is that when the DEP-IO is dominating, we get the candidate in (a) because it violates the other constraint, but satisfies DEP-IO. On the other hand, when the other constraint SCL- SEMI dominates DEP-IO, candidate (b) wins the competition, as it does not violate the dominating constraint. Violation is avoided by the insertion of a vowel to break up the rising sonority across the coda and the following semisyllable.

What about cases where the coda cluster in final position satisfies SCL- SEMI; that is, the cluster has a falling sonority towards the syllable boundary? Example words are [bint] 'girl', [darb] 'way', and [dars] 'lesson'.

Table 16: Input: /bint/ →Output: [bint] only.

/bin.t/	ALIGNR	MAX-IO	SCL-SEMI	DEP-IO
a.☞(bin)t				
b. bi.nit				*!
c. bin.ti	*!			*
d. bin		*!		

Recall that in Lee's account, optionality occurs because the two optimal candidates both have one violation mark of the two reversed constraints in question. Thus, they both have the same number of violation marks; no priority is given to one over the other, and that is why both candidates win the competition. In this tableau, however, the situation is different. Candidate (a) has a falling sonority towards the syllable boundary; thus, it does not violate SCL-SEMI. It also respects the other constraint DEP-IO by not having a motivation for vowel insertion. In Table 16, candidate (a) is selected as the only optimal candidate because it encounters the least number of fatal violations compared to the other candidates. It fares better than candidate (b) where the latter violates DEP-IO by inserting a vowel to break up the cluster. Candidate (c) violates a high ranked constraint, ALIGNR, where the right edge of the second syllable in the output does not coincide with the right edge of the input. Candidate (d) violates another top ranked constraint, MAX-IO, by deleting the last consonant.

Table 16 then shows that when one reversible constraints is violated but another is not, one output candidate fares better than the other, and thus is chosen as the only optimal candidate.

In sum, the Reversible Ranking strategy provides a solution to the problem of optionality in Najdi where it allows two optimal candidates to appear on the surface in the same tableau.

Now let us consider the other part of the problem that is related to the absence of optionality when words are uttered in phrases. The idea is that when the word [ħukm] 'decision' is produced in an utterance such as [ħukm il.maħkamah] 'the court's decision', only one optimal candidate must win the competition in the tableau, and that is the form with a coda cluster CVCC.

Before introducing the ranking of constraints related to this pattern, it is of equal importance to highlight the analysis I follow in this paper in explaining the exclusion of the other possible candidate: [ħuk**u**m il.maħkamah]. I suggest that when the word [ħukm] is followed by a vowel-initial word, vowel insertion is prohibited and the word [ħukm] is produced with a coda cluster. This is because the semisyllable [m] moves to the following syllable forming its onset: [ħuk. mil. maħkamah]. As a result, the violation of SCL-SEMI is no longer an issue as the new resyllabification is subject to the other sub-constraint of SCL: SCL-SYLL, sonority is banned from rising across two syllables: (mil) and (maħ). I claim that SCL-SEMI is ranked higher than SCL-SYLL because it is only violated in the isolation case where DEP-IO dominates the SCL-SEMI. Other than that, SCL-SEMI is always preserved. SCL-SYLL, by contrast, is violated in Najdi in numerous cases. Consider the following examples:

(4.8)	(mas)(raħ)	'theater'
	(mat)(ħaf)	'museum'
	(mad)(xal)	'entrance'

Words in (4.8) all show violations of SCL-SYLL as the sonority rises across two syllables; that is, sonority rises from the codas of the first syllables to the onset of the second syllables. All these words, and some others, are grammatically accepted in the dialect. This, then, should reflect a low ranking of SCL-SYLL in Najdi. Another interesting observation in this regard is that when target words are followed by a consonant-initial word, vowel insertion becomes possible. Consider the following examples:

(4.9)	a.	/ħuk**u**m/ ~ /ħukm/	'decision'
		/gasˤ**i**r/ ~ /gasˤr/	'palace'
	b.	/ħu**km** il.maħkamah/	'the court's decision'
		/ga**sˤr** il malik/	'the king's palace'
	c.	/ħuk**u**m maħkamat il. gasi:m/	'the decision' of Algasim's court'
		/gasˤ**i**r Khalid/	'Khalid's palace'

In (4.9)(a), when words are produced in isolation, vowel epenthesis is applied as a repair tool to avoid violating SCL-SEMI due to the reversed ranking of two important constraints DEP-IO and SCL-SEMI. In (4.9)(b), when target words are followed by a vowel-initial word, vowel epenthesis is no longer a grammatical option. This is because the semisyllables [m] and [r] form onsets of the following syllables to satisfy the high-ranked constraint ONSET. This resyllabification process renders SCL-SEMI irrelevant (and therefore automatically satisfied), but results in a violation of the lower ranked constraint SCL-SYLL. Further evidence for this structure is observed in (4.9)(c) where vowel epenthesis occurs when target words are followed by consonant-initial words. In such cases, there is no way to move the semisyllables to the adjacent syllable because it already has an onset. Leaving these semisyllables where they are will result in a fatal violation of SCL-SEMI. Thus, vowels are inserted to break up the cluster and obey the SCL-SEMI. Consider the following tableau (the sign # indicates word boundary):

Table 17: Input: /ħukm il maħkamah/ → Output: [ħuk mil maħkamah] 'the court's decision'

/ħukm# #il# #maħkamah#	MAX-IO	DEP-IO	SCL-SEMI	SCL-SYLL
a. ħuk.m il. maħkamah			*!	
b. ħuk il. maħkamah	*!			
c. ħu.kum il. maħkamah		*!		
d. ☞ ħuk mil maħkamah				*

*Note that the relation between SCL-SEMI and DEP-IO is no longer reversed because optionality is absent in this case.

In Table 17, Candidate (a) loses because it violates one of the top ranked constraints: SCL-SEMI where sonority rises across a coda and the following semisyllable. Candidate (b) is ruled out because it violates the Faithfulness constraint MAX-IO by deleting the unsyllabified segment [m]. Candidate (c) is also eliminated because it fatally violates the other Faithfulness constraint: DEP-IO by inserting a vowel between the two clusters. Finally, candidate (d) is the winner in this competition, as it does not violate any of the three highly ranked constraints. It only has one violation, and that is of the SCL-SYLL after the resyllabifying of the semisyllable segment to the following syllable. However, the winner in Table 17 violates another important constraint in

Najdi, ALIGNR, because its right edge does not correspond to the right edge of the input, as shown in the following tableau:

Table 18: Input: /ħukm il maħkamah/ → Output: [ħuk   mil maħkamah]

/ħukm# #il# #maħkamah#	ONSET	MAX-IO	ALIGNR	DEP-IO	SCL-SEMI	SCL-SYLL
a. ħuk.mu il. maħkamah	*!		*	*		*
b. ☞ ħuk mil maħkamah			*			*

Table 18 shows that both candidates (a) and (b) violate the alignment constraint ALIGNR. Although both violate the same high-ranked constraint, candidate (b) still fares better as it has fewer violation marks (two compared to four in a). However, we need to introduce a new constraint to the competition that dominates ALIGNR and is, at the same time, obeyed by the winner to eliminate the other candidate. Such constraint is: ONSET, which requires syllables to have onsets. This constraint is obviously respected by the winner candidate after the attachment of the unsyllabified segment to the vowel-initial word (il) → (mil). Candidate (a), thus, is ruled out as it violates this dominating constraint and encounters a higher number of violations compared to candidate (b).

Btoosh (2006) supports this idea by emphasizing that in Arabic, codas at both morpheme boundaries and across word boundaries resyllabify as the onset of the following onsetless syllable. This process is blocked when the following word begins with a consonant. This confirms that ONSET is a top ranked constraint in Arabic.

One might argue that consonant epenthesis could be used as a repair tool to satisfy the ONSET constraint without having to attach semisyllables to the following syllables. For example, the insertion of the glottal stop [ʔ] in Table 19 obeys ONSET by forming an onset to the following vowl-initial article –il. Thus, [ħukm **ʔ**il. maħkamah] becomes a possible optimal candidate. However, a closer look to this solution shows a sequence of three consonants, and this violates a top-ranked constraint in Najdi: *CCC, where a sequence of three consonant clusters is not allowed.

Table 19: Input: /ħukm il maħkamah/ → Output: [ħuk   mil maħkamah]

/ħukm# #il# #maħkamah#	*CCC	ONSET	MAX-IO	ALIGNR	DEP-IO	SCL-SEMI	SCL-SYLL
a. ☞ ħuk mil maħkamah				*			*
b. ħu**km ʔ**il. maħkamah	*!				*	*	

To sum up the analysis, optionality in Najdi is attributed to the constraint ranking stated in (4.10), and the optionality in the isolation form is attributed to the reversed ranking of the two important constraints DEP-IO and SCL-SEMI following the Reversible Ranking strategy introduced by Lee (2001). Since *CCC, MAX-IO and ONSET are never violated in Najdi, they form top-ranked constraints in the dialect:

(4.10) *CCC, MAX-IO, ONSET >> ALIGNR>> DEP-IO, SCL-SEMI >> SCL-SYLL, *CXCOD.

According to this ranking, the sub-constraint SCL-SEMI is ranked higher than SCL-SYLL. This is evident in cases where SCL-SEMI is never violated unless the word is followed by an onsetless vowel that by *Resyllabification* process renders the violation to be of the other low-ranked type of SCL, SCL-SYLL. This revised ranking then, shows that faithfulness in Najdi can be violated only to satisfy a constraint on semisyllables, but not to satisfy a constraint on syllables.

Interestingly, in a similar approach, Btoosh (2006) explains that in the Karak dialect of Jordanian Arabic, and in almost all dialects of Arabic, onsetless syllables are dispreferred and, thus, are avoided by following one of two phonological processes: *Onset-motivated epenthesis* or *Onset-motivated resyllabification* (example cited from [Btoosh, 2006]).

(4.11)	**UR**	**SR**	**Gloss**	**Process**
a.	šift+ak	šif.**t**ak	'I saw you'	*Onset-motivated Resyllabification*
b.	aħmad	**?**aħmad	'ProperN'	*Onset-motivated Epenthesis*

Example (4.11)(a) is similar to the analysis I proposed earlier. Btoosh claims that the second segment of the coda is resyllabified as the onset of the following adjacent syllable only to satisfy a high-ranked constraint in Karak, and that is the Markedness constraint: ONSET. In (4.11)(b), he shows that the other way to avoid undesired onsetless syllables is epenthesis, where a consonant is inserted preceding the vowel to form its onset. Since only the process of *Onset-motivated Resyllabification* is related to the discussion presented in this section, the other process of *Onset-motivated Epenthesis* will not be further considered in this section. Consider the following tableau from (Btoosh, 2006;197):

Table 20: ONSET >> ALIGN (R)

/baɪt+ak/ 'your house'	ONSET	ALIGN (R)
a. baɪt.ak	*!	
b. ☞ baɪ.tak		*

In Table 20**,** candidate (a) is ruled out because it has a fatal violation of a high-ranked constraint, ONSET because the second syllable starts with a vowel. Candidate (b), on the other hand, satisfies this constraint and violates a low ranked one, which is the alignment constraint ALIGN (R), Align root morpheme boundaries with syllable boundaries at both edges (Harris and Gussmann, 2003). This tableau shows the ranking of these two constraints of Karak at the lexical level. At the post-lexical level, Btoosh introduces the same constraints with a minor modification to the alignment constraint where ALIGN (R) is changed to ALIGN (w), Align the right edge of a word with the right edge of a syllable (Harris and Gussmann, 2003).

Table 21: ONSET >> ALIGN (W)

/baɪt# #aħmad/ ‘Ahmad’s house’	ONSET	ALIGN (W)
a. baɪt.aħ.mad	*!	
b. ☞ baɪ.taħ.mad		*

Similar to the previous tableau, candidate (a) fatally violates a top-ranked constraint and, thus, is eliminated. Candidate (b) wins the competition where the second segment of its complex coda is re-syllabified as the onset of the following vowel satisfying the high-ranked constraint in the dialect.

3. Conclusion:

Optionality, where two forms are used interchangeably within one dialect/language, has been dealt with in the literature by different stratigies, such as Tied Ranking (Broihier, 1995), Re-Ranking (Kager, 1999), and Reversible Ranking (Lee, 2001). In this chapter, I showed, using OT tableaus, that optionality in Najdi Arabic further supports the claim by Lee (2001) that Reversible Ranking is the best strategy to account for optionality in one dialect. I claim that the two Najdi constraints that must be reversed are: DEP-IO and SCL-SEMI following this constraint ranking: *CCC, MAX-IO, ONSET >> ALIGNR>> DEP-IO, SCL-SEMI >> SCL-SYLL, *CXCOD.

Chapter Five: Najdi Vowel Epenthesis and Vowel Quality

This chapter reviews the process of vowel epenthesis and observes the quality of vowels inserted to avoid violating the SCL-SEMI in Najdi. The aim is to show that such insertion is predictable. Vowel epenthesis in Najdi is claimed to undergo a harmony process where inserted vowels copy the features of the stem vowels. Section one provides examples of Najdi words that optionally employ vowel epenthesis to break up the rising sonority in final clusters of CVCC. It also considers cases where epenthetic vowels fail to harmonize to stem vowels. Blocking of such harmony effect is attributed to 'Homophony Avoidance' where a segment is changed to avoid having a form or a pattern that is identical to another existing one in the language. Section two presents a phonological analysis of the Vowel Harmony process and discusses it within the framework of two phonological theories: the Autosegmental Theory and the Optimality Theory. The discussion includes an overview of the Correspondence Theory (introduced in McCarthy and Prince, 1995) that is crucial to understand how Homophony Avoidance operates in the dialect.

1. The Process of Vowel Epenthesis in Najdi Arabic.

The insertion of vowels in words with final clusters splits CVCC structures to CV.C(V)C. Three vowels are found in the inventory of Najdi Arabic: the low back vowel [a], the high front vowel [i], and the high back vowel [u] along with their long counterparts [a:],[i:], and [u:], respectively. The discussion starts with the insertion of the vowel [i] first, followed by [u], then [a]. Note that in all examples below, insertion of vowels takes place when words are produced in isolation, as explained in previous chapters, as a way to avoid violating SCL-SEMI across a syllable and the following unsyllabified segment.

(5.1) <u>Insertion of the vowel [i] to break up the coda cluster in final position:</u>

/ʔið(i)n/	'ear'
/ħib(i)r/	'ink'
/tˤif(i)l/	'child'
/ʕitˤ(i)r/	'perfume'
/fitˤ(i)r/	'mushroom'
/ʔis(i)m/	'name'
/sidʒ(i)n/	'body'
/ʕiq(i)d/	'necklace'
/sidʒ(i)n/	'prison'

Example (5.1) shows that the inserted vowel copies the stem vowel, which is the high front vowel [i] in this example. This process is known as Vowel Harmony where features of the vowel in the first syllable spread to the vowel in the second syllable, causing it to be identical to the preceding vowel.

(5.2) <u>Insertion of the vowel [u] to break up the coda cluster in final position:</u>

/ħuk(u)m/	'decision'
/ruʁ(u)m/	'although'
/xub(u)z/	'bread'
/ʕuð(u)r/	'excuse'
/qutˤ(u)r/	'diameter'
/ʕum(u)r/	'age'
/θul(u)θ/	'one third'
/ðux(u)r/	'honor'

The insertion of the high back vowel [u] renders CVCC forms to CV.CVC where the vowel in the final syllable copies the features of the preceding vowel.

Similar to the findings of this study, Al-Mohanna (2009) investigates the behavior of the epenthetic vowel in the clusters of Hijazi Arabic and concludes that whenever the stem vowel is the high front vowel [i] or the high back vowel [u], the quality of the epenthetic vowel becomes identical to that of the stem.

(5.3) <u>Insertion of the vowel [a] to break up the coda cluster in final position:</u>

/baħ(a)r/	‘sea’
/nah(a)r/	‘river’
/ʃaʕ(a)r/	‘hair’
/nax(a)l/	‘palm tree’
/laʁ(a)m/	‘mine’
/ðˤah(a)r/	‘back’
/tˤaʕ(a)m/	‘taste’
/mah(a)r/	‘money’
/gah(a)r/	‘grievance’
/dah(a)r/	‘century’

In example (5.3), the insertion of the low back vowel [a] shows a similar pattern to that of the other two vowels discussed previously. The vowel in the final syllable, which is inserted to avoid violating SCL-SEMI when words are produced in isolation, copies the features of the preceding vowel. However, there are some words that deviate from this pattern where the vowel in the first syllable is the low back vowel [a], but the vowel inserted to break up the cluster is of a different quality, namely [i]. Consider the following:

(5.4)	/sˤad(i)r/	‘chest’
	/ħaz(i)m/	‘firmness’
	/ras(i)m/	‘drawing’
	/xat(i)m/	‘stamp’
	/ħab(i)s/	‘imprisonment’
	/baʃ(i)r/	‘peeling’
	/tˤaħ(i)n/	‘grinding’
	/ʁas(i)l/	‘washing’
	/daʕ(i)m/	‘support’
	/ħam(i)l/	‘pregnancy’
	/fasˤ(i)l/	‘class’
	/xasˤ(i)m/	‘discount’

All words in (5.4) violate SCL-SEMI by having a coda cluster with a rising sonority towards the word boundary. We would assume, following the previous pattern of vowel insertion, that the inserted vowel copies the quality or features of the preceding vowel, namely [a] in this example.

However, the high front vowel [i] is inserted, instead. What prevents the expected low back vowel [a] from being inserted here?

(5.5)

	NOUN		+ [a]	VERB
/sˤadr/	'chest'	→	/sˤad(a)r/	'was announced'
/ħazm/	'firmness'	→	/ħaz(a)m/	'decided'
/rasm/	'drawing'	→	/ras(a)m/	'he drew'
/xatm/	'stamp'	→	/xat(a)m/	'he stamped'
/ħabs/	'imprisonment'	→	/ħab(a)s/	'he imprisoned'
/baʃr/	'peeling'	→	/baʃ(a)r/	'he peeled'
/tˤaħn/	'grinding'	→	/tˤaħ(a)n/	'he grinded'
/ʁasl/	'washing'	→	/ʁas(a)l/	'he washed'
/daʕm/	'support'	→	/daʕ(a)m/	'he supported'
/ħaml/	'pregnancy'	→	/ħam(a)l/	'he carried'
/fasˤl/	'class'	→	/fasˤ(a)l/	'he separated'
/xasˤm/	'discount'	→	/xasˤ(a)m/	'he put on sale'
/ʕagl	'mind'	→	/ʕag(a)l/	'he became well-behaved'

As the words in (5.5) show, the addition of the low back vowel [a] would derive the verb form, rather than an epenthesized variant of the noun, causing a change in the syntactic category of the word from being a noun to a verb. To avoid this, a different vowel is inserted to distinguish verbs from nouns that are derived from them. In the literature, this process is called 'Homophony Avoidance' where a segment is changed in order to avoid having a form or a pattern that is identical to another existing one in the language. Rose (2000) defines homophony avoidance in Arabic as pertaining to the avoidance of identical templatic shapes.

Sometimes, the insertion of the vowel [a] will not result in deriving verb forms, but other nouns, instead:

(5.6)	/ħaðˤr/	'prohibition'	→	/ħaðˤar/	'non Bedouin'
	/nafs/	'soul'	→	/nafas/	'breath'

Example (5.6) shows that the meaning of the noun formed by the vowel insertion differs from the meaning of the noun with a cluster. This could be another case of Homophony Avoidance where the insertion of the vowel [a] results in deriving another word that already exists in the language.

In sum, when vowels are inserted to break up the rising sonority in CV**CC**, they are predicted to follow a harmony process where inserted vowels copy stem vowels. However, there are some cases where this harmony effect is blocked, namely, when its application will result in Homophony; that is, generating a form that is identical to another existing one in the dialect. The templatic morphology of Arabic contributes to the existence of Homophony in Najdi, because [a…a] pattern changes the word from a noun to a past-tense verb (5.7).

(5.7) Past Verb template

Vowel Melody	a a	
CV skeleton	CaC**a**C	
Root	r s m	
Example	rasam	'he drew'

Note that not all nouns with the pattern [a…a] can be changed to verbs, but only those that are derived from verbs. For example, the noun [rasm] 'drawing' is derived from the verb [rasam] 'he drew', but the noun [nahr] 'river' does not have a verb *nahar. Thus, when vowels are inserted, [nah(a)r] is an acceptable form for a noun because it does not yield homophony. Other than the cases exemplified in (5.6) and (5.7), vowel harmony in Najdi produces no other homophonous forms.

2. Identifying Vowel Quality: Analysis of Vowel Harmony.

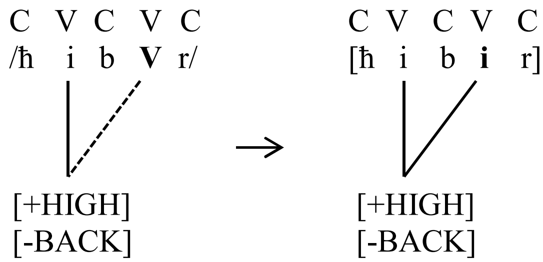
The analysis of vowel harmony is observed in this section using two phonological theories: The Autosegmental Theory (discussed in section 2.1), and The Optimality Theory (OT) (discussed in section 2.2).

2.1. Vowel Harmony in Autosegmental Theory.

Vowel insertion in Najdi is not arbitrary and shows an interesting pattern in which the vowel inserted is underspecified for features and acquires them through spreading of features of the preceding vowel. This process is phonologically defined as the ‘Underspecification Theory’ in which a certain segment is underspecified for some or all features and acquires them through spreading of features of some other preceding segments (Pulleyblank, 1988). Spreading of features in this Autosegmental Theory accounts for vowel harmony that takes place in Najdi; that is, it shows how inserted vowels copy stem vowels. However, despite the fact that Autosegmental Theory help us better understand how vowel harmony works in the dialect, it alone cannot account for the full Harmony process that is observed in Najdi. This is due to its failure to explain why harmony can sometimes be blocked. OT, on the other hand, fills in this gap by treating spreading of features as a separate constraint, [Spread], that can be dominated by other constraints; thus, its application can be blocked. In other words, OT shows that [Spread] is a violable constraint. Before discussing the notion of spreading in OT, it is important to understand first how it works in Najdi. In this regard, Autosegmental Theory provides a clear analysis of spreading.

To apply Autosegmental Theory to Najdi data, I claim that the epenthetic vowel in the final syllable is underspecified for all features (height, frontness, and backness), and acquires them through feature spreading of the preceding vowel. The representation in (5.8) shows the spreading of [+high] and [-back] features of the stem vowel when the vowel [i] is inserted in the second syllable:

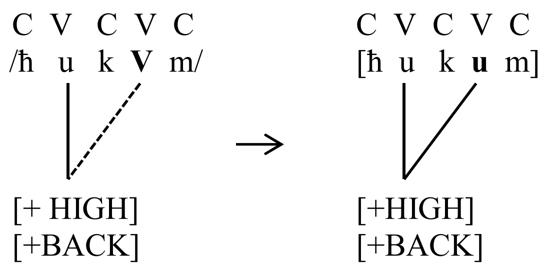
(5.8)



'ink'

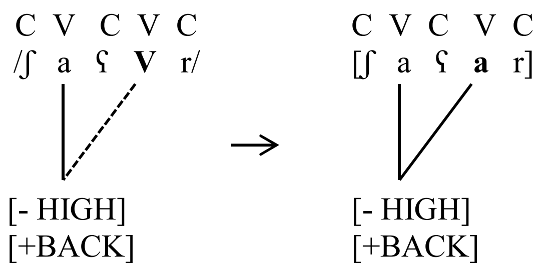
Similarly, insertion of the high back vowel [u] and the low back vowel [a] follows the same pattern, as the following representations illustrate, respectively:

(5.9)



'decision'

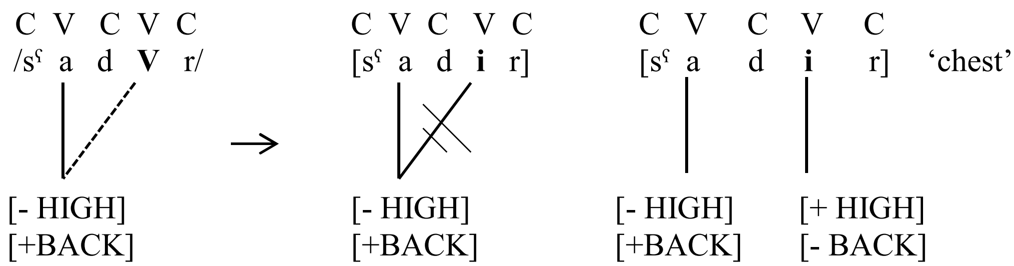
(5.10)



'hair'

In these two examples, (5.9) and (5.10), the features of the first vowel spread to the underspecified, inserted vowel, rendering it identical to the vowel in the first syllable. Up to this point, spreading successfully accounts for vowel harmony. However, this theory fails to explain cases where Homophony Avoidance takes place. Consider the following representation where the stem vowel has the features [-high] and [+back], but the inserted vowel has different qualities, namely [+high] and [–back]. Feature spreading is blocked here:

(5.11)



Unfortunately, Autosegmental Theory does not have a mechanism to explain why a different vowel is inserted in order to avoid Homophony. Thus, another theory is needed to explain the blocking of spreading in these cases. Such theory is the OT where spreading is treated as a distinct constraint, SPREAD [αF] (5.12) that, for example, generates the output [CiC**i**C] from the input /CiC**V**C/ (details about how this constraint works is discussed in section 2.2 below):

(5.12) SPREAD [αF] (Padgett 1997: 22):

“Spread requires (multiple) feature linking, and the spreading constraint is satisfied only when the same feature is shared by all of the vowels in a particular domain”.

2.2. Vowel Harmony in OT Perspective.

In this part of the chapter, OT tableaus are provided to show how vowel epenthesis and vowel harmony operate in Najdi. In doing so, it is important to understand the basic concepts of the Correspondence Theory (introduced in McCarthy and Prince, 1995), on which the following discussion is based. Let us first review how vowel harmony works in Najdi using OT tableaus, and then a discussion of the Correspondence theory will follow.

Table 22 shows how Vowel Harmony works in Najdi based on an Input-to-Output relationship I-O:

Table 22**:** Input /ʔism/ 'name' → Outputs: [ʔism] and [ʔis(i)m]

[ʔism]	MAX-IO	ALIGNR-IO	SPREAD [αF]-IO	SCL-SEMI	DEP-IO	*CXCODA
☞ a. ʔism				*		*
☞ b. ʔis(i)m					*	
c. ʔis(u)m			*!		*	
d. ʔis(a)m			*!			
e. ʔis.mi		*!			*	
f. ʔis	*!	*				

*Note that dashed lines means that constraints are equally important in ranking while dotted lines indicate the Reversible Ranking (as in Lee, 2001)

In Table 22**,** the input /ʔism/ has two possible outputs: [ʔism] and [ʔis(i)m]. The first output [ʔism] is not an issue here because it does not have inserted vowels that must undergo harmony. The other output [ʔis(i)m], however, is what concerns us here because it has an optional vowel inserted that must undergo vowel harmony. Following discussions of previous chapters, optionality is a result of reversing two constraints: SCL-SEMI and DEP-IO. If the ranking SCL-SEMI >> DEP-IO is adopted, we will get [ʔis(i)m] as the output. Since [ʔis(i)m] has a vowel inserted, it must obey a top ranked constraint in the dialect: SPREAD [αF], which requires that features of the previous vowel spread to the inserted vowel. This step is crucial to understand how vowel harmony operates in Najdi. In Table 22**,** both (a) and (b) win the competition as two optimal candidates. Each winner violates one of the two reversed constraints SCL-SEMI and DEP-IO, which allows optionality to emerge. Most importantly, the two winners do not encounter any fatal violations of the three top ranked constraints (separated by dashed lines in the tableau). Candidate (c), on the other hand, is eliminated because it violates the top ranked constraint SPREAD [αF], which requires that the features [+high, -back] of the vowel [i] spread to the second vowel. In (c), the vowel [u] with different features is inserted, instead; thus, this candidate loses. Similarly, candidate (d) has a different vowel inserted and therefore violates SPREAD [αF]. In sum, SPREAD [αF] regulates the insertion of vowels and eliminates any candidate that violates it by inserting a vowel of different qualities than those of the stem. Candidate (e), on the other hand, violates another top ranked constraint: ALIGNR-IO, which requires that the right edge of an output corresponds to the right edge of an input. Finally, candidate (f) is eliminated because it deletes its final segment and this violates a top ranked constraint, which is MAX-IO, by which deletion of segments is prohibited.

After reviewing how vowel harmony works within the OT perspective, now it is time to introduce an important theory on which the remaining discussion is based: The Correspondence Theory, which was first introduced in McCarthy and Prince (1995). In this theory, the GEN component of OT; that is, the candidate set, takes an input and produces a set of ordered triples each of which consists of the input string, a candidate output string, and a relation between the segments of the input string and the segments of the output string. Thus, the basic correspondence relationship, if no other relationship is specified, is the Input-to-Output (I-O) relationship:

(5.13) Input-Output relationship:

GEN (/dɔg/) → {(/dɔg/, [dɔg], R_1), (/dɔg /, [dɔ], R_2), (/dɔg /, [dɔgi], R_3), (/dɔg /, [kæt], R_4), ...}

In (5.13), the relation R that is specific to each I-O pair shows the range of differences and similarities between them. This theory has a set of Faithfulness and Markedness constraints that govern the behavior of such pairs. IDENT, for example, is one Faithfulness constraint that observes the members of these pairs and determines whether or not they are identical to one another. Correspondence Theory has two types of relationships: the I-O relationship, which is described in (5.13) above, and the Output-to-Output (O-O) relationship, discussed below.

Benua (1997) introduced the Transderivational Correspondence Theory (TCT), which links one output form to another, as shown in the following diagram

(5.14) Transderivational (Output-Output) Correspondence (cited from Benua (1997):

OO-correspondence

[root$_i$] → [root$_i$ +affix]

I-O correspondence ↑ ↑ I-O correspondence

/root/ /root+affix/

In this theory, related words are required to be faithful to their underlying forms by I-O correspondence constraints, and they may be required to be identical to other surface words by O-O correspondence relation between two surface words. In other words, each output word is evaluated for faithfulness to its input by IO faithfulness constraints, such as applying IDENT between the base /sˤadr/ ‘chest’ in Najdi and its output [sˤad(i)r] ‘chest’, and the base /sˤadr/ ‘chest’ and its output [sˤad(a)r] ‘was announced’. Then the two outputs [sˤad(i)r] ‘chest’, and [sˤad(a)r]‘was announced’ are compared by OO-Identity constraints, such as the ANTI- IDENT constraint (5.15) that blocks forms from being identical to one another.

(5.15) ANTI-IDENT: (as reported in Crosswhite, 1999)

> “For two forms, S1 and S2, there must be some segment α which is a member of S1 such that α is not identical to its correspondent in S2.”
>
> For two forms, S_1 and S_2, where $S_1 \neq S_2$, $\exists\ \alpha, \alpha \in S_1$, such that α▪ $\neq R(\alpha)$.

Thus, to apply the Anti-Faithfulness constraints to Najdi, a correspondence relation is established between two outputs: [sˤad(i)r] ‘chest’ and [sˤad(a)r] ‘was announced’ with the following mapping: [sˤad(i)r] <----> [sˤad(a)r].

An example of O-O correspondence is discussed in Crosswhite (1999) in her analysis of Homophony Avoidance in Trigrad Bulgarian. Consider the following example cited from Crosswhite (1999):

(5.16) Homophony Blocking in Trigrad Bulgarian: Masculine Animate Nouns in -o

Nominative	**Accusative**	**Gloss**
ˈag**o**	ˈag**a**	‘older brother’
buˈbajk**o**	buˈbajk**a**	‘father’
ˈdɛd**o**	ˈdɛd**a**	‘uncle’
ˈdaʃ͡ʃ**o**	ˈdaʃ͡ʃ**a**	‘uncle’

In this language, mid vowels typically undergo reduction when they appear in unstressed syllables; that is, unstressed mid vowels [o] and [e] lower to [a], as seen in the middle column of (5.16). However, vowel reduction is blocked when its application will result in Homophony. In example (5.16), the mid vowel [o] occurs in unstressed syllables in the nominative form; however, it does not reduce. The reduction here is blocked because if it were to apply, the words in the first column will be homophonous with the accusative forms in the second column. To explain this within the framework of Correspondence Theory, the words in the first row: *ˈag**o*** (‘older brother’-NOM) and *ˈaga* (‘older brother’-ACC), are two words that are crucially in correspondence with one another, with a mapping [ago] <----> [aga]. Faithfulness constraints then can regulate these two words because they are in correspondence relation. Thus, if we applied the IDENT constraint here, it would require that both forms surface as [aga] with vowel reduction. However, this will result in Homophony. To solve this problem, Crosswhite's analysis uses the ANTI- IDENT constraint to require that the two forms be different. So, the mapping [ago]<----> [aga] violates IDENT, but it satisfies ANTI- IDENT which is more highly ranked. Thus, for blocking to occur in Trigrad Bulgarian, ANTI-IDENT must outrank IDENT: ANTI-IDENT >> IDENT.

Note that Anti-Faithfulness is technically a separate concept from correspondence relationships. It typically only applies to O-O correspondence, and not to I-O correspondence. This is because violations of I-O faithfulness are made only to satisfy more highly-ranked markedness constraints. But violations of O-O faithfulness can be made for other reasons, such as avoiding homophony. For example, Homophony Avoidance in Trigrad Bulgarian and Najdi requires ANTI-FAITHFULNESS. Alderete (2001) also claims that Anti-Faithfulness hypothesis is integrated within recent theories of Output–Output (OO) correspondence (Burzio, 1994; Benua, 1997), and is argued to apply on a surface-to-surface correspondence relation.

Another crucial fact that is related to our discussion below is that O-O correspondence is not only governed by ANTI-FAITHFULNESS constraints, but can also be governed by other constraints including Faithfulness constraints. For example, the constraint IDENT can be specified to be used in either I-O correspondence (IDENT- IO) where identity is required between an input form and its output, or in O-O correspondence (IDENT- OO) where identity is required between two output forms. The following tableaus will better show these facts.

Now let us turn to cases where Homophony Avoidance and ANTI-FAITHFULNESS constraints are introduced in the ranking of Nadji. Following previous discussion, ANTI-IDENT, in particular, seems like the right constraint to introduce in the Najdi ranking to account for Homophony Avoidance that takes place in the dialect when the vowel [a] is concerned.

(5.17)	**NOUN**	**Gloss**		**VERB**	**Gloss**
	/sˤad(i)r/	‘chest’	→	/sˤad(a)r/	‘was announced’
	/ħaz(i)m/	‘firmness’	→	/ħaz(a)m/	‘he decided’
	/ras(i)m/	‘drawing’	→	/ras(a)m/	‘he drew’

The words in (5.17), and many others, show clear cases of potential homophony where the insertion of the low back vowel [a] to nouns would derive an existing verbal form, causing words in the first column to be homophonous with those in the second column. In this example, an O-O correspondence relation is established between, for example, words in the first row: [sˤadir] ‘chest’ and [sˤadar] ‘was announced’ with a mapping [sˤadir] <----> [sˤadar]. On its own, the IDENT constraint would predict that both forms surface as [sˤadar] with the inserted vowel copying the stem vowel. However, this results in Homophony. To handle this, ANTI- IDENT is introduced to regulate homophony by requiring that the two forms be different. So, the mapping [sˤadir] <----> [sˤadar] violates IDENT, but it satisfies ANTI- IDENT which reflects a higher ranking of the latter in the dialect. In sum, ANTI- IDENT dominates IDENT in Najdi.

Recall that these ANTI-FAITHFULNESS constraints only apply to O-O correspondence relationships. As a result, in all of the following OT tableaus, the comparison is based on output-to-output correspondence, where the output form with a vowel inserted is the one used as a reference. For example, the input /sˤadr/ has two possible outputs: [sˤadr] and [sˤad(i)r]. Only the output [sˤad(i)r] will be considered in O-O correspondence, and it will be used as the base in evaluating possible candidates. Note that all other Faithfulness constraints that are listed in Table 23 are based on O-O correspondence relationship, as well:

Table 23: Correspondence relationship:
Output [sˤad(i)r] ‘chest’ <---> Output [sˤad(a)r] ‘was announced’

Candidate forms for ‘chest’	MAX-OO	ALIGNR-OO	ANTI-IDENT	IDENT-OO
☞ a. sˤad(i)r				*
b. sˤad(a)r			*!	
c. sˤad(u)r				*!
d. sˤad.ri		*!		*
e. sˤad	*!	*		*

In this tableau, ANTI-IDENT is introduced into the ranking of Najdi. The first candidate, (a), wins as the optimal candidate. Crucially, it satisfies ANTI-IDENT by not being identical to the other otuput that it is in a correspondence relationship with, namely, [sˤad(a)r] ‘was announced’. As a consequence, it violates IDENT-OO, which requires that the two output forms that are in correspondence relation be identical; however, since IDENT-OO is ranked lowest in the tableau, candidate (a) still emerges as the winner. Candidate (b) violates ANTI-IDENT, which requires that ‘chest’ and ‘was announced’ have distinct output forms. Thus, although [sˤad(a)r] is the output candidate that we would expect on the basis of vowel harmony, it nevertheless loses the competition because it violates a top ranked constraint which requires that the two output forms in correspondence be different from one another. This shows that ANTI-IDENT outranks IDENT in Najdi, and this is crucially important to eliminate the candidate [sˤad(a)r] from being an optimal candidate, and only allows the form [sˤad(i)r] with a different vowel quality to survive. Candidate (c) violates the Faithfulness constraint IDENT-OO, by inserting a different vowel. Candidate (d) also loses because it violates a top-ranked constraint in the dialect, ALIGNR-OO, which requires that the right edge of the output coincide with the right edge of the input. Finally, candidate (e) is eliminated because it violates another top-ranked constraint, MAX-OO that prohibits the deletion of any segments. It also violates both ALIGNR-OO and IDENT-OO.

Now let us turn to cases where Homophony is not an issue. Consider the following tableaus:

Table 24: Correspondence relationship: None

Candidate forms for ‘river’	MAX-OO	ALIGNR-OO	ANTI-IDENT	IDENT-OO
☞ a. nah(a)r				
b. nah(i)r				*!
c. nah(u)r				*!
d. nah.ri		*!		*
e. nah	*!	*		*

In this tableau, candidate (a) wins the competition although it has the inserted vowel [a] copying the stem vowel. This time, the insertion of the low back vowel [a] vacuously satisfies the ANTI-IDENT constraint, because [nah(a)r] is not identical with any other forms in the dialect and therefore does not enter into any output-output correspondences. Thus, candidate (a) satisfies both IDENT-OO and ANTI-IDENT constraints. The insertion of a different vowel, namely [i] or [u], in candidates (b) and (c), respectively violates the IDENT-OO constraint and thus, they both get eliminated. Candidate (d) also loses because it violates a top-ranked constraint in the dialect: ALIGNR-OO, which requires that the right edge of the two output forms match. Finally, candidate (e) is eliminated because it violates another top-ranked constraint, MAX-OO that prohibits the deletion of any segment. It also violates both ALIGNR-OO and IDENT-OO.

In a similar pattern, when the inserted vowels [i] and [u] copy stem vowels, both constraints IDENT-OO and ANTI-IDENT are respected because such insertion does not yield cases of Homophony and thus, does not require a repair. Consider the following tableaus:

Table 25: Correspondence relationship:
None

Candidate forms for 'name'	MAX-OO	ALIGNR-OO	ANTI-IDENT	IDENT-OO
☞ a. ʔis(i)m				
b. ʔis(u)m				*!
c. ʔis(a)m				*!
d. ʔis.mi		*!		*
e. ʔis	*!	*		*

The inserted vowel in the winner, (a), does not violate any of the top or low constraints, thus, it fares better than the other candidates. Most importantly, it satisfies ANTI-IDENT by not having a motivation for changing the quality of the inserted vowel. In fact, changing the quality of the inserted vowel to be different from that of the stem violates an important constraint: IDENT-OO and causes candidates to lose, as shown in (b) and (c). Candidate (d) violates another top ranked constraint: ALIGNR-OO and thus, is eliminated. Finally, candidate (e) loses because it deletes its final segment and this violates a top ranked constraint in the dialect, which is the MAX-OO where deletion of segments is prohibited.

Table 26: Correspondence relationship:
None

Candidate forms for ‘decision’	MAX-OO	ALIGNR-OO	ANTI-IDENT	IDENT-OO
☞ a. ħuk(u)m				
b. ħuk(a)m				*!
c. ħuk(i)m				*!
d. ħuk.mi		*!		*
e. ħuk	*!	*		*

In Table 26, the winner satisfies ANTI-IDENT by not having a homophonous form, and satisfies IDENT by being faithful to [ħukum]. Candidates (b) and (c) both lose the competition because they violate IDENT by having inserted vowels with different qualities than those of the stem vowels. Candidate (d) violates ALIGNR-OO where its right edge does not coincide with the right edge of the output [ħukum]. Finally, candidate (e) is eliminated because it violates MAX-OO by having its final segment deleted.

In sum, I suggest the following constraint ranking to account for the Vowel Harmony and Homophony Avoidance processes that exist in Najdi Arabic:

(5.18) MAX-OO, ALIGNR-OO, ANTI-IDENT >> IDENT-OO

This ranking shows that MAX-OO, ALIGNR-OO, and ANTI- IDENT are top-ranked constraints where they are never violated in the dialect. It also shows that IDENT-OO is dominated by ANTI-IDENT only in cases where two forms will end up homophonous in Najdi. In this chapter, I have shown that because OT permits vowel harmony constraints to be violated, it allows us to analyze Najdi forms that would otherwise seem like exceptions.

Chapter Six: SCL- SEMI in Other Languages

In this chapter, I show that the newly introduced constraint, SCL-SEMI, is operative not only in Najdi, but is also in other languages such as German, Diola Fogny, Slovak and English. It also applies to other dialects of Arabic, namely Jordanian and Palestinian Arabic.

SCL-SEMI exists in languages that allow semisyllables in their prosodic structure inventory. Semisyllables appear as a result of violating some important language-specific rules including, sonority restrictions, stress assignment, coda filter, maximum allowed syllable structure, and so on. In this chapter, five different languages that have semisyllables are introduced and discussed. These also help us understand how SCL-SEMI is operative in such langugaes, and how it accounts for the different behavior of semisyllables within a new perspective.

1. Karak Arabic.

In Karak Arabic, a variety spoken in the Karak Governorate in the middle part of Jordan, the final -C in coda clusters of super heavy syllables counts as weightless. Btoosh (2006) explains that although Karak Arabic syllable types are similar to those of other Arabic varieties, constraint interactions between dialects can be different. Karak Arabic distinguishes itself from most other Arabic dialects in two ways: 1) it has ultra-heavy syllables CVVCC[3], and 2) its complex codas –CC adhere to SSP. Btoosh further elaborates that Karak Arabic treats final unsyllabified segments as semisyllables that are directly attached to the prosodic word, thus they are protected from being deleted. Unsyllabified segments in Karak Arabic are not deleted because they satisfy the undominated constraint of Arabic: MAX-C-IO, in which input consonants must have output correspondents. These semisyllables also satisfy another highly ranked constraint in Karak

[3] For this type of syllables, Btoosh (2006) claims that both cluster consonants –CC are semisyllables (for more details on the nature of his claim, see (Btoosh, 2006).

Arabic, the (SON)ority constraint, where sonority is expected to increase towards the peak and decrease towards the margins (Clements, 1990). I diverge from Btoosh in this regard and claim, instead, that if Karak Arabic allows semisyllables, as it is the case in Najdi, then SON restrictions should not apply on these segments. I further argue that Karak Arabic, similar to Najdi, respects the constraint SCL-SEMI, instead; that is, what Btoosh shows as satisfaction of the SON constraint is, in fact, a satisfaction of the SCL-SEMI where sonority is banned from rising across a syllable and the following semisyllable.

Semisyllables are necessary in Karak Arabic to explain the validity of super heavy syllables with either long vowels as CVVC, or complex codas as in CVCC. If the final segments in these two syllable structures are not semisyllables, the entire syllables will be ruled out as they violate the biomoraic constraint of Karak: *3μ, where no trimoraic syllables are allowed (Kager, 1999).

Btoosh (2006) shows that, unlike many other Arabic dialects, complex codas in Karak Arabic are special because they obey the SON constraint (6.1):

(6.1)	ʃa**ms**	'sun'
	ka**lb**	'dog'
	ħa**md**	'praise'
	ħi**lm**	'dream'
	wa**rd**	'roses'

What is interesting about this dialect is that some clusters do indeed violate the SON constraint, despite Btoosh's claim that SON is highly-ranked. He provides few examples such as [ʔa**mr**] 'order', and [ha**bs**] 'prison' where sonority rises towards the syllable boundary even though falling sonority is predicted by the constraint. In his study, Btoosh does not provide a logical analysis to why such violations occur. He, instead, clarifies that these violations are produced by a minority of native speaker informants, while the majority prefer to produce these words with a vowel breaking up the rising sonority such as [ʔam(i)r] 'order', and [hab(i)s] 'prison'. His reasoning for avoiding delving into these violations is to follow the patterns of populations rather than individuals[4].

If sonority is a top-ranked constraint in Karak Arabic, then why there is a different behavior of vowel epenthesis among native speakers in words such as [ʔamr] and [habs]? How is optionality in vowel epenthesis is accounted for in this dialect? Assuming that these violations are excluded only because they occur in the speech of minorities is not an answer. These violations must reflect a different ranking of constraints, or maybe an emergence of new ones.

Such violations are similar to what I observe in Najdi Arabic. In Najdi, coda clusters with falling sonority towards the syllable boundary (e.g., [bi**nt**]) are produced with no vowel epenthesis between the two consonants *[bi**nit**]; however, when the cluster has rising sonority towards the syllable boundary (e.g., /ħu**km**/), vowels are optionally inserted to break up the rising sonority ([ħu**km]** ~ [ħu**kum**]). I argue that the different behavior of optionality observed in Najdi is not attributed to violations of SON constraint, but as violations to the closely related constraint SCL, instead. In particular, they show violations of SCL-SEMI where sonority is banned from rising across codas and the following semisyllables. Similarly, I suggest that in the production of these speakers, words where the SCL-SEMI is violated, such as [ʔamr] and [habs], exist either because this constraint is violable in this dialect, or because they follow similar pattern of Najdi where such clusters allow optional vowel epenthesis.

2. Ma'ani Arabic.

Ma'ani is one dialect of Arabic that is spoken in the South of Amman, the capital of Jordan. Simialr to other Arabic dialects, final consonants in this dialect are semisyllables where heavy

[4] Btoosh (2006) does not provide a clear analysis of the two different forms, but he explains that no attention is paid to such violation since it does not represent the population's norm.

syllables attract stress word-initially and word medially, but never word-finally. Rakhieh (2009) emphasizes that SSP plays an important role in the dialect. Coda clusters that conform to this principle are allowed to surface, as shown in (6.2), while those that violate it undergo obligatory vowel epenthesis as a repair strategy to break up the rising sonority, as shown in (6.3):

(6.2) Final consonant clusters in Ma'ani Arabic that conform to SSP (cited from Rakhieh (2009))

a) /ʔ**irs**/ → *[ʔi.ris] ‘wedding’
b) /ri**mʃ**/ → *[ri.m**i**ʃ] ‘eye lash’□
c) /ʃ**arg**/ → *[ʃa.**ri**g] ‘East’
d) /ka**lb**/ → *[ka.lib] ‘dog’
e) /bi**nt**/ → *[bi.n**i**t] ‘girl’

(6.3) Final consonant clusters in Ma'ani Arabic that violate SSP (cited from Rakhieh (2009))

a) /ʕa**bd**/ → [ʕa.b**i**d] ‘slave’
b) /ti**bn**/ → [ti.b**i**n] ‘hey’□
c) /ga**bl**/ → [ga.b**i**l] ‘before’
d) /dʒ**ism**/ → [dʒi.s**i**m] ‘body’
e) /bi**kr**/ → [bi.k**i**r] ‘first baby’
f) /ħa**fr**/ → [ħa.f**i**r] ‘digging’
g) /ʕa**dl**/ → [ʕa.dil] ‘justice’
h) /ma**hr**/ → [ma.h**i**r] ‘dowry’

In (6.2), the sonority is dropping towards the syllable boundary; as a result, there is no motivation for vowel epenthesis to occur. However, in (6.3), coda clusters violate the sonority principle by having rising sonority from the first consonant in the clusters to the second consonant. Thus, vowels are inserted between the two clusters to avoid such rising and to obey the SSP. Rakhieh suggests the following OT ranking to account for this behavior.

(6.4) SONSEQ>>MAX-IO>>ALIGN>>DEP-IO>>*COMPLEXCOD

Consider the following tableau from Rakhieh (2009):

Table 27: Input /ʕadl/ → Output [ʕadil]

/ʕadl/	SONSEQ	MAX-IO	ALIGN	DEP-IO	*COMPLEXCOD
a. ʕadl	*!				*
b. ☞ ʕadil				*	
c. ʕad.li			*!	*	
d. ʕad		*!	*		

According to Rakhieh, in this tableau, candidate (b) wins the competition because it does not violate the top ranked constraint SONSEQ, which requires sonority to drop towards the margin. It, however, violates the faithfulness constraint DEP-IO, which prohibits the insertion of new segments. This reflects a low ranking of DEP-IO in the dialect. In sum, SONSEQ outranks DEP-IO. Candidate (a) is eliminated because it shows a rising sonority toward word boundary, and thus, violates the top ranked constraint SONSEQ. Candidate (c) loses because it violates another important constraint, the alignment, where the right edge of the output must coincide with the right edge of the input. Candidate (d) also loses the competition due to its violation of MAX-IO by deleting the final segment.

I, instead, suggest that SCL-SEMI should replace the position of SONSEQ in the Ma'ani ranking of constraints. This is due to the fact that SSP should not apply to segments that are out of the final syllable. Violations of SONSEQ in this dialect, is in fact, violations of the SCL-SEMI, which requires sonority to drop across a syllable and the following semisylalble. So, in Table 27, candidate (b) wins the competition because it satisfies SCL-SEMI by having a dropping sonority from its codas to the following semisyllable. So, the ranking in (6.4) should instead be:

(6.5) SCL-SEMI >> MAX-IO>>ALIGN>>DEP-IO>>*COMPLEXCOD

3. Palestinian Arabic.

Palestinian Arabic is one dialect of Levantine Arabic, which is a general term that covers a number of spoken dialects along the Eastern Mediterranean Coast of Syria, Lebanon, Jordan, and Palestine. Gouskova and Hall (2007) show that final -CC exists in Levantine Arabic dialects, although the position where vowels are inserted to break up the cluster differs from one dialect to the other. In Palestinian, vowels are inserted after the first consonant in the cluster. The insertion can either be optional or obligatory depending on sonority restrictions. Vowel insertion is obligatory in Palestinian when sonority rises towards syllable boundary, as in /dʒisr/ → [dʒisir̠] 'bridge', and is optional when sonority is dropping or flat, as in /bint/ → [bint] or [binit] 'girl'. In fact, this behavior of vowel epenthesis in Palestinian shows that it strictly conforms to SCL-SEMI. Final consonants in Palestinian are semisyllables, just like the case in Najdi. This is evident in the important rule that *3µ plays in the dialect where syllables must be biomoraic, and in the stress assignment behavior in Palestinian where CVC attracts stress anywhere in the word, but never word finally.

(6.6) Optionality in Palestinian epenthesis (Cited from (Gouskova and Hall, 2007):

UR	**No epenthesis**	**Epenthesis**	
/siʒn/	*siʒn	siʒ**i**n	'prison'
/nimr/	*nimr	nim**i**r	'tiger'
/kils/	kils	kil**i**s	'whitewash'
/ʒild/	ʒild	ʒil**i**d	'leather'
/bint/	bint	bin**i**t	'girl'
/alf/	alf	al**i**f	'thousand'

Example (6.6) shows that when sonority rises towards syllable boundary, a vowel is obligatorily inserted to break up the rising sonority. However, when sonority drops towards syllable boundary, words can either be produced with a cluster as in [bint] or with a vowel epenthesis as in [bin(i)t]. Such insertion has been explained in the literature in terms of sonority violation avoidance. If this is the case, why are vowels optionally inserted when sonority is dropping towards syllable boundary? SSP requires that sonority drop towards the margins and this is what we see in words like [bint]; however, vowel insertion is nevertheless an option to break up the cluster. I claim that what motivates such insertion even in cases where SSP is obeyed is the role that SCL-SEMI plays in the dialect. Palestinian conforms strictly to the new constraint SCL-SEMI by avoiding having a rising sonority across a syllable and the following semisyllable; thus, insertion becomes obligatory in words like [siʒ**i**n] 'prison'.

One difference between Najdi and Palestinain is that optionality observed in Palestinain exists in clusters that have dropping sonority towards semisyllables while in Najdi, optionality occurs in clusters that show rising sonority, instead. Considering this, it would be interesting to show how the OT tableaux I present for Najdi are modified to handle this dialect. In particular, what ranking is necessary such that optionality in rising clusters becomes obligatory, and what ranking is necessary such that falling sonority clusters are now optional? To answer these questions, I suggest the following ranking for Palestinian:

(6.7) MAX-IO, ALIGNR, SCL-SEMI >> CXCOD, DEP-IO

I further suggest that the two constraints that must be reversed to account for optionality in Palestinian Arabic are: CXCOD and DEP-IO. According to this ranking, MAX-IO, ALIGNR, and SCL-SEMI are top ranked constraints that must not be violated.

In cases where sonority falls towards syllable boundary, optionality emerges to yield two optimal candidates. Consider the following tableau where both [bin.t] and [bi.nit] 'girl' win the competition.

Table 28: Input: /bint/ →Outputs: [bint] and [bi.nit].

/bint/	ALIGNR	MAX-IO	SCL-SEMI	*CXCOD	DEP-IO
a. ☞ (bin)t				*	
b. ☞ bi.nit					*
c. bin.ti	*!				*
d. bin		*!			

*Note that dashed lines means that constraints are equally important in ranking while dotted lines indicate the Reversible Ranking (as in Lee, 2001)

In Table 28**,** SCL-SEMI forms a top ranked constraint because it is never violated in this dialect. Both candidates (a) and (b) win the competition because they equally violate the two reversed constraints; that is, candidate (a) violates *CXCOD by having a cluster word-finally reflecting the ranking DEP-IO >> *CXCOD, and candidate (b) violates the other reversed constraint DEP-IO by inserting a vowel to break up the cluster following the ranking *CXCOD >> DEP-IO.

On the other hand, in cases where sonority rises towards the syllable boundary, optionality disappears and vowel epenthesis becomes obligatory. For example, the input [nimr] 'tiger' with sonority rising from the nasal [m] to the following semisyllable [r] will yield one output only and that is [ni.mir] with a vowel inserted between the two cluster to break up the rising sonority. Consider the following tableau:

Table 29: Input: /nimr/ →Output: [ni.mir] only.

/nimr/	ALIGNR	MAX-IO	SCL-SEMI	*CXCOD	DEP-IO
a. (nim)r			*!	*	
b. ☞ ni.mir					*
c. nim.ri	*!				*
d. nim		*!			

In Table 29, candidate (a) violates SCL-SEMI, a top ranked constraint in the dialect. As a result, it is eliminated from the competition even before it gets a chance to compete on the two reversed constraints. Candidate (b), on the other hand, satisfies all the three top ranked constraints, but violates a lower ranked constraint DEP-IO by inserting a vowel to break up the rising sonority. Thus, (b) fares better than (a) in this tableau as it encounters fewer violation marks; that is, one compared to two. Candidate (c) is also eliminated because it violates a top ranked constraint: ALIGNR, where the right edge of the output does not coincide with the right edge of the input. Candidate (d) violates MAX-IO by having its last segment deleted, thus, it loses the competition.

Reviewing these two tableaus, Table 28 and Table 29, shows that the difference between Najdi and Palestinian Arabic then is that in Najdi, SCL-SEMI is one of the two reversed constraints that can be violated in the dialect under certain conditions while in Palestinian, SCL-SEMI is a top ranked constraint that is never violated. This different ranking of SCL-SEMI in the two dialects explains the obligatory behavior of epenthesis in Palestinian final clusters with rising sonority, and the optionality of epenthesis for such clusters in Najdi.

4. German.

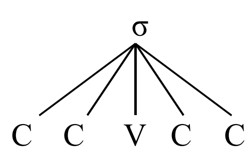
The existence of semisyllables in German is already established by previous authors, but there is a curious fact about semisyllables in this langugae, namely that they are all obstruents. Previous authors (Hall, 1992 and others) have claimed that semisyllables get added by Stray Adjunction Rules, but if this were the case, we should expect to see any type of segment in the semisyllable position. In fact, we only see obstruents, and I show that SCL-SEMI provides the crucial link between these two facts. Several parts of my argument focus on the status of coronals in German. Specifically, I will show that, contrary to claims made by previous authors, there is nothing special about the status of coronal consonants in the language, because a) final consonants in German clusters may also be velar or labial, and b) many published examples of the so-called "special" behavior of coronals actually conform perfectly to permitted German syllable templates and therefore do not require a special application of Stray Adjunction. With these two facts established, we will see that whenever the final consonants of a German word do genuinely violate the permitted syllable templates, those consonants are always obstruents. I claim that this is no accident, because when low-sonority obstruents occupy semisyllable position, satisfaction of SCL-SEMI is guaranteed.

Two major explanations which provide evidence for the existence of German semisyllables (stray consonants) in the literature are: 1) templatic requirements are not fulfilled (Moulton, 1956; Wiese, 1996), and 2) these stray segments violate the sonority principle (Hall, 1992).

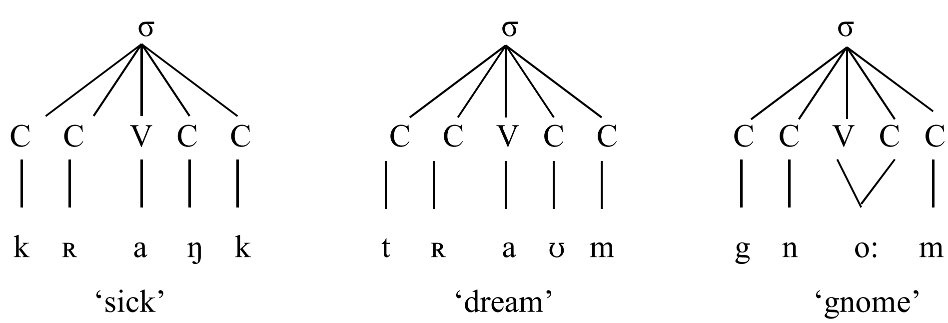
For the first explanation, Moulton (1956) and Wiese (1996) argue that the maximal syllable size in German is CCV$\underline{\text{C}}$C; that is, a single V slot is preceded and followed by two C slots only (where the underlined $\underline{\text{C}}$ can be either a vowel or a consonant, in Wiese's account), as the following representation shows:

(6.8) The maximal syllable form in German (examples are cited from Wiese, 1996):

a.

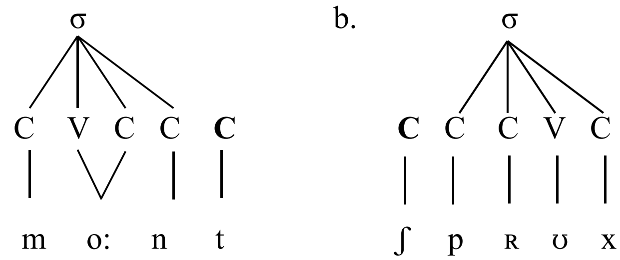


b.



Wiese claims that extra consonants that are attached to the coda position have no available slots to occupy; thus, they remain outside of the syllable only because attaching them to the syllable will violate the maximal size constraint in German. Examples of such cases include [mo:nd] ‘moon’ and [ʃpʀʊx] ‘saying’ (cited from Wiese, 1996):

(6.9) a. b.



Example (6.9)(a) shows that [d] is left out of the syllable because the two available slots after the vowel are already occupied. Attaching this segment to the syllable yields a violation of the maximal size restriction in German. Similarly, (6.9)(b) shows that the onset [ʃ] is left out of the syllable and is treated as a stray segment because the syllable already has two consonant clusters preceding the vowel as the onset of the word.

Violations of the size restriction in German occur when extra segments are found either in word-final position following VXC (X= a vowel or a consonant), or preceding CCV. The exact environments are a) in word-final position with three different possibilities: after a short vowel and two consonants, after a long vowel and a single consonant, or after a diphthong and a single consonant, or b) in word-initial position before onset clusters CC. I will only review cases with final clusters in coda position because the focus in this paper is on semisyllables in coda position.

Extra consonants can be up to three members in German, consider the following words:

(6.10) a. A single consonant after VXC:

Mon<u>d</u>	[mo:nt]	‘moon’
Freun<u>d</u>	[fʀɔɪnt]	‘friend’
feil<u>sch</u>	[faɪlʃ]	‘bargain’
film-<u>t</u>	[fɪlmt]	‘film’

b. Up to three consonants after VXC:

Dienst	[di:nst]	‘service’
Herbst	[hɛɐpst]	‘autumn’
hilf-st	[hɪlfst]	‘help (2sG)’
Herbst-s	[hɛɐpsts]	‘autumn (GEN SGP)’
feilsch-st	[faɪlʃst]	‘bargain (2SG)’

Now let us turn to the second explanation of sonority violations, stray segments violate the sonority principle. Hall (1992) supports the idea that some German segments are considered stray because German conforms strictly to the SSP. In this regard, Hall provides a complicated analysis to account for the behavior of final clusters in German. In doing so, he introduces a different version of the sonority hierarchy that groups stops and fricatives into one category, namely obstruents[5]. The suggested sonority hierarchy is presented in (6.11):

(6.11) German Sonority Hierarchy:

Vowels > [ʀ] > [l] > Nasals > Obstruents

According to the hierarchy in (6.11), plateaus such as combinations of stops and fricatives violate the SSP because they do not show a falling sonority. Consider the following example:

(6.12) a. Word-final obstruent following an obstruent: (underlined consonants are semisyllables)

Gips	[gɪps]	'plaster'
Wachs	[vaks]	'wax'
Akt	[ʔakt]	'act'
seufz	[zɔɪfts]	'sigh (IMP SG)
hübsch	[hʏpʃ]	'pretty'

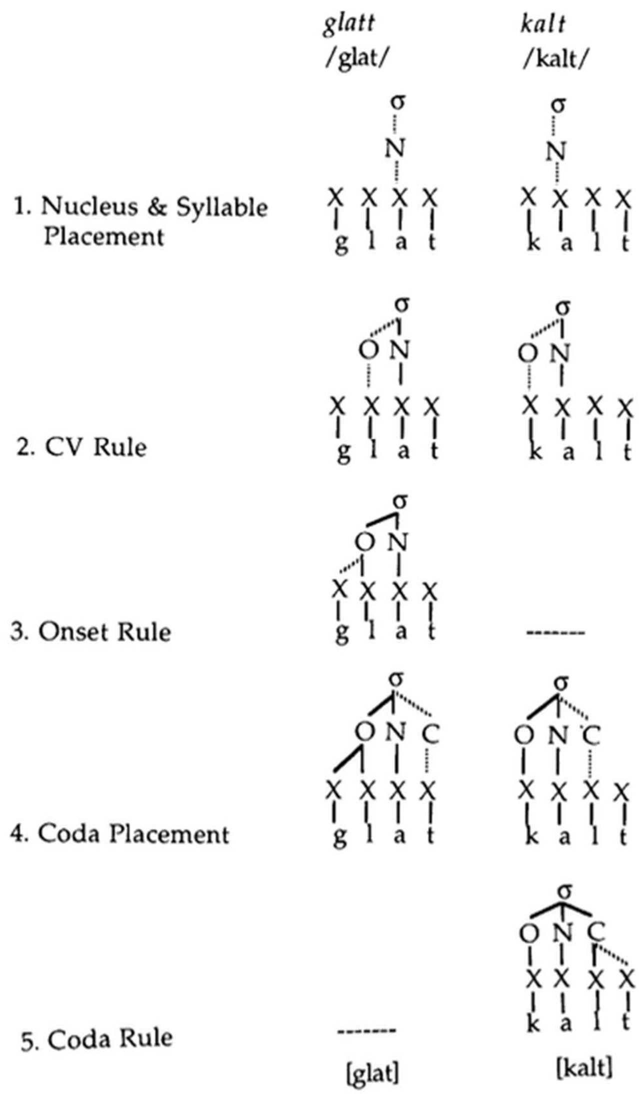
b. Up to three obstruents following an obstruent:

Axt	[ʔakst]	'axe'
Herbst	[hɛɐpst]	'autumn'
Herbst-s	[hɛɐpsts]	'autumn (GEN SG)'

[5] Previous studies have shown that German fricatives are more sonorous than stops (Vennemann 1982: 283; Wiese 1988:91).

Hall claims that final clusters that conform to the SSP hierarchy in (6.11) are syllabified by a Coda Rule, which only applies once, while those that do not conform to the hierarchy are syllabified by a different rule of Stray Segment Adjunction. Consider the following syllable structure assignment (cited from (Hall, 1992)):

(6.13)



In this structure, (1) highlights the nucleus of the words (vowels) and assigns them to syllable nodes, (2) identifies the onsets of these syllables, (3) joins any extra onset clusters by the application of the Onset Rule, (4) assigns codas to the right node, and finally (5) attaches any extra coda clusters to the Coda node only if they abide by the sonority restrictions introduced in (6.11).

Under Hall's account, the Coda Rule only applies when the consonants of the cluster are separated by a minimal sonority distance of one step on the hierarchy; that is, the second segment of the cluster that is adjoined by the Coda Rule must be less sonorous than the preceding one. For example, sequences like [ʀl], [ʀn], and [ln] are acceptable while [lʀ], [nʀ], and [mn] are not. This means that plateaus such as [td], and [st] cannot adjoin by the application of Coda Rule due to their violations of the minimal sonority distance requirement, which must be at least one. The following data clarifies the analysis of Hall's argument (cited from (Hall, 1992)):

(6.14) Sonorant consonant + Sonorant consonant

rl	kerl	[kɛrl]	'fellow'
rm	surm	[ʃtuʀm]	'storm'
lm	halm	[halm]	'blade'

(6.15) Sonorant consonant + Obstruent

ʀp	herb	[hɛʀb]	'dry'
lt	alt	[alt]	'old'
ls	Hals	[hals]	'neck'
mt	Amt	[amt]	'office'
nʃ	Mensch	[mɛnʃ]	'person'

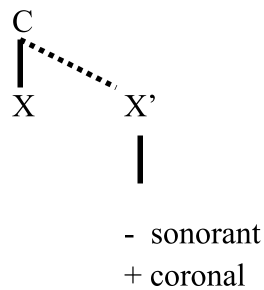
(6.16) Obstruent + Obstruent

st	list	[lɪst]	'deception'
kt	Akt	[akt]	'act'
ps	raps	[ʀaps]	'rape'
çt	echt	[ɛçt]	'genuine'

The final clusters in examples (6.14) and (6.15) show a falling sonority by at least one sonority distance between the two final segments, and thus their final consonants are syllabified by the

Coda Rule. On the other hand, given that obstruents form a single category in the hierarchy, the final clusters in (6.16) are plateaus of equal sonority; that is, the sonority distance between the two final segments is zero. As a result, these final consonants are assumed to be semisyllables (stray) and are adjoined by a different rule, namely Stray Segment Adjunction. Furthermore, Hall claims that the second consonant in such clusters must always have the feature [+coronal], following the rule in (6.17) (where X' = unsyllabified segment).

(6.17) Coronal Obstruent Adjunction (can apply more than once)



I, instead, argue against Hall's claim and support the first explanation in which semisyllables exist in German only when the maximal syllable size is violated. My analysis to why only obstruents exist as semisyllables in German is because the SCL-SEMI is highly respected in this language. Since, according to Hall (1992), obstruents form the least sonorous category in the SSP hierarchy, they are the only possible group to attach as codas to ensure that sonority will never rise and violate SCL-SEMI across the coda and the following semisyllable. The maximal syllable size in German is CCVXC where (X=V or C).

In the examples Hall provided, he claims that the words in (6.14) and (6.15) have no semisyllables because the final coda cluster adheres to the SSP. In the words in (6.16), on the other hand, because the final cluster has an equal sonority (violation of SSP), the second consonant of the cluster is assumed to be a semisyllable. However, a closer look at these examples show that they have the form VCC where the second consonant of the cluster occupies an available C slot without violating any size constraints. On this basis, I offer the alternative proposal that SSP is a violable constraint in German and all words in (6.14)-(6.16) adhere to the maximal CCVCC with no semisyllables on their surface.

Two pieces of evidence support my argument: 1) Hall shows that when the Coda Rule is not applicable due to some sonority violations, Coronal Obstruent Adjunction comes into play. However, on a different part of his paper, he mentions that some German words do, in fact, have syllable final cluster of [sp] and [sk] sequences where the second consonant of the cluster is not coronal, a bilabial and a velar respectively. He explains that only few words have the cluster [sk] and even fewer have the other sequence [sp]. Consequently, these two clusters are ignored and the question of whether or not their existence is systematic or accidental is left open. Examples of this form include:

(6.18)	brüsk	[bʀʏsk]	'abrupt'
	Kiosk	[ki.osk]	'kiosk'
	Obelisk	[o.be.lɪsk]	'obelisk'
	Kafka-esk	[kaf.ka.ɛsk]	'kafkaesque'

The question is, under Hall's account, how would the Coronal Obstruent Adjunction Rule account for the attachment of the velar consonant [k] in these words since it is obviously not a coronoal, but a dorsal segment? If, on the other hand, we consider the templatic structure of German where the maximal syllable size is CCVCC, we would not consider [k] in these words a semisyllable since it occupies the second available C slot after the vowel. The only violation that might occur, however, is that of SSP where the plateaus [sk] have an equal sonority.

2) Hall shows that unlike the Coda Rule, the Coronal Obstruent Adjunction Rule is iterative and this explains the existence of clusters like those in (6.19):

(6.19)	a. obst	[o:p**st**]	'fruit'
	b. text	[tɛk**st**]	'text'
	c. knechts	[knɛç**ts**]	'knight'
	d. markts	[maʀk**ts**][6]	'market'

In (6.19), Hall argues that due to sonority restrictions, consonants in bold are adjoined by the application of the Coronal Obstruent Adjunction Rule. The possibility of reapplying this rule yields two unsyllabified segments instead of one. Instead, I argue that there is no need to reapply the Rule of Coronal Obstruent Adjunction. Any consonant after the maximal syllable size of VXC in word-final position is considered a semisyllable. In cases where more codas are needed, such as in (6.19), the solution is to attach the least sonorous category in the hierarchy, and that is obstruents, only because attaching other consonants will cause sonority to rise, and thus violate the highly ranked constraint SCL-SEMI. The issue of attaching more than one unsyllabified consonant is not observed in this dissertation, however, and is left open for future research.

5. Diola Fogny.

Diola Fogny (also known as Jola-Fonyi) is a language spoken in the Casamance region of Senegal, and neighboring countries. In Diola Fogny, only a single consonant is allowed in coda position. Iverson (1990) claims that codas are semisyllables (stray segments) if they do not abide by the following Coda Filter:

(6.20) *C] σ
 |
 [PLACE]

According to this filter, the occurrence of a syllable-final consonant is prohibited when its place of articulation specification is unique to itself. In other words, if this consonant stands alone where it has no adjacent consonant to share the place feature with, then it is considered stray, and

[6] The segment /k/ in this example is attached by the application of the Coda Rule since it obeys the sonority restrictions in the language.

the syllable CVC will become an open syllable CV. Semisyllables are deleted by the application of Stray Erasure rule (see Steriade, 1982; Itô, 1986).

Clusters in Diola Fogny are restricted to a nasal or a liquid followed by an obstruent, or a nasal geminate; that is, non-final coda consonants must have the feature [+sonorant], as shown in (6.21). Otherwise, syllables are open, except word-finally, where they may be closed by up to two consonants meeting the preceding restrictions (Iverson, 1990). Consider the following data (cited from Iverson [1990]; Sapir [1965]):

(6.21)	a.	ka**ŋ-k**an	'made'	
		je**n-s**u	'undershirt'	
		ku**n-d**on	'large rat'	
		sa**l-t**e	'be dirty'	
	b.	u-ju-ja	'if you see'	/uju**k**+ja/
		le-ku-jaw	'they won't go'	/le**t**+ku+jaw/
		ko-ko-ben	'yearn,long for'	/ko**b**+kob+en/
	c.	fa**mb**	'annoy'	
		ka-ba**nd**	'shoulder'	
		bu**nt**□	'lie'	

In (6.21)(a), nasal and lateral codas of the first syllables survive because they are followed by another consonant that can share their place feature, for example in the word [ka**ŋ-k**an], both [ŋ] and [k] are velars. Thus, the coda [ŋ] exists in the surface. On the other hand, the underlying codas in (6.21)(b) (shown in bold), are followed by other consonants; however, each consonant has its own unique place feature. As a result, these codas are not allowed to surface and are treated as stray segments because they violate the Coda Filter in (6.20). For example, in the first word [u-ju**k**+ja], the coda [k] is a velar while the following consonant [j] is palatal. Each consonant has its own place feature; thus, the coda [k] is prohibited to surface and gets deleted as it forms a stray segment. Monosyllabic words with final complex codas –CC in (6.21)(c) show an interesting pattern and highlight the importance role of the SCL-SEMI in this language. In these words, the first segment of the coda cluster surfaces only because it is followed by another consonant that shares its place feature. In [fa**mb]**, for example, both [m] and [b] are labials; thus, the coda [m] is not considered a stray because it obeys the Coda Filter and occupies an available C slot. The second member of the cluster [b], however, is treated as a semisyllable because it is an extra segment that does not have a C slot to occupy; that is, only one coda is allowed in Diola Fogny. In principle, the coda filter would also permit words like [fa**bm**] since the two clusters share the same place feature. However, we do not see words like this in Diola Fogny. This, in particular, suggests the importance of another constraint that regulates such sequence and prevents sonority from rising across the coda and the following semisyllable, and that is the SCL-SEMI.

This language is interesting because besides syllable size constraints, stress assignment, and sonority violations, it offers another restriction that needs to be taken into account when observing more languages with semisyllables, namely the Coda Filter Rule. All four restrictions share one important issue to my own claim, and that is they yield semisyllables, which allows us to examine how SCL-SEMI operates in different languages.

6. Slovak:

Slovak, an Indo-European language, belongs to the West Slavic languages, and conforms strictly to the sonority principle. Segments that violate this principle are left out of the syllables; that is, they form semisyllables. Other linguists also claim that final consonants in this language are extrametrical and this is evident in the stress assignment of Slovak. In its syllable structure system, Slovak has *yers*, floating vowels that appear in the underlying form and have no X slots assign to them unless in certain situations where they get vocalized; that is, only when they are followed by another yer. These yers play an important role in understanding how semisyllables operate in Slovak.

In the following discussion, we will be considering three different types of words in Slovak. The first two types occur when a verb such as *nies* ‘carry’ is followed by the past participle suffix *-l,* creating an underlying form */nies-l/.* Here, [l] is a semisyllable with higher sonority than the preceding [s], producing a potential violation of SCL-SEMI. In the masculine case, no further suffixation occurs, and SCL-SEMI is satisified with a process of [o]-epenthesis between consonants, producing the final surface form *niesol* ‘carry-PASTPARTICIPLE-MASC.’ In the feminine and neuter cases, however, further suffixation occurs, creating underling forms of */nies-l-a/* and */nies-l-o/.* In these words, SCL-SEMI is satisifed because [l] resyllabifies and becomes the onset of the following syllable, producing final surface forms *niesla* ‘carry-PASTPARTICIPLE-FEM.’ and *nieslo* ‘carry-PASTPARTICIPLE-NEUT.’ The third type of Slovak words, such as [sartr] ‘satre’ and [dabl] ‘double, end with a liquid on the surface, but crucially contain an underlying *yer* vowel which is represented as [U], i.e. /sartrU/ and /dablU/. The presence of *yer* means that the liquids in these words are not word-final, and therefore not extrametrical, and therefore not semisyllables. In these words, the liquid becomes a syllable in its own right, yielding final surface forms [sartr̩] and [dabl̩]. Because no semisyllables are present, SCL-SEMI is vacuously satisfied.

In sum, final consonants are assumed to be semisyllables in Slovak; however, if they are followed by a *yer* in the underlying form, they are no longer semisyllables because the condition for extrametricality is not met; that is, segments are no longer in final position. Slovak shows an interesting variety of mechanisms in which a language might try to satisfy SCL-SEMI.

Understanding these mechanisms relies on principles from Slavic phonology (*yers*) and principles from the theory of lexical phonology.

These two mechanisms are: 1) O-insertion between the consonant clusters that show rising sonority towards the syllable boundary in final position, and 2) semisyllables join the following vowel-initial suffixes and form their onsets; that is, they are no longer left out. Rubach and Booij (1992) explain that determining which mechanism to apply in resolving semisyllables requires that Syllable Structure Algorithm rule (SSA) applies continuously[7], and that phonological derivation is organized following principles of lexical phonology. In specific, they are referring to their claim in (1987) in which there are two lexical components: cyclic vs. postcyclic. The distinction between the two situations is crucial to understand how semisyllables are handled in this language. In the postcyclic component where rules apply after morphology, liquids undergo the first mechanism: the o-insertion. Consider the following example that explains the first and second mechanisms: o-insertion and resyllabification of semisyllables, respectively.

(6.22)	**Infinitive**	**Past Participle [-l]**			
		Masculine	**Feminine**	**Neuter**	**Gloss**
		None	**[-a]**	**[-o]**	
	hrýz+t’	hrýz+(o)l	hrýz+l+a	hrýz+l+o	‘bite’
	nies+t’	nies+(o)l	nies+l+a	nies+l+o	‘carry’
	riec+t’	riek+(o)l	riek+l+a	riek+l+o	‘say’
	piec+t’	piek+(o)l	piek+l+a	piek+l+o	‘bake’

Rubach and Booij (1992) argue that alternation between [o] and zero before the past participle morpheme –l is due to the fact that the vowel [o] is inserted in the masculine form that has no gender marker compared to the other two forms that have gender markers on the surface: [a] for

[7] This is necessary in order to determine whether a segment is extrasyllabic and in order to resyllabify codas as onsets once the vowel has been inserted (Rubach and Booij, 1992).

the feminine form and [o] for the neuter form. In example (6.22), the liquid [l] is a semisyllable because it is the last segment in the word, and it violates the SSP by showing a rising sonority towards the word boundary. For example, in the first word: /hrýz-l/ of the masculine form, [l] is a semisyllable because it is the last segment and the sonority rises from the fricative [z] to the lateral [l]. Rubach and Booij claim that the insertion of the vowel [o] before the semisyllable –l in the masculine form is a way to rescue this extrasyllabicity problem since this form does not have a vowel following the semisyllable as a gender marker. However, in the two other forms, namely feminine and neuter, gender markers that follow the semisyllable –l can rescue it from being unsyllabified by resyllabification where it turns to be an onset of the new syllable. In sum, the o-insertion only applies when the liquid is left unsyllabified following this rule: (*L means unsyllabified)

(6.23) o-insertion Ø → o/ --- *L

On the other hand, in the cyclic component, where rules are applied in the lexicon and interact with morphological rules, liquids are syllabified following another mechanism: Liquid Syllabification, which applies to liquids that are not considered semisyllables in Slovak. That is, there are words that end in liquids with rising sonority towards the word boundary, but at the same time, do not undergo o-insertion or resyllabification because these liquids are not semisyllables due to the existence of *yers* underlingly. Instead, they follow a new mechanism: Liquid Syllabification. Such as the word [sartr̩] where an underlying yer [U] appears after the liquied [r] and cancels its extrametriclity [sartrU]; that is, [r] is no longer in final position. Liquid Syllabification mechanism then applies on unsyllabified segments that are not semisyllables following this rule: (* means unsyllabified).

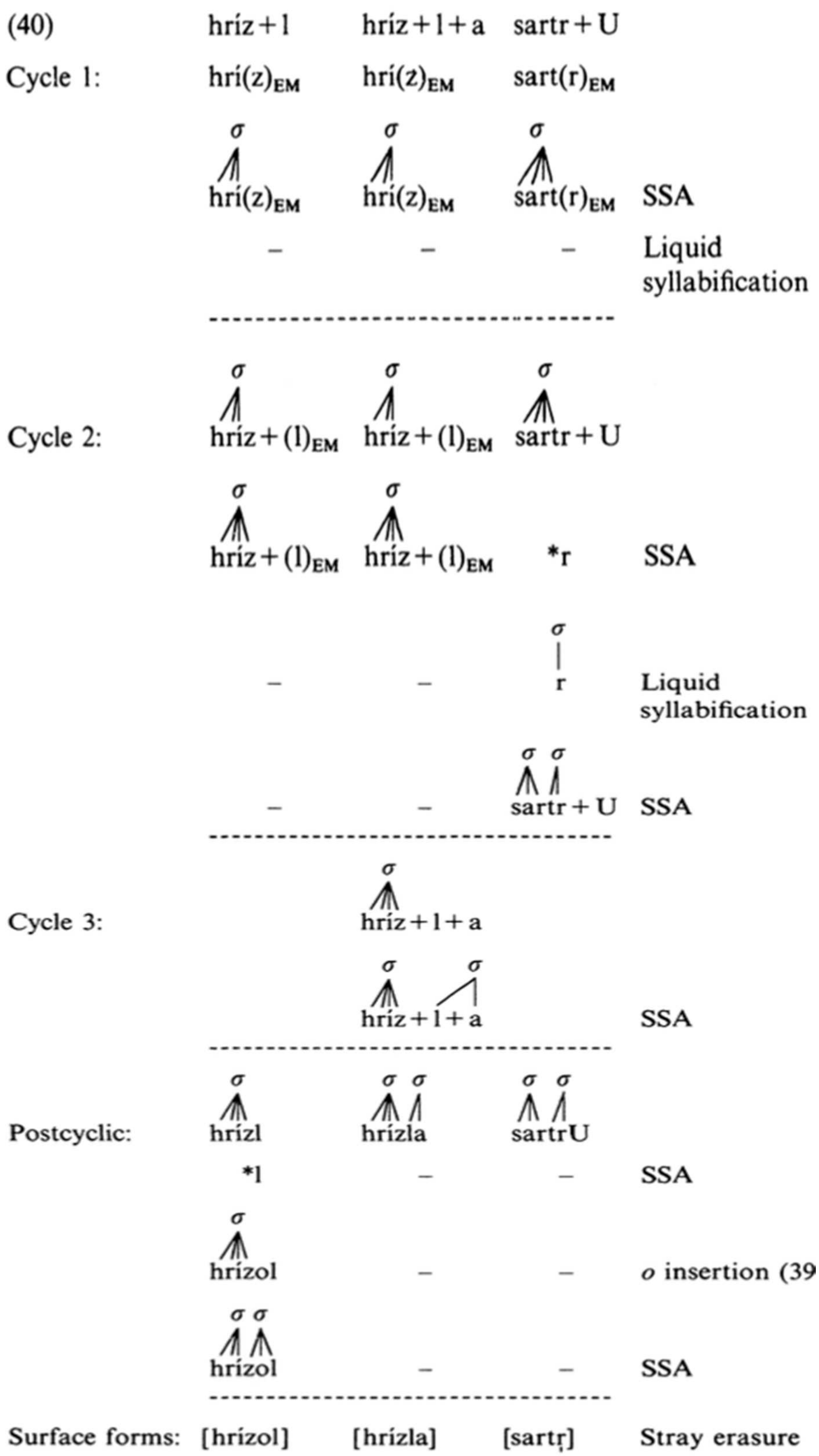
$$
\begin{array}{llccc}
 & & & & N \\
 & & & & | \\
 & & X & & X \\
 & & | & & | \\
(6.24) & \text{Liquid Syllabification} & *L & \rightarrow & L
\end{array}
$$

A closer look at the two rules in (6.23) and (6.24) shows that they both share the same environment, and apply in the same context word-finally. According to Rubach and Booij (1992), the decision on which mechanism to be used is based on whether or not the rule is cyclic vs. postcyclic. They show that the Liquid Syllabification rule is crucially cyclic because it interacts with other cyclic rules in the derivation (see representation (6.25) below) while the O-insertion rule is postcyclic that is applied at the word level after all the suffixes have been added. This also explains why o-insertion only occurs in the masculine form, but never in the feminine and neuter; that is, in cycle 3 of the derivation below, the [l] in [hrýz+l+a] 'she bit' is syllabified by the application of SSA rule to form the onset of the following vowel while the [l] in [hrýz+l] 'he bit' is not.

The words *sartre* [sartr] and *double* [dabl] 'double game' are two examples where the cyclic Liquid Syllabication rule applies and yields [sartṛ] and [dabḷ] instead of *[sartor] and *[dabol], respectively. To explain why [hrýz+l] does not undergo liquid syllabification and instead undergoes epenthesis to yield [hrýzol], Rubach and Booij (1992) provide the following analysis: both [r] in [sartr] and the [l] in [hrizol] are semisyllables because they are the last segments in these words. However, [sartr] is a noun and thus takes the nom.sg. marker, which happens to be the *yer [U]*, unvocalized vowel underlyingly. The existence of this *yer* underlyingly, /sartrU/, eliminates the condition for extrametricality, which is word-final position as the liquid is no longer the last segment in the word, and thus should not be a semisyllable. On the other hand, the [l] in [hriz+1] is not followed by a *yer* underlingly and thus, it is the last segment in the word. In sum, *yers* cancel extrametricality in Slovak. When they are present, Liquid Syllabification comes into play, and word-final liquids become independent syllables, rather than semisyllables, as in [sartr̩] and [dabl̩].

Consider the following representation in (6.25) (Cited from Rubach and Booij, 1992). In the first cycle, final consonants are assigned semisyllables and when the SSA rule applied, they are left out of their syllables. The following rule, the liquid syllabification, then cannot apply to the word [sartr] because it does not apply on semisyllable segments. Similarly, it cannot apply to the other words [hriz+l] and [hriz+l+a] since they both have semisyllables word-finally. In cycle 2, the *yer* is introduced to the third word and this eliminates extrametricality of final consonant [r] making it visible to the rule of Liquid syllabification. Only then, the liquid becomes syllabic. Since the other words do not have *yers*, the liquid [l] resyllabifies with the following vowel in [hriz+l+a], while the rule of O-insertion applies to the first word: [hriz+l].

(6.25) (Yers are represented with capital letters)



This interesting analysis of semisyllables and the two different mechanisms that apply to rescue them when sonority is violated provides evidence to the important role that SCL-SEMI plays in this language. Rescuing semisyllables and breaking up the rising sonority that occurs between the final clusters can show that sonority is not allowed to rise across syllables and the following semisyllables, which is what the SCL-SEMI is calling for. This cannot be attributed to SSP violation since these violations occur outside of the SSP domain.

Further support to the important role of SCL-SEMI in Slovak is found in the following example, (6.26), where a different dialect of Slovak prefers to delete semisyllables only to avoid rising sonority across syllables and the following semisyllables.

(6.26) Treatment of [l] in the masculine gender past participles (Rubach and Booij,1992)

Central Slovak	**East Slovak**	**Gloss**
nies+ol	nis	‘he carried’
piek+ol	pik	‘he baked’
vied+ol	vid	‘he led’

In (6.26), East Slovak prefers to delete the semisyllable [l], instead of applying the o-insertion rule, to avoid having sonority rise across syllables and the following semisyllable.

7. English:

The analysis I adopt in this language is related to the templatic structure of English. Specifically, I discuss evidence for the fact that only two consonants CC are typically allowed in either onset or coda position. My analysis shows that SCL-SEMI is operative and can explain the special behavior that [s] plays in English. It, however, does not solve everything, namely the issue of coronality.

Many studies have reported that coronal obstruents in both word-initial and word-final positions have a special status in English. English exhibits constraints on consonant clusters at both edges of the word. Word-initially, the following restrictions hold. 1) clusters must consist of two consonants maximally, as in *plaque*. 2) Clusters must show rising sonority towards the vowel peak, as in ***drum***. 3) The second consonant of the cluster cannot be a nasal, *[fn], *[fm]. 4) Coronal consonants are not followed by the lateral [l], *[dl]. However, English words exist where one or more of these rules are violated. Consider the following examples: (Examples are cited from Aïm (2004)):

(6.27)	scream	[skrim]	violation of (1) → CCC
	stem	[stɛm]	violation of (2) → Falling sonority
	snow, smell	[sno:], [smɛl]	violation of (3) → C_2 is a nasal consonant
	slide	[**sl**aɪd]	violation of (4) → coronal /s/ is followed by lateral [l]

Such violations are attributed to the special behavior that coronal [s] plays in English. This consonant has been treated differently in the literature: as an appendix (Fudge 1969), as an extrasyllabic segment (Kenstowicz, 1994), as a coda of an empty onset (Kaye, 1992), and recently as a segment that does not belong to any syllable, but is instead attached to the prosodic word.

Word-final coronal obstruents also show similar restrictions and special behaviors. Word-finally, clusters must: 1) consist of two consonants maximally, as in he**mp** and di**sk**. 2) show a falling sonority towards the word boundary, as in ne**st** and wo**lf**. However, violations occur, as shown in (6.28):

(6.28)	sixths	[sɪ**ksθ**]	violation of (1) → CCC
	adze	[æ**dz**]	violation of (2) → Rising sonority

Similar to the treatment of initial [s], the behavior of violations in (6.28) has been described in the literature as the addition of appendices, extrasyllabicity, an onset followed by an empty nucleus, and so on (Iverson, 1990). One shared feature between these two special behaviors is that both the initial [s] and final consonants in coda clusters are always coronal. In word-initial position, it is always the coronal fricative [s], and in word-final position it is always coronal stops or fricatives that show violations to the restrictions imposed on clusters in English. In this regard, I argue that it is not only the status of coronality that shows violations to such restrictions, but also that SCL-SEMI is highly respected in this language.

The English syllable structure allows up to two consonant clusters at both word boundaries; that is CCVCC is the maximal syllable structure allowed in the language. As a result, initial and final CC must not be treated as semisyllables only because they violate the SSP. Instead, I argue that the SON constraint is a violable constraint in the language and this is evident in the existence of words that do not abide by its restrictions, such as in words like *stop, stem* where sonority drops towards the peak in word-initial position, and in words like *adze, six* and *cats* where sonority rises towards word boundary in final position. I claim that it is crucially only those consonants which occur beyond the allowed syllable template in English that are considered a semisyllable. Thus, [s] in words like *stem* and *spare* is part of the syllable onset since it exists in one of the two available C slots in the language, and the dropping sonority is just a case of violating the SSP. Similarly, in *adze* and *cats,* the final two consonants occupy two available C slots and thus, should not be treated as being out of the syllable only because they show violations to the SSP.

On the other hand, in words with three consonant clusters CCC such as ***str**eet*, ***str**ap*, *si**xth***, and *te**xt***, the third consonant should be considered outside of the syllable because it violates an important templatic structure of the language. Only then, SCL-SEMI appears to play a role in these words. That is, in all of these English words, the consonant at the margin is a semisyllable because it does not have an available C slot to occupy. In order to obey SCL-SEMI, sonority must not rise across a syllable and its following semisyllable. This is clearly the case because sonority always drops between initial [s] and the following syllable in word-initial position. Similarly, sonority always drops or is equal across syllables and the following semisyllables in word-final position, such as in [siksθ] (flat sonority) and [tɪkst] (dropping sonority).

Note that only obstruents are allowed to exist as the third consonant in a cluster of CCC in English in either final or initial position. This provides further evidence for the role of SCL-SEMI because attaching obstruents, the least sonorous segments in the sonority hierarchy, can ensure that sonority will never rise at the word edge. Of course, we cannot ignore that only coronals occur in these semisyllable positions, and in word-initial position, it is always the coronal fricative [s]. I do not have a valid explanation of why these particular segments appear in such cases, and I leave this issue open for further investigation.

8. Conclusion.

Semisyllables appear when language-specific rules are violated in a language. Such rules include sonority restrictions, stress assignment, coda filter, maximum allowed syllable structure, and so on. SCL-SEMI can apply to any language with semisyllables. In this chapter, I showed that the new constraint, SCL-SEMI, is operative not only in Najdi, but in other languages such as German, Diola Fogny, Slovak and English, as well as other dialects of Arabic including Jordanian and Palestinian Arabic.

Chapter Seven: Psycholinguistic Study
The Production and Perception of Nonsense Final Clusters by Ten Najdi Speakers

This chapter presents a psycholinguistic study to test the effect of phonotactic restrictions imposed on Najdi clusters on the perception and production of Najdi speakers who employ optional vowel epenthesis. Phonotactic restrictions are the rules that govern what sequences of phonemes are allowed in an utterance, and in Najdi these restrictions are governed by sonority rising vs. falling in the final clusters of CVC(C). The study observes the perception and production of fifteen English nonsense words by ten monolingual native speakers of Najdi. In particular, it investigates whether participants are willing to apply the pattern they adopt for their own dialect to nonsense words that have the same structure; that is, applying optional vowel epenthesis to nonsense words that have rising sonority in final clusters CV**CC**.

This study is similar to the idea of the 'Wug Test' experiment introduced by Gleason (1978), which was designed as a way to investigate the acquisition of the plural rule and other inflectional rules in English-speaking children. Gleason claimed that young children find patterns in languages they hear around them and learn important aspects about these languages from these patterns, rather than from direct imitation of others. She showed that children successfully attached the appropriate English endings to nonsense words that they have never heard before, and this reflects children's implicit knowledge of English patterns for making noun plurals, verb tenses, and other basic morphological modifications to word stems. For example, in her experiment, children were presented with an unfamiliar creature that is identified as a 'wug'. Then, they were presented with another similar object, and were asked to identify the objects as 'two ___'. Results show that the majority of her participants applied the rule-based allomorph [z] of the English plural morpheme to words they heard for the first time and responded: [wugz].

In a similar vein, in this study, adult Najdi speakers were tested to observe whether they epenthesized a vowel into nonsense words with final rising-sonority clusters, such as [tabr]. This 'Wug Test' is interesting for two reasons. First, unlike English allomorphy rules, the epenthesis pattern is optional in real Najdi words; indeed, my OT analysis predicts epenthesized and non-epenthesized forms are equally likely. Nevertheless, it remains possible that the phonological grammar of Najdi actually prefers epenthesis (or alternatively, prefers clusters), a possibility that I tested by asking speakers to respond to novel forms. Second, although evidence from stress assignment and other processes strongly supports the idea that the final consonants in CVCC sequences are semisyllables in real Najdi words, no such evidence is available for final consonants in nonsense words. Thus, this study also tests the generalizability of the semisyllable consistutent, by asking whether Najdi listeners will assign semisyllable status to *any* unsyllabifiable consonant, even those occurring in nonsense words.

In addition, the study also acoustically analyzes the quality of the stem vowel and the inserted vowel that participants produced in the production task. For example, when speakers produced the nonsense form [lutun], I measured F1 and F2 of the first [u] and second [u]. The purpose of this acoustic analysis was to investigate the generalizability of vowel harmony in novel forms. This is important because the "vowel" between [t] and [n] could conceivably be nothing more than a short, schwa-like transition from one consonant to the next, rather than an actual phonological constituent. In other words, when participants were asked to repeat [lutn], they may have produced something like [lut^{ə}n], in which the formants are present but do not reflect the presence of a true vowel. By measuring formant values, we can establish whether or not speakers epenthesized a full vowel, and whether they generalize vowel harmony to novel forms.

1. Introduction and Research Questions.

Peperkamp and Dupoux (2003) claimed that non-native sound structures were assimilated to ones that are well-formed in the native language and argued that adaptation of non-native words originated in perceptual assimilations. They provided psycholinguistic evidence that non-native phonological structures were systematically distorted during speech perception. Other linguists also tackled similar issues (Kiriloff 1969; Goto 1971; Massaro and Cohen 1983; Dupoux et al. 1997, 1999; Hallé et al. 1998; Pitt 1998), both by monolingual speakers and bilinguals (Pallier et al. 2001; Sebastián-Gallés and Soto- Faraco 1999). These perceptual assimilations were then reflected in the adaptation of non-native sounds and words.

Many perceptual assimilation models have been introduced in the literature and showed degrees of perceptual difficulties. For example, Best's Perceptual Assimilation Model (Best, 1994) showed that a non-native sound can be processed in two ways: if the phonetic characteristics of this sound are similar to an existing phoneme category in the native language, the sound will be assimilated to that category. In such cases, listeners will only be able to judge whether it is a good or a bad examplar of that category, but will not have access to its detailed phonetic characteristics. On the other hand, if the non-native sound is too different from any of the available categories, it will not be assimilated at all and listeners will have conscious access to its fine phonetic properties. One limitation of such models, however, is that they only consider the effects of the phonemic repertoire, but not the rules that govern what sequences of phonemes are allowed in an utterance; that is, phonotactic constraints. Human languages are different in this regard, for example, Spanish language-specific constraints play a role in the speech perception of some Spanish speakers. In Spanish, [s]+consonant clusters are always preceded by a vowel. Many Spanish speakers have reported that they hear an illusory vowel preceding

English words that start with a /sC/ cluster, and accordingly they produce such English words with an epenthesized vowel, as in *especial* instead of *special* and *esport* instead of *sport.*

Similarly, the existence of clusters in some languages (e.g., French) versus their absence in others (e.g., Japanese) might affect speech perception and cause Japanese speakers to hear an illusory vowel inserted to break up the two consonants only because clusters are prohibited in their native language. To test this assumption, Dupoux et al. (1999) conducted four cross-linguistic experiments comparing French and Japanese listeners to test the hypothesis that speech perception is heavily influenced by phonotactic knowledge, and to support the claim that language-specific constraints go beyond phonemic categorization. Their findings confirmed that speech perception is heavily influenced by phonotactic knowledge, and this is evident in the perception of Japanese speakers of an "illusory" phoneme that has no acoustic correlates. In Experiment 1, they created a nonword stimuli continuum ranging from [ebuzo] to [ebzo] by removing the acoustic correlates of the vowel. Japanese and French participants were then asked to judge whether the vowel [u] was present or absent. They predicted that, if epenthesis effect had a perceptual basis, Japanese participants would report the presence of [u] more often than French participants. Results showed that French listeners reported the absence of the vowel [u] in [ebzo] and its presence in [ebuzo], but Japanese listeners reported its presence in both cases. Experiment 2 was conducted to avoid possible coarticulation cues in the adjacent consonants that were especially salient to Japanese hearers because the speaker used to record the stimuli in the first experiment was Japanese. Solving this issue confirmed that results reflected a pure perception effect, with the exclusion of any other possible cue. In this experiment, a French speaker recorded the stimuli. The prediction was that if the results of Experiment 1 were due to coarticulation information about the vowel on the adjacent consonants, then Japanese [u] responses to [ebzo] by the new speaker should drop. If, in contrast, results of the first experiment reflected phonotactic cues, then Japanese [u] responses to [ebzo] cluster tokens should produce at least as many [u] responses as those produced in the first experiment. Results showed that, similar to the results of Experiment 1, Japanese participants consistently reported a vowel between two consonants in CC sequences. The other two experiments, Experiment 3 and 4, were also conducted to test the assumption that listeners applied the phonology of their native language to unfamiliar linguistic stimuli, whether this stimuli was native or foreign. They used an ABX paradigm for identity judgments. Participants listened to three stimuli in a row, and then decided whether the third stimulus was similar to the first or to the second. Two contrasts were considered for this ABX discrimination task: an epenthesis contrast (ebzo-ebuzo) and a vowel length contrast (ebuzo-ebuuzo). If it were true that there was a perception effect, Japanese participants should have difficulties distinguishing the two stimuli [ebuzo] and [ebzo] because they would in fact "hear" the same thing twice. The other contrast with vowel length was considered to observe the effect of perception on the French participants as vowel length was not contrastive in their native language, but was contrastive in Japanese: Japanese [tokei] ('watch') vs. [tookei] ('statistics'). The prediction was that French participants might have trouble distinguishing [ebuzo] from [ebuuzo] whereas Japanese participants should have no problem at all as such contrast exists in Japanese. Results showed a crossover interaction: Japanese participants had more difficulty with the epenthesis contrast while French participants had more difficulty with the vowel length contrast. Dupoux et al. (1999) concluded that when perceiving nonnative sounds, participants were influenced by their native phonotactic knowledge to the degree that they not only assimilate these new forms to their native categories, but also might distort segments to conform to the typical phonotactics of their language.

Japanese is different from Najdi. While Japanese clusters are highy restricted in the same fashion for all speakers, Najdi clusters exhibit optionality. Some Najdi speakers prefer producing clusters, while others prefer to break them up and insert a vowel in between. This in turn makes predictions regarding the effect of perception on Najdi speakers more complicated. Those who prefer insertion are predicted to be influenced by the phonotactic knowledge (sonority restrictions) of their production and insert a vowel to break up clusters whenever they produce them. They will also hear an illusory vowel when perceiving clusters. On the other hand, those who prefer producing clusters are predicted to conform to their phonotactic knowledge and produce and percieve clusters of nonsense words as they hear them. Unlike the Japanese case, Najdi speakers who prefer to epenthesize must have been exposed to other speakers who do not epenthesize because epenthesis is optional, so we might predict that they would not hear an illusory vowel. This makes the prediction about their behavior is more interesting to observe to confirm whether or not there exists a link between speakers' perception and production.

Another interesting issue to cover in this study is related to the "Wug Test" idea by (Gleason, 1978) where children were able to apply the English plural rule to nonsense words they had never heard before. Similarly, adult Najdi speakers were tested to observe their behavior with nonsense words that they have never heard before. Because they are completely novel, nonsense words with final CC clusters could conceivably be analyzed as *either* containing a complex coda, *or* as containing a sequence of a single coda plus a following semisyllable. In other words, there is no explicit evidence to support the idea that nonsense words like [lutn] contain a semisyllable [n]. In other words, given no language-specific rules govern the final clusters of these nonsense words, which do not belong to any specific language, Najdi speakers may not apply their Najdi pattern to nonsense words. Such rules include stress assignment, coda filters, and sonority restrictions (see Chapter six). Following previous discussions, semisyllables arise as a result of violating at least one of these important rules. If semisyllables do not exist in these nonsense words, then SCL- SEMI also does not. This would, in turn, eliminate the motivation for vowel insertion to occur in such words.

Finally, the quality of the vowel inserted is also observed in this study under the assumption that it is identical to the stem vowel (a detailed description of vowel epenthesis is discussed in Chapter five).

Similar to the assumption of vowel harmony, Al-Mohanna (2009) investigated the behavior of the epenthetic vowel in the clusters of Hijazi Arabic and concluded that whenever the stem vowel was the high front vowel [i] or the high back vowel [u], the quality of the epenthetic vowel became identical to that of the stem. The claim that inserted vowels were identical to the stem vowels was proposed by few Arab linguists before. For example, Aljarrah (1993) claimed that epenthetic vowels were determined by stem vowels in Hijazi dialect, but he had not provided any acoustic evidence for his claim.

In sum, the perception and production of ten Najdi speakers of fifteen English none-sense words that violate the SCL-SEMI in coda position were observed to answer the following three questions:

1. Do Najdi speakers apply patterns of epenthesis to nonsense words? (The Wug Test)
2. Do Najdi speakers who apply patterns of epenthesis in production, also report illusory vowels in perception? In other words, is there a production-perception link?
3. Do Najdi speakers who apply vowel harmony in real Najdi words also apply it in nonsense words?

2. The study.

2.1. Participants.

Ten monolingual native speakers of Najdi participated in the study (six males and four females). The mean age of all participants was 24. All participants were monolinguals who accompanied their husbands or wives in United States while staying at home with no knowledge in the English language. The ten speakers were divided into two groups with five participants in each group. The division was based on participants' performance in producing fifteen real Najdi words that violated SCL-SEMI by having a rising sonority across the syllable and the following semisyllable in final coda clusters of CV**CC.** Participants who violated the SCL-SEMI and produced clear clusters formed the first group: *No Epenthesis Group* (*P1-P5*), and participants who obeyed SCL-SEMI by inserting a vowel to break up the rising sonority in final clusters formed the second group: *Epenthesis Group* (P6-P10).

2.2. Methodology and Data Analysis.

A list of fifteen English non-words of the form CV**CC** with clusters that show rising sonority towards the boundary was created. Clusters included all possible consonants combinations: stop and fricative [tiks], stop and nasal [lutn], fricative and nasal [rafn] nasal and approximants [taml], etc. The full list of target words is provided in Appendix B. Since the vowel quality of the inserted vowel was targeted in this study, uvulars and pharyngealized consonants were eliminated for their possible effect on the adjacent vowel. Two tasks were completed for this study: *Delayed Repetition task* and *Perception task*. An English native speaker with training in linguistics recorded the stimuli. Note that English does not permit coda clusters with rising sonority, such as *[lutn]. Therefore, it was important to verify that the speaker did indeed produce the target clusters without epenthesis, rather than producting [lutən] or [lutun]. Visual and acoustic inspection confirmed that no epenthetic vowels were present.

2.2.1 Delayed Repetition Task.

For the *repetition task,* participants listened to an English native speaker reading each word (with clusters) in isolation twice. Then, after ten seconds, participants were instructed to produce the same nonsense word twice at normal speed. The interval of ten seconds between the listening and the production of the stimuli is likely to stimulate subjects to produce what is stored in their long-term memory (Best et al. 2001), which reflects the application of phonological knowledge rather than mere acoustic imitation.

Recording sessions took place at the Language Resource Center lab located in the basement of Curtin Hall at UWM. The lab provided booths that ensured high quality recordings. The microphone was placed 8" inches to the side of the speaker's mouth. Every session lasted for approximately twenty-five minutes. Participants were instructed verbally, and then were tested for practice to ensure that they had understood the instructions. Recording was done using Praat program. Data was then analyzed using Praat and Excel programs.

Each participant produced thirty tokens; two tokens per word (15 words in total), yielding a total of 300 words for all ten participants. Recordings were saved as WAV files and analyzed using Praat. Spectrograms were visually inspected to determine clusters were produced as heard in the test stimuli (Figure 1) or with the insertion of a vowel in between the final cluster by formants (Figure 2). The presence of visible formants on the spectrogram was taken to be indicative of the epenthesis while the absence of formants was taken to be indicative of no epenthesis:

Figure 1 *Spectrogram of the word [tiks] that shows clear coda cluster of the form CVCC:*

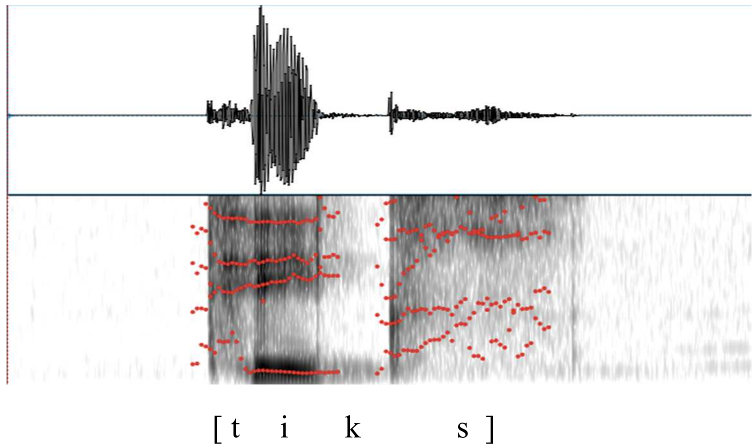
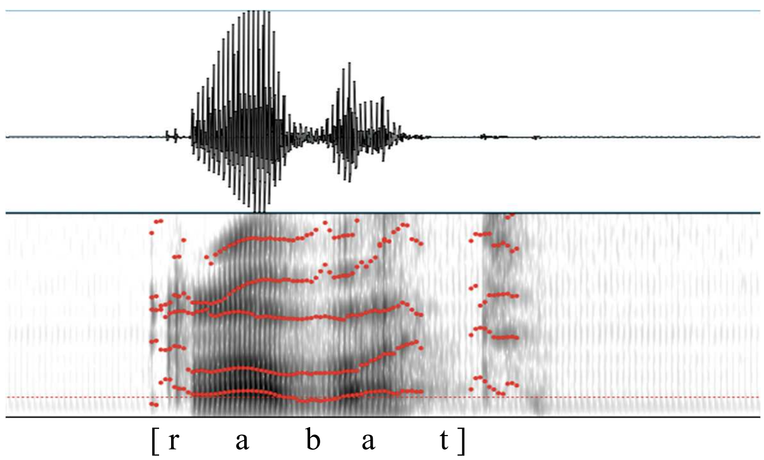


Figure 2 *Spectrogram of the word [rabat] that shows vowel epenthesis between the coda cluster of the form CVC(V)C:*



Vowel duration was measured from the onset of the first formant to the offset of the second formant. Any falling or rising of the formants due to consonantal transition effect was avoided to ensure that only the formants of vowels were highlighted for accurate measurements. Values of F1 and F2 were then reported in tables using Excel for better calculations (See *Appendix* C and D). When no vowels were present, as in Figure 1, the values of F1 and F2 were reported as zero. When vowels were present, as shown in Figure 2, the entire duration of the vowel was highlighted for the purpose of calculating the values of the first two formant frequencies.

The average values of F1 and F2 of the two tokens produced by every participant per word were calculated, and based on these values, vowel charts were created to visualize a vowel space for each participant. These charts help to identify the quality of vowels inserted and to observe whether subjects' epenthesis undergoes the same process of vowel harmony attested in their native language. A vowel chart of the stem vowels was also created and was used as a reference for comparison purposes. It worth noting here that the number of tokens with the stem vowel [a] exceeded the number of tokens with the two other stem vowels [i] and [u], and this is due to the fact that vowel quality of the epenthesized vowel was not a main goal in the study from the beginning, but was added later after the recordings were completed.

2.2.2 Perception Task.

For the *perception task*, participants listened to a recording of an English native speaker reading each word once, and then completed a forced-choice task where they used an answer sheet that included three answer options for each word: CV**CC** (cluster), CV**CV:C** (long vowel), and CV**CVC** (short vowel). Since only epenthesis is the target in this task (with the exclusion of vowel quality), their answers were categorized into two groups: either *vowel epenthesis* (CVCVC or CVCV:C), or *no vowel epenthesis* (CVCC). Note that initially, an investigation of the length of the inserted vowel (long vs. short) was also planned for this study, although I later decided to exclude it and therefore will not discuss it further.

The three vowels of Najdi, [i], [u], and [a], were used. Their distribution was predicted to follow the pattern of vowel harmony attested in their native language where inserted vowels copy stem vowels. The three choices were then translated into Arabic and presented to participants in an ordinary Arabic consonantal script. Since short vowels were not normally written in Arabic, diacritics were used to distinguish clusters from those with vowel epenthesis;

short vowels were indicated by the use of (َ) for [a], and (ُ) for [u], and (ِ) for [i] on the top or bottom of the consonant preceding the epenthetic vowel. Long vowels were indicated by writing actual Arabic vowels where appropriate. It is important to mention that the use of diacritics in this task was not going to be a relevant factor because vowel quality was not targeted for the *Perception Task*. After listening to each word, participants circled the one word on the answer sheet which, in their opinion, was the closest to the word they just heard. Then, they pressed a button to start listening to the next word.

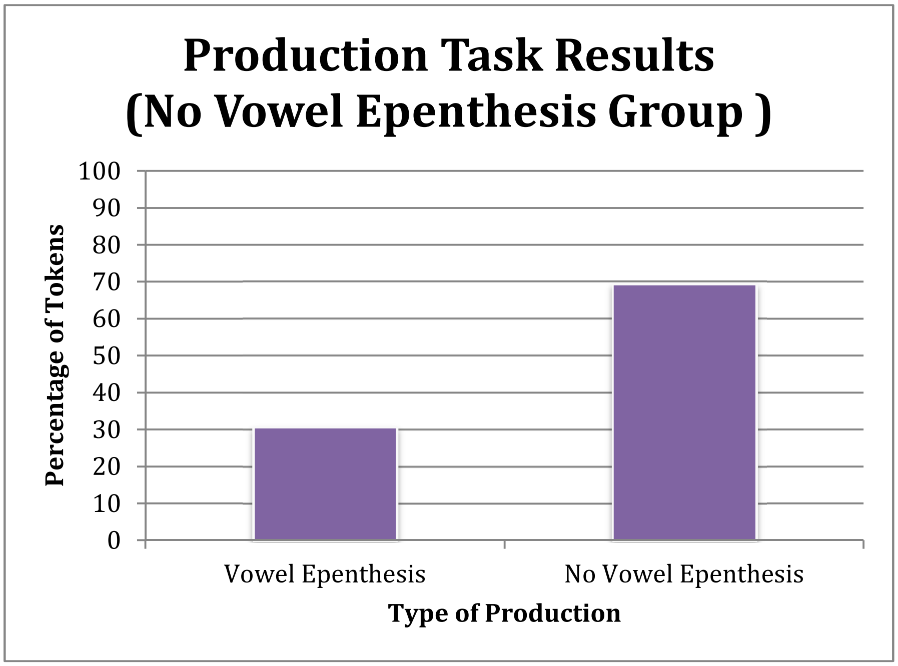
2.3 Results and Discussion.

2.3.1 Delayed Repetition Task:

For this task, it was predicted that the *No Epenthesis Group*, whose members produce clusters with no vowel insertion that violate SCL-SEMI, would produce nonsense clusters as they were heard, with no vowel insertion. The *Epenthesis Group*, on the other hand, was predicted to insert a vowel in between the final clusters of the nonsense CVCC to break up the rising sonority and to satisfy SCL-SEMI.

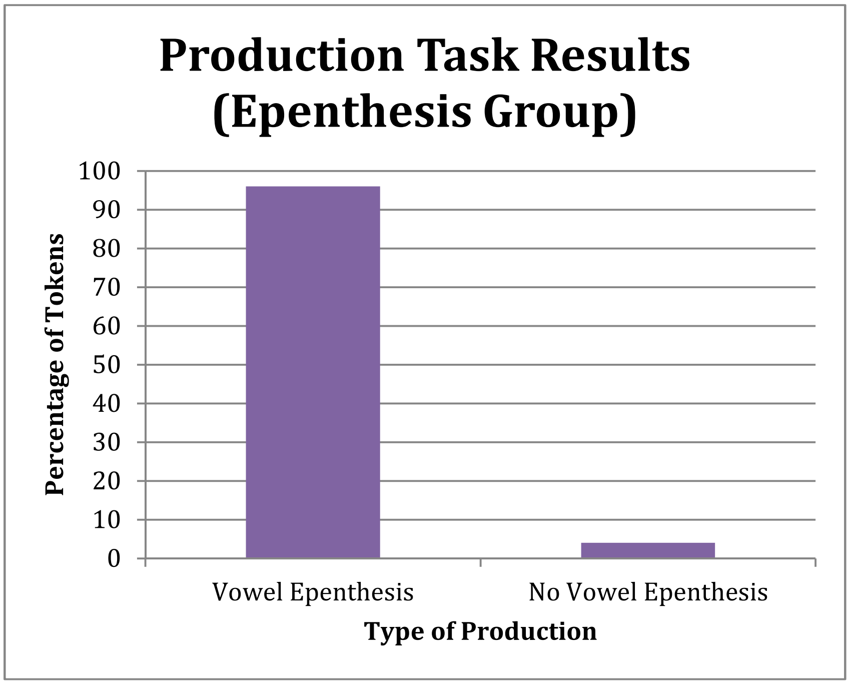
Figure 3 below shows that, generally speaking, the first prediction partially holds true where participants who produced Najdi words with final clusters with no vowel epenthesis also produced nonsense clusters with no vowel epenthesis 69% of the time, while only 30% of tokens were produced with vowel epenthesis. The 30% represents the production of two participants out of five. Only Participant 1 (P1) and Participant 2 (P2) of the *No Epenthesis Group* produced most instances with vowel epenthesis; P1 produced 11 words out of 15 (73% of total production) with a vowel inserted between the two clusters while P2 produced 12 out of 15 words with vowel epenthesis (80% of total production). Participant 5 (P5) produced one word only (of the two tokens) with vowel epenthesis. However, her production was not consistent; that is, one token was produced with a clear cluster while the other token was produced with a vowel epenthesized between the coda clusters. Since the average number of her tokens showed a preference towards avoiding vowel epenthesis (99%), this one word was discarded. Overall, for the *No Vowel Epenthesis* group, the percentage of tokens with no epenthesis exceeded the percentage of tokens with epenthesis.

Figure 3 *Production Task Results of the No Epenthesis Group*



Turning to the *Epenthesis Group*, my prediction was generally upheld. The percentage of words produced with vowel epenthesis exceeded the percentage of words produced with clusters. Figure 4 below shows that 96% of tokens were produced with a vowel inserted between the coda cluster while only 4% of tokens were produced with clear clusters. I assume that the insertion of vowels between the two clusters in CVCC by these participants was a way to satisfy SCL-SEMI by repairing clusters with rising sonority.

Figure 4 *Production Task Results of the Epenthesis Group*



In sum, the results of the production task showed that Najdi monolinguals who violate SCL-SEMI in real Najdi words (*No Epenthesis Group*) also produced coda clusters that violate SCL-SEMI in nonsense words, most of the time (69%). However, two participants who produced coda clusters in Najdi words failed to produce clusters in nonsense in most of their productions; that is, their tokens were more like the prediction about the *Epenthesis Group* and would satisfy SCL-SEMI. This pattern might be attributed to the fact that these two participants did not adhere to a single constraint ranking and were able to produce words either with or without clusters. It is extremely interesting to observe the behavior of these two particular participants on the other task, the perception task, to confirm whether or not there exists a link between their production and their perception.

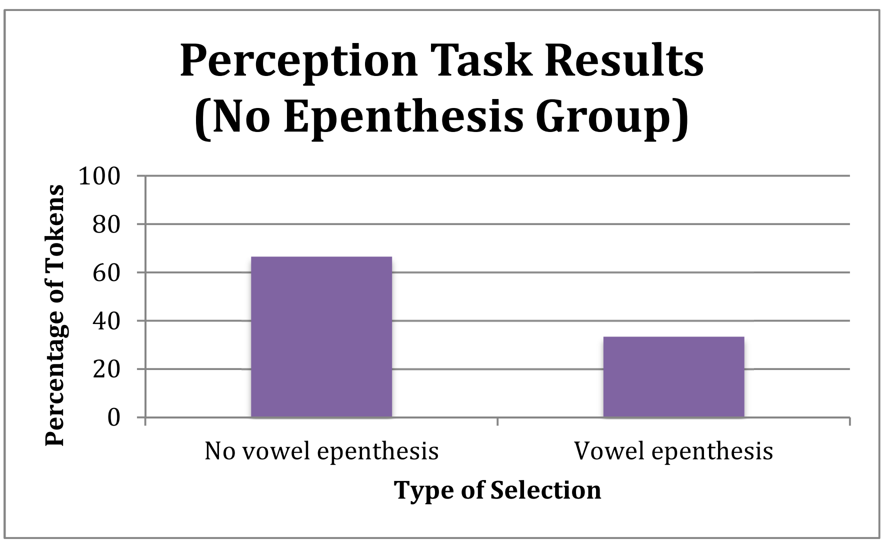
As for the other group, the *Epenthesis Group,* results showed that Najdi speakers who prefered vowel epenthesis in Najdi words also inserted a vowel to break up the cluster in the nonsense words, even though the stimuli that they were asked to repeat contained a cluster with no epenthesis. These specific results provided answers to the first research question of this study:

4. Do Najdi speakers apply patterns of epenthesis to nonsense words? (The Wug Test)

2.3.2 Perception Task:

For this task, it is predicted that the *No Epenthesis Group* would perceive nonsense clusters as they are heard, with no vowel insertion, just as they produced them. The *Epenthesis Group*, on the other hand, was predicted to hear an illusory vowel inserted between the final clusters of the nonsense CVCC, because they prefered to obey SCL-SEMI. Since the quality of the vowel inserted was not targeted in this task, the following figures group results as either with vowel epenthesis or without vowel epenthesis, without indicating whether the selected vowel was short or long. Figure 5 shows that for *No Epenthesis Group,* as predicted, the percentage of tokens that were perceived with clusters was higher (67%) compared to the percentage of tokens perceived with a vowel epenthesized between the two clusters (33%).

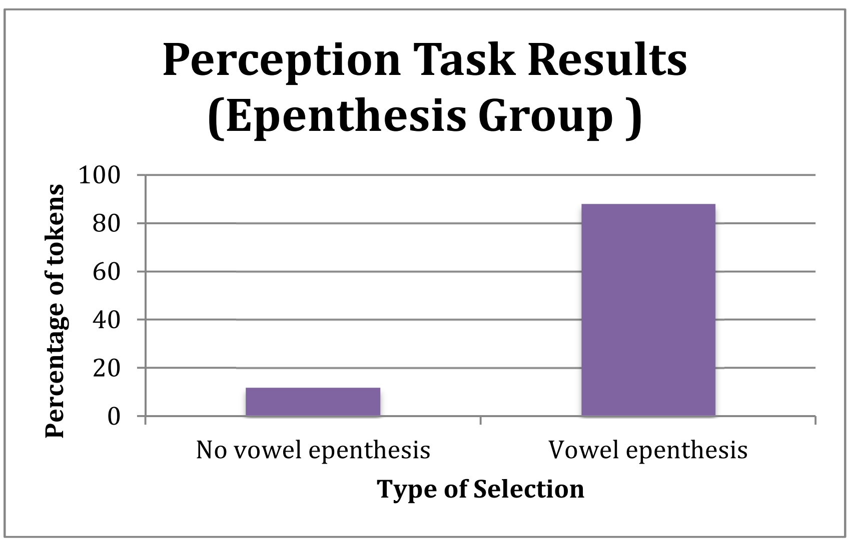
Figure 5 *Perception Task Results of the No epenthesis Group: epenthesis vs. no epenthesis*



Interestingly, the 33% of tokens perceived with vowel epenthesis represented the perception of P1 and P2, who also showed similar behavior in the delayed repetition task, where they produced nonsense clusters with vowel epenthesis. This misperception might be attributed to the differences between real words and non-words, or to the optional nature of epenthesis in Najdi. Most importantly, there is a strong relation between the perception and production of clusters for these two participants.

Figure 6 below shows the results of the perception task of the second group, the *Epenthesis Group*. As predicted, most tokens were perceived with a vowel between the two clusters to obey SCL-SEMI, even though the target words were produced with clusters. The percentage of tokens perceived as clusters was only 12% compared to the percentage of tokens perceived with a vowel epenthesized between the two clusters 88%.

Figure 6 *Perception Task Results of The Epenthesis Group: epenthesis vs. no epenthesis*



The results of this section showed that, as predicted, the *No Epenthesis Group* perceived most of the nonsense words with no vowel insertion. The prediction about *Epenthesis Group* also held true, as the percentage of tokens they perceived with vowel epenthesis exceeded that of clusters. Results of this section provided answers to the second research question:

5. Do Najdi speakers who apply patterns of epenthesis in production, also report illusory vowels in perception? In other words, is there a production-perception link?

It is clear from Figures 4 and 6 that the *Epenthesis Group* both produced and perceived more tokens with a vowel inserted between the two clusters even though participants heard an English native speaker producing clusters. The perception of these participants was compatible with their production of the same clusters. This then suggests a link between perception and production where participants were heavily influenced by their phonotactic knowledge of clusters in Najdi (sonority restrictions), and applied it to nonsense forms.

Interestingly, while the *Epenthesis Group* conformed strongly to the predictions of this study, the *No Epenthesis Group* conformed less strongly. That is, two out of five participants in this group inserted vowels to break up the cluster in both production and perception of nonsense words. Their behavior resembled that of the second group, the *Epenthesis Group*. Despite the fact that these two participants unexpectedly deviate from the pattern they followed for Najdi real words, their production and perception showed a strong relation and support the prediction that there existed a perception-production link.

Going back to the OT analysis of Najdi optionality in vowel epenthesis discussed in Chapter four, optionality is assumed to exist in the production of each Najdi participant equally; that is, each participant is able to produce words that have final clusters in isolation in two different ways: with a cluster, or with a vowel epenthesis. However, results of this psycholinguistic study showed that participants were divided into two groups according to their preference of whether or not to apply vowel epenthesis. Two participants of the *No Epenthesis group,* however, deviated from the predicted pattern. Their production and perception were interesting as it fits into the OT analysis I presented earlier; that is, they produced real Najdi words with clusters, but produced and perceived nonsense words with vowel epenthesis at the same time. Two explanations are possible for such behavior: 1) they might be able to apply either pattern interchangeably depending on their preference at the time of production or perception, and 2) while they apply learned (i.e., "imitated") patterns to real Najdi words, their phonological grammar actually prefers to satisfy SCL-SEMI, a fact which only becomes evident when we examine unlearned nonsense words. As for their production of real Najdi words with cluster, they might produce these clusters imitiating others whom they contact with on a daily basis.

2.3.3 Vowel Quality.

For this part of the study, the key prediction regarding vowel harmony is met. That is, the stem vowel predicts the quality of the epenthesized vowel in the production of the seven Najdi participants who produced epenthesis.

Following the pattern explained in Chapter five, it is predicted that the inserted vowel copies the quality of the stem vowel: CaCC → CaC(a)C; CiCC → CiC(i)C; and CuCC → CuC(u)C. To determine the quality of the vowel inserted, a vowel chart of stem vowels was created first to locate the vowel space of all three Najdi vowels: [i], [u] and [a]. Figure 7 shows a chart of the first vowel in CVCC words by all participants. According to the figure, the high front vowel [i] has a range of F1 values between 350 and 550 Hz and F2 values between 1800 and 2500 Hz; the high back vowel [u] has F1 values between 320 and 550 Hz and F2 values between 1100 to 1700 Hz; and the low back vowel [a] has F1 values between 450 and 920 Hz and F2 values between 1200 to 1900 Hz. This particular vowel has unexpectedly low F1 values that are not characteristics of a low vowel. The low F1 values of the vowel [a] cause it to overlap with the high back vowel [u] where the two meet at F1 range of 450-500 Hz (represented as triangles vs. squares in Figure 7). Consonants preceding the vowel [a] were checked to determine if they have an effect in having low F1 values. This is considered a possible cause because the duration of the vowel was measured from the onset of its F1 to the offset of its F2; that is, the whole vowel duration. This might have an effect of formant transition from consonants to vowels. However, all consonants preceding the vowel [a] shared the feature [+CORONAL] where no back features are involved to explain the overlapping of the two vowels [a] and [u] in the figure. Two tokens also showed low F1 values to the point that they made contact with the vowel [i] at F1 value of 500 Hz and F2 values of 1800 Hz. I think that for these two cases, the preceding consonants might have an effect on the following vowel considering the fact that the vowel [i] is somehow produced in the palatal area (Coronal). Besides the overlapping of these two vowels, the figure shows the three vowels clustered in three separate areas where it is easy to distinguish the three spots of vowels.

Figure 7 *Vowel Chart of The Stem Vowels*

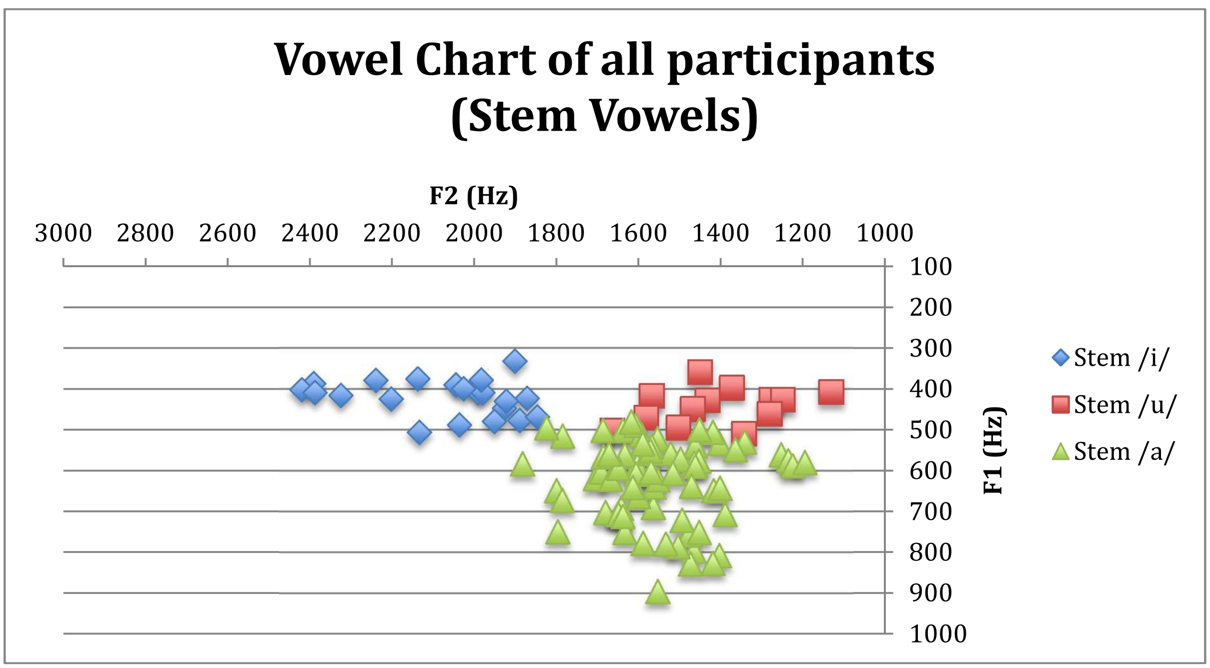


Figure 8 *Vowel Chart of the Epenthesized Vowels*

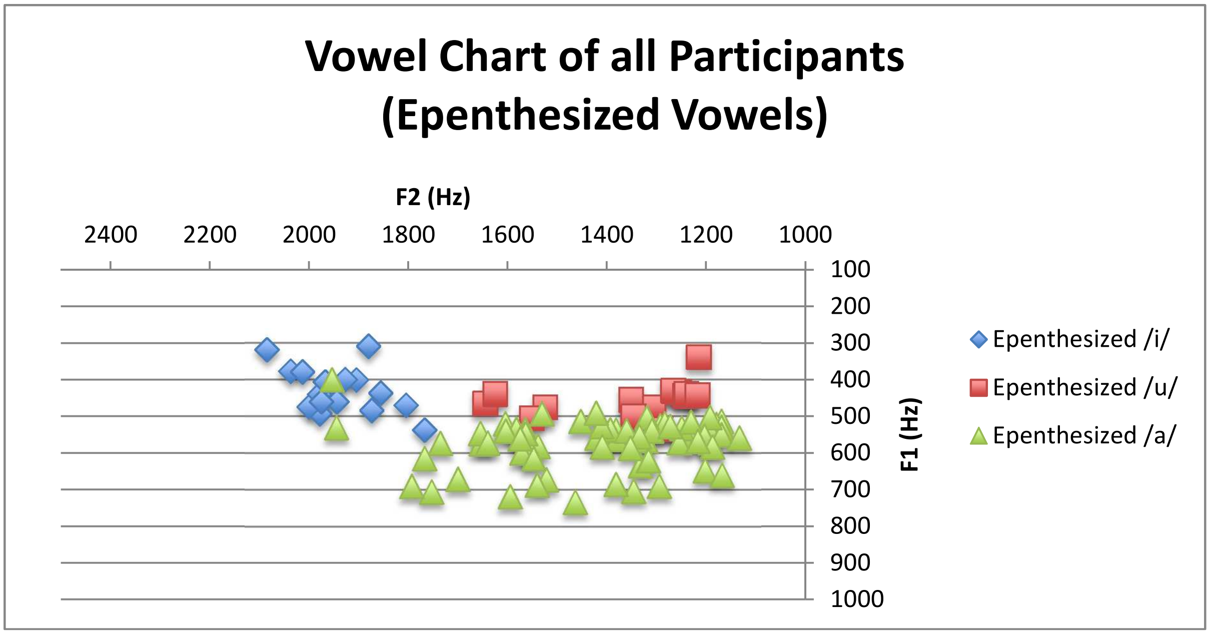


Figure 8 shows the vowel quality of the three epenthesized vowels: [i], [u] and [a]. All participants who inserted a vowel in their production of any token and were consistent with their insertion were considered in this figure. Participants 3, 4 and 5 from *No Epenthesis Group* were excluded due to the absence of vowel epenthesis in their production. Reported values and accouctic measurments of F1 and F2 of the inserted vowels are important here to show that prticipants do in fact insert a new segment (vowel) in between the final two clusters. Results show that these valuses are nearly identical to the values of stem vowels. This, in particular, clear up any doubts regarding the identification of this inserted segment. In other words, many would assume that no vowels are inserted and what listners hear is just a transition between one consonant to the other. This is clearly not the case and the reported values represent real vowels.

Figure 8 shows three different spots where each vowel is clustered. The epenthesized vowel [u] has slightly different F1 values of that of the stem [u] where most tokens are more clustered at a higher F1 values between 450 Hz to 550 Hz. The F2 values of this epenthesized vowel ranges between 1200-1650 Hz compared to 1100-1650 Hz of the stem [u]. Overall, the distribution of the epenthesized vowel [u] shows similar pattern to that of the stem [u] with a slight difference of either F1 or F2 values (around 100Hz).

The distribution of the epenthesized vowel [i] shows an interesting behavior compared to that of the stem [i]; stem [i] in Figure 7 is more spread out and has an F2 range of 1800-2450 Hz while the epenthesized vowel [i] in Figure 8 is more clustered and has a smaller range of F2: between 1700-2100 Hz. This is compatible with what Gouskova and Hall (2009) report in their study where they claim that the inserted [i] is acoustically backer than the lexical [i] in Lebanese. Gouskova and Hall observed epenthetic and lexical vowels in Lebanese that were assumed to be identical and found that they were acoustically different. In particular, they claimed that the high front vowel [i], which was mostly inserted to break up the final cluster of CVCC forms in Lebanese, was acoustically distinct from the lexical [i] where the former was either shorter, backer or both.

Other than the lower values of F2 for the epenthesized vowel [i], F1 values do not show a great difference between the stem [i] and epenthesized vowel [i]; both vowels have an F1 range of 300-550 Hz.

The distribution of the epenthesized vowel [a] in Figure 8 shows similar unexpected contact with the vowel [u]. Values of F1 range between 500-750 Hz and F2 values range between 1100-1800 Hz while the stem [a] in Figure 7 has F1 values between 500-900 Hz and F2 values between 1200-1900 Hz. One noticeable difference between the stem [a] and the epenthesized [a] is found in the low F1 values of the latter where it ranges between 500-750 Hz compared to a range of 500-900 Hz of the stem [a]. Moreover, the epenthesized vowel [a] is more clustered at lower F1 frequencies; mostly between 500-600 Hz while the stem vowel [a] is more clustered between 500-800 Hz. No great difference is observed in the F2 values of the two

[a] vowels; however, more tokens are clustered between F2 values of 1100-1500 Hz for the epenthesized vowel [a] while the stem [a] is more clustered at a higher F2 values, between 1400-1700 Hz. Interestingly, two tokens where the vowel [a] is predicted to be epenthesized appear in the area of the vowel [i], as shown in Figure 8. I do no have a good explanation to why this occurs as these words are nonsense and the insertion of a different vowel here cannot be attributed to Homophony Avoidance (See Chapter five for more details).

Generally speaking, the inserted vowels are clustered at the same spots where the stem vowels appear with little differences. The epenthesized vowel [i] shows more clustering compared to the wide spread of the tokens of the stem vowel [i]. Both epenthesized and stem vowels [u] appear in the same region with the epenthesized vowel [u] more clustered at a slightly higher F1 values; that is, between 450-550 Hz. Similarly, the epenthesized vowel [a] shows the same unexpected behavior of stem [a] where low F1 values are detected to the point that they overlap with both the stem and epenthesized vowels [u]. One might assume that the tokens where the epenthesized vowel [a] shows low F1 values should not be identified as [a], but as [u] instead. However, this might be true only if the stem [a] shows a different behavior! But since both the stem [a] and the epenthesized vowel [a] have pretty much the same distribution, I will assume that the values of F1 and F2 reported in this study are of the vowel [a] in both charts. This might be a feature of the participants' dialect where their [a] and [u] occupy the same central space. One noticeable difference between the stem and the epenthesized vowel [a] is the lower F1 values of the latter. In sum, results show that the inserted vowels copy stem vowels, but are more centered; that is, they have slight different qualities including lowering of both F1 and F2 values of the epenthesized vowel vowels [a] and [i], respectively, and raising of F1 values for the epenthesized vowel [u].

One explanation to the overlapping observed in the distributions of the two vowels [a] and [u] might be attributed to the way the vowel duration is measured in this study; from the onset of the first formant to the offset of the second formant. To test this, I conducted a second set of measurements, taken from a point in the middle of the highlighted duration instead of measuring the average of formants from the whole duration (see some examples on *Appendix* E). Results show the same overlapping behavior, which entails that it is not due to measurement methods. This shows that the behavior of [a] and [u] in Najdi dialect is special and might be considered a characteristic of the participants' dialect.

The results of this section provided answer to the third research question addressed in this study:

6. Do Najdi speakers who apply vowel harmony in real Najdi words also apply it in nonsense words?

3. Conclusion.

Najdi dialect is special in that it allows optional vowel epenthesis to break up the coda cluster in CVCC forms only when that cluster violates the SCL-SEMI: sonority is banned from rising across a syllable and the following semisyllable. This study investigated the perception and production of English nonsense words by ten monolingual native speakers of Najdi. In particular, it investigated whether Najdi speakers were perceptually influenced by their native dialect and its sonority restrictions when they hear non-native forms especially in the case of perceiving and producing clusters that have rising sonority in final position of CV**CC** forms. Two tasks were completed for this purpose: *Repetition Task* and *Perception Task.* The ten native speakers were divided into two groups and the division was based on participants' performance in producing fifteen real Najdi words that violated SCL-SEMI in final coda clusters CV**CC**. Participants who prefered the following ranking: DEP-IO >> SCL-SEMI, and produced clear clusters formed the first group (*No Epenthesis Group*, P1-P5), and participants who obeied the SCL-SEMI by inserting a vowel to break up the final cluster following this ranking: SCL-SEMI >> DEP-IO, instead, formed the second group (*Epenthesis Group*, P6-P10). A parallel behavior in the perception and production of coda clusters that violate SCL-SEMI of the two groups was predicted; that is, participants who inserted a vowel to break up the cluster in Najdi would also insert a vowel in the production of the nonsense words that violate SCL-SEMI, and they would also perceive vowel insertion when hearing such clusters. On the other hand, participants who did not insert vowels to break up the cluster in Najdi would be able to produce nonsense clusters that violate SCL-SEMI just like they did in their dialect with no vowel epenthesis. Results showed that the two groups differed in their production and perception of the nonsense coda clusters that violated the SCL-SEMI: *No Epenthesis Group* showed preference towards producing clusters as they were heard with no vowel epenthesis, and perceiving nonsense words with clusters most of the time. On the other hand, *Epenthesis Group* showed preference towards inserting vowels to break up the rising sonority in final coda clusters although they heard an English native speaker producing the same words with a clear cluster, and they also perceived an illusory vowel inserted between the two clusters.

The quality of the inserted vowel was also observed in this study where it was predicted that it copied the stem vowel in a Vowel Harmony process where stem vowels predict the quality of the inserted vowels. Results showed that this prediction held true where little differences were detected between the stem vowels and the epenthesized ones.

One limitation of this study is the small number of participants involved. With only ten participants, it was hard to generalize predictions. Future research should include a larger number of participants. Another limitation is that the speaker recording the target words for this study was an English native speaker. Although she was a linguist and was trained to produce clusters that did not exist in English, this was considered a disadvantage as she might fail to produce clear clusters in some cases and, thus, affected the perception of participants in this study. For future studies, I suggest replacing the English native speaker with a Najdi speaker who is willing to produce such clusters clearly as they exist in Arabic.

Chapter Eight: Conclusion

Kiparsky (2003) shows that final consonants in Arabic CVCC structures are semisyllables; that is, unsyllabified segments that are attached to the prosodic word immediately. If this is the case, rising sonority in these final clusters is questionable. It cannot be attributed to violations of the SSP because sonority restrictions only apply to segments within syllables, not to segments that are left out of their syllables (semisyllables). Najdi Arabic is one dialect of Arabic that allows semisyllables in final position. One interesting observation in these Najdi clusters is the optionality in vowel epenthesis to break up the final clusters only when the cluster shows rising sonority towards syllable boundary, such as [nisr] ~ [nisir] 'eagle'. Falling sonority in final clusters, on the other hand, allows no vowel epenthesis at any level: [bint], not *[binit]. Following Kiparsky's perspective combined with the fact that SSP only applies within syllables, this difference in vowel epenthesis cannot be attributed to SSP. Thus, I argue in this dissertation that vowel epenthesis in Najdi coda clusters of CV**CC** should be explained as a solution to violations of the SCL. In this regard, I further divide SCL into tow sub-constraints within the frame of OT: 1) the SCL-SYLL, where sonority is banned from rising across syllables, and 2) the newly suggested constraint: SCL-SEMI, where sonority is banned from rising across a syllable and the following semisyllable. I claim that SCL-SEMI outranks SCL-SYLL. This is due to the fact that SCL-SYLL is violated in Najdi in numerous cases, but SCL-SEMI is not. To account for optionality in vowel epenthesis where words can either be produced with clear clusters, or with a vowel breaking up the two clusters, I adopt the *Reversible Ranking Strategy* introduced in Lee (2001) where two constraints must be reversed in order to allow two optimal candidates to survive at the same time: DEP-IO and SCL-SEMI.

I further show that SCL-SEMI is not only restricted to Najdi, but can apply to any language that employs or has semisyllables. I discuss this possibility in five different languages and/or varieties of Arabic and show that SCL-SEMI is operative and can provide better analysis to what has been proposed in the literature.

Moreover, a psycolinguistic study is conducted where the perception and production of ten Najdi speakers were tested to observe whether they epenthesized a vowel into nonsense words with final rising-sonority clusters, such as [tabr]. The study also tests the generalizability of the semisyllable consistutent, by asking whether Najdi listeners will assign semisyllable status to any unsyllabifiable consonant, even those occurring in nonsense words.

SCL-SEMI, as a new constraint, definitely supports the claim that semisyllables exit and shows that even though these segments are left out of their syllables, their behavior is governed by constraints that are designed for unsyllabified segments. This new idea of SCL-SEMI also opens doors to look more into this neglected notion of semisyllables. One possibility is to consider languages that allow more than one semsyllable to be adjacent. Interestingly, some languages such as Bella Coola restrict the number of semisyllables to be one semisyllable per morpheme edge. So far, the suggested constraint SCL-SEMI deals with violations where sonority rises across a syllable and a following semisyllable because this is the type observed in Najdi. However, not all languages are similar to Najdi; that is, there exists languages where more than one semisyllable is allowed.

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APPENDICES

Appendix A: Differences between VC-, CV-, and C-dialects as reported in (Kiparsky, 2003).

	VC-dialects	C-dialects	CV-dialects
Languages involved	Dialects of Syria, Lebanon, Iraq, and Turkey, Bedouin and Bedouin-type dialects such as Bani-Hassan, the Hijazi dialects of Central Arabia.	Over a large area in North Africa, including Morocco, Tunis, and Mauretania, Like the coterritorial Berber, Certain Bedouin-type dialects, and Maltese language.	The majority of the dialects of Egypt, including Cairo, most of the Delta, the oases of the Libyan desert, and Middle Egypt
Features:	**VC-dialects**	**C-dialects**	**CV-dialects**
1.	Allows semisyllables only at the word level.	Allows semisyllables at both word level and postlexically.	Allows no semisyllables at all levels. Final consonants in final CVVC and CVCC bear no moras.
2.	License-μ is ranked below the constraints that impose Syllable and Foot well-formedness and below the constraint Reduce; License-μ is outranked by a number of faithfulness constraints (both Max and Dep type), by the markedness constraints FootBin, License-C and by Reduce.	License-μ is ranked below the constraints that impose Syllable and Foot well-formedness and below the constraint Reduce; License-μ is outranked by a number of faithfulness constraints (both Max and Dep type), by the markedness constraints FootBin, License-C and by Reduce.	License-μ is a highly ranked constraint; no semisyllables are allowed.
3.	Allows either no phrase-final -CC clusters or -CC clusters that have a falling sonority: /kalb/ ‘dog’	Phrase-final -CC clusters occur unrestrictedly. They can be broken up by an epenthetic vowel. /ʔism/ → /ʔisim/ ‘name’	Phrase-final -CC clusters occur unrestrictedly. They can be broken up by an epenthetic vowel.
4.	Phrase-initial onset CC-clusters are allowed; deletes high vowels in open syllables to reduce even initial CiC- to CC-. Resulting clusters are often broken up by a prothetic vowel: /ħmar/ ~ /ʔiħmar/	Phrase-initial onset CC-clusters are allowed; deletes high vowels in open syllables to reduce even initial CiC- to CC-: /ħmar/ ‘donkey’	No initial CC- clusters are allowed: /ħimar/ ‘donkey’.

	‘donkey’.		
5.	Initial geminates CC- are allowed as a result of assimilation.	Initial geminates CC- are allowed as a result of assimilation.	Initial geminates CC- are not allowed.
6.	Medial -CCC- can be broken up by a vowel CiCC. Metathesis is also allowed; CCiC to CiCC.	Medial -CCC- exists with no vowel insertion. /yiktbu/ ‘they wrote’	Medial -CCC- are broken by a vowel after the second consonant CCiC. No metathesis allowed; always retai CCiC.
7.	No	No	Desonarization of word final which involves devoicing and glottalization occur in CV dialects. Final consonants, including sonoroants, are glottalized after a long vowel and devoiced in clusters: V̥:ʔC̥, -VCC̥.
8.	A vowel is inserted in phrase-final -CC clusters that violate sonority sequencing. the lexical representation of /akl/ ‘food’ is ʔak.l_{μ} and a vowel is inserted to break up the cluster → ʔakil.	Phrase-final -CC clusters that violate sonority sequencing; have rising sonority, occur and the second consonant is licensed as a semisyllable at the word level.	Phrase-final -CC clusters that violate sonority sequencing occur and the second consonant is parsed in the word phonology as a non-moraic stray consonant; “extrametrical” consonant adjoined to the prosodic word.
9.	High vowels delete after geminate consonants: /y-kallim-u/ → y(i)kal(l)mu ‘they talk to someone’	High vowels delete after geminate consonants: /y-kallim-u/ → y(i)kal(l)mu ‘they talk to someone’	High vowels rettain after geminate consonants: /y-kallim-u/→ yikallimu ‘they talk to someone’
10.	Opague epenthesis; Inserted vowels are invisible to lexical processes such as stress and shortening; postlexical.	Inserted vowels are invisible to stress; postlexical.	Epenthetic vowels are visible to lexical processes; get stressed under same conditions as regular vowels.
11.	No	No	Shorting of non-final CVVC before word level ending: /baab-ha/ ‘her door’ → /babha/. Further evidence to the rejection of semisyllables where the vowel is shortened to get one mora

			and the second mora goes to the coda /b/ instead of marking it as a semisyllable.
12.	Post lexically, VC dialects epenthesize a vowel before moraic consonants (yik)t_{μ}.bu → (yi.ki)t_{μ}.bu	No	Post lexically, CV dialects epenthesize a vowel after the extra consonant to avoid treating it as a semisyllable: (ʔul)t.lu → (ʔul)(ti.lu) 'I told him'

Appendix B: List of fifteen English non-words of the syllable CVCC with clusters that violate the sonority principle:

1. ti**ks**
2. da**br**
3. lu**tn**
4. ra**bt**
5. di**mn**
6. ta**br**
7. ra**fn**
8. na**θl**
9. ta**ðm**
10. ri**dʃ**
11. du**br**
12. ga**zr**
13. ta**ml**
14. da**bl**
15. ra**bl**

Appendix C: F1 and F2 values of stem vowels:

F1 and F2 values of the three stem vowels by all participants

Subject	**Original word**	**F1**	**F2**	**Stem Vowel**
p1.word1	tiks	386.5	2390.5	i
p1.word5	dimn	415	2324.5	i
p1.word10	ridʃ	378.5	2239.5	i
p2.word1	tiks	389.5	2044.5	i
p2.word5	dimn	402	2419	i

p2.word10	ridʃ	408	2387.5	i
p6.word1	tiks	506.5	2133.5	i
p6.word5	dimn	487	2036	i
p6.word10	ridʃ	476	1889.5	i
p7.word1	tiks	331.5	1901	i
p7.word5	dimn	408.5	1990.5	i
p7.word10	ridʃ	408	1979	i
p8.word1	tiks	468	1846.5	i
p8.word5	dimn	424	2201.5	i
p8.word10	ridʃ	447	1926.5	i
p9.word1	tiks	422.5	1871	i
p9.word5	dimn	479.5	1950.5	i
p9.word10	ridʃ	377.5	1982.5	i
p10.word1	tiks	375	2137.5	i
p10.word5	dimn	398.5	2026	i
p10.word10	ridʃ	430	1922	i
p1.word2	dabr	744	1535.5	a
p1.word4	rabt	795.5	1465.5	a
p1.word6	tabr	756.5	1478.5	a
p1.word7	rafn	648	1418	a
p1.word8	naθl	619.5	1705	a
p1.word9	taðm	777.5	1589.5	a
p1.word12	gazr	689	1564.5	a
p1.word13	taml	691.5	1642	a
p1.word14	dabl	640	1562.5	a
p1.word15	rabl	642.5	1402	a
p2.word2	dabr	806.5	1403.5	a
p2.word4	rabt	721.5	1494	a
p2.word6	tabr	826.5	1419.5	a
p2.word7	rafn	828	1473.5	a
p2.word8	naθl	785.5	1504.5	a
p2.word9	taðm	705	1650	a
p2.word12	gazr	779	1533.5	a
p2.word13	taml	895.5	1553	a
p2.word14	dabl	748.5	1796.5	a
p2.word15	rabl	750.5	1452.5	a
p6.word2	dabr	662.5	1600	a
p6.word4	rabt	702	1680.5	a
p6.word6	tabr	706	1649	a
p6.word7	rafn	706.5	1390	a
p6.word8	naθl	750.5	1933.5	a

p6.word9	taðm	648	1800	a
p6.word12	gazr	501	1938	a
p6.word13	taml	712	1638	a
p6.word14	dabl	587.5	1903.5	a
p6.word15	rabl	671.5	1785.5	a
p7.word2	dabr	538.5	1462.5	a
p7.word4	rabt	601.5	1567.5	a
p7.word6	tabr	557.5	1576.5	a
p7.word7	rafn	622.5	1553.5	a
p7.word8	naθl	521	1554	a
p7.word9	taðm	501.5	1687	a
p7.word12	gazr	511.5	1593	a
p7.word13	taml	530	1342	a
p7.word14	dabl	533	1404	a
p7.word15	rabl	560	1253	a
p8.word2	dabr	557	1522	a
p8.word4	rabt	575	1236.5	a
p8.word6	tabr	581.5	1465	a
p8.word7	rafn	587.5	1225.5	a
p8.word8	naθl	583.5	1882	a
p8.word9	taðm	540	2068.5	a
p8.word12	gazr	489	2107	a
p8.word13	taml	602.5	1691.5	a
p8.word14	dabl	515	1784.5	a
p8.word15	rabl	579.5	1195.5	a
p9.word2	dabr	548	1364.5	a
p9.word4	rabt	561.5	1634	a
p9.word6	tabr	551	1571.5	a
p9.word7	rafn	565	1686	a
p9.word8	naθl	571	1498	a
p9.word9	taðm	506	1419.5	a
p9.word12	gazr	480.5	1618	a
p9.word13	taml	576	1453.5	a
p9.word14	dabl	499.5	1452	a
p9.word15	rabl	534	1590	a
p10.word2	dabr	588.5	1462	a
p10.word4	rabt	605.5	1517	a
p10.word6	tabr	637.5	1471.5	a
p10.word7	rafn	620	1668	a
p10.word8	naθl	607.5	1606	a
p10.word9	taðm	593.5	1649.5	a

p10.word12	gazr	494.5	1823.5	a
p10.word13	taml	641	1614.5	a
p10.word14	dabl	558.5	1672	a
p10.word15	rabl	603.5	1570	a
p1.word3	lutn	358.5	1450	u
p1.word11	dubr	395.5	1410	u
p2.word3	lutn	417	1567.5	u
p2.word11	dubr	428	1432	u
p6.word3	lutn	501.5	1663.5	u
p6.word11	dubr	470	1580.5	u
p7.word3	lutn	426.5	1276.5	u
p7.word11	dubr	426.5	1248.5	u
p8.word3	lutn	509.5	1343	u
p8.word11	dubr	407.5	1131	u
p9.word3	lutn	449	1467.5	u
p9.word11	dubr	397.5	1372.5	u
p10.word3	lutn	494.5	1503	u
p10.word11	dubr	461	1280.5	u

Appendix D: F1 and F2 values of all inserted vowels:

F1 and F2 values of the three epenthesized vowels by all participants

Subject	Original word	F1	F2	Epenthesized vowel
p1.word1	tiks	0	0	i
p1.word5	dimn	484	1874	i
p1.word10	ridʃ	0	0	i
p2.word1	tiks	0	0	i
p2.word5	dimn	437	1856	i
p2.word10	ridʃ	0	0	i
p6.word1	tiks	537	1767	i
p6.word5	dimn	460	1944	i
p6.word10	ridʃ	309	1880	i
p7.word1	tiks	470	1805	i
p7.word5	dimn	401	1905	i
p7.word10	ridʃ	319	2085	i
p8.word1	tiks	0	0	i
p8.word5	dimn	493	1978	i
p8.word10	ridʃ	377	2037	i

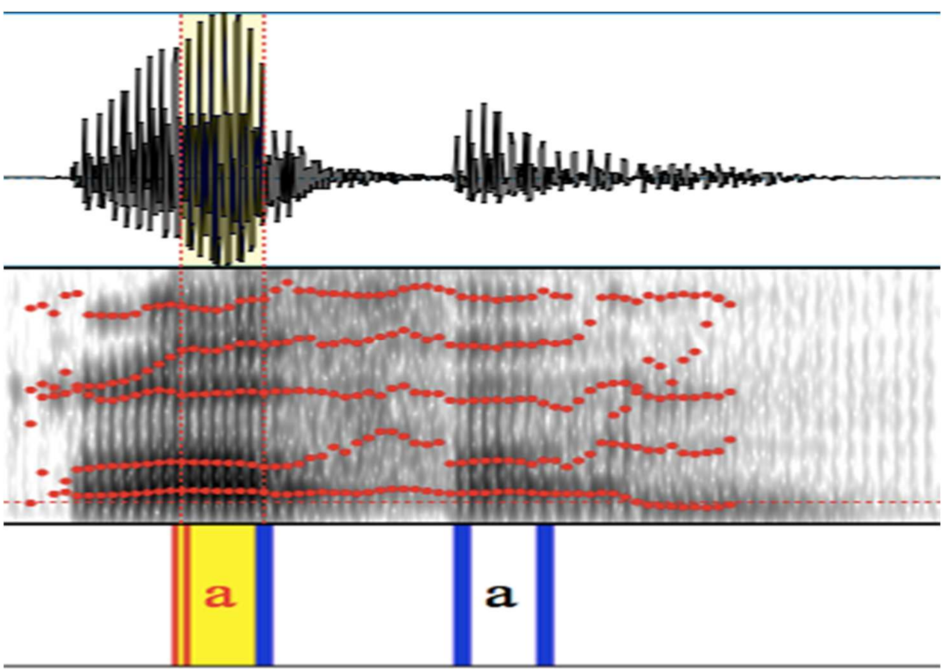
p9.word1	tiks	474	2000	i
p9.word5	dimn	400	1927	i
p9.word10	ridʃ	440	1979	i
p10..word1	tiks	406	1967	i
p10.word5	dimn	460	1975	i
p10.word10	ridʃ	379	2013	i
p1.word2	dabr	536	1565	a
p1.word4	rabt	0	0	a
p1.word6	tabr	520	1605	a
p1.word7	rafn	573	1736	a
p1.word8	naθl	0	0	a
p1.word9	taðm	535	1583	a
p1.word12	gazr	514	1453	a
p1.word13	taml	513	1170	a
p1.word14	dabl	522	1180	a
p1.word15	rabl	529	1170	a
p2.word2	dabr	548	1386	a
p2.word4	rabt	0	0	a
p2word6	tabr	563	1381	a
p2.word7	rafn	574	1654	a
p2.word8	naθl	571	1192	a
p2.word9	taðm	647	1203	a
p2.word12	gazr	672	1522	a
p2.word13	taml	660	1169	a
p2.word14	dabl	703	1347	a
p2.word15	rabl	540	1193	a
p6.word2	dabr	689	1295	a
p6.word4	rabt	718	1595	a
p6.word6	tabr	685	1382	a
p6.word7	rafn	733	1464	a
p6.word8	naθl	400	1954	a
p6.word9	taðm	705	1753	a
p6.word12	gazr	530	1945	a
p6.word13	taml	690	1793	a
p6.word14	dabl	614	1767	a
p6.word15	rabl	671	1700	a
p7.word2	dabr	525	1293	a

p7.word4	rabt	550	1170	a
p7.word6	tabr	553	1225	a
p7.word7	rafn	502	1193	a
p7.word8	naθl	537	1382	a
p7.word9	taðm	520	1284	a
p7.word12	gazr	503	1320	a
p7.word13	taml	532	1250	a
p7.word14	dabl	515	1231	a
p7.word15	rabl	554	1204	a
p8.word2	dabr	0	0	a
p8.word4	rabt	536	1394	a
p8word6	tabr	583	1188	a
p8.word7	rafn	634	1333	a
p8.word8	naθl	540	1604	a
p8.word9	taðm	581	1539	a
p8.word12	gazr	493	1531	a
p8.word13	taml	597	1554	a
p8.word14	dabl	546	1655	a
p8.word15	rabl	572	1640	a
p9.word2	dabr	558	1134	a
p9.word4	rabt	566	1322	a
p9.word6	tabr	0	0	a
p9.word7	rafn	571	1255	a
p9.word8	naθl	559	1421	a
p9.word9	taðm	527	1411	a
p9.word12	gazr	491	1422	a
p9.word13	taml	583	1410	a
p9.word14	dabl	539	1361	a
p9.word15	rabl	539	1310	a
p10.word2	dabr	527	1273	a
p10.word4	rabt	555	1335	a
p10.word6	tabr	568	1218	a
p10.word7	rafn	620	1317	a
p10.word8	naθl	547	1564	a
p10.word9	taðm	599	1572	a
p10.word12	gazr	687	1541	a
p10.word13	taml	615	1548	a

p10.word14	dabl	561	1575	a
p10.word15	rabl	586	1353	a
p1.word3	lutn	465	1645	u
p1.word11	dubr	475	1524	u
p2.word3	lutn	439	1625	u
p2.word11	dubr	475	1307	u
p6.word3	lutn	505	1551	u
p6.word11	dubr	535	1292	u
p7.word3	lutn	434	1255	u
p7.word11	dubr	431	1267	u
p8.word3	lutn	445	1243	u
p8.word11	dubr	455	1351	u
p9.word3	lutn	501	1347	u
p9.word11	dubr	439	1240	u
p10.word3	lutn	443	1218	u
p10.word11	dubr	339	1215	u

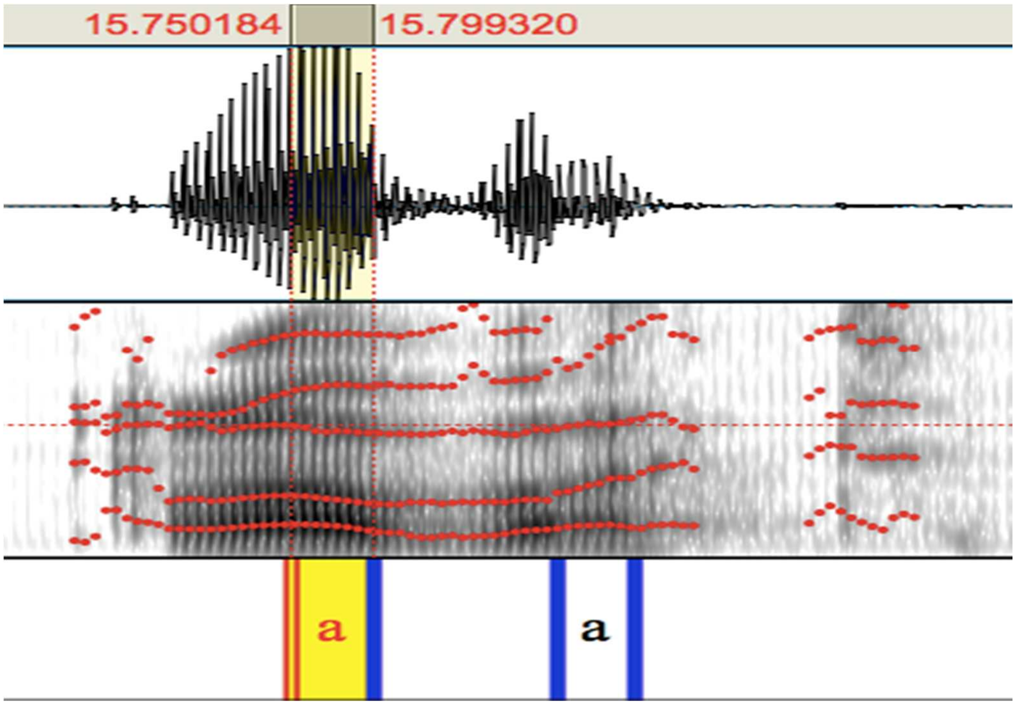
Appendix E: Two examples of how vowels are measured using the function TextGrid on Praat:

Figure 9 *Spectrogram of the stem and epenthesized vowels [a] from the word /rafan/ produced by P10*



* The highlight shows the duration of the vowel [a] where any dropping or rasing of formants is avoided to ensure that only the vowel [a] is heard with no consonantal transition effect.

Figure 10 *Spectrogram of the stem and epenthesized vowels [a] from the word /rabat/ produced by P7*



* The highlight shows the duration of the vowel [a] where any dropping or rasing of formants is avoided to ensure that only the vowel [a] is heard with no consonantal transition effect.

CURRICULUM VITAE

Reham Alhammad

Place of birth: Riyadh, Saudi Arabia

Education:

B.A., King Saud University, May 2004
Major: English Translation

M.A., California State University-Fresno, May 2014
Major: Linguistics