

A COMPREHENSIVE ANALYSIS OF CODA CLUSTERS IN HIJAZI ARABIC:  
AN OPTIMALITY-THEORETIC PERSPECTIVE

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November 12, 2020

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To my parents,  
and my family

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A COMPREHENSIVE ANALYSIS OF CODA CLUSTERS IN HIJAZI ARABIC: AN  
OPTIMALITY-THEORETIC PERSPECTIVE

In Hijazi Arabic, an urban dialect spoken in the western region of Saudi Arabia, sonority, which is defined as the loudness of a particular speech sound relative to others (Ladefoged & Johnson 2010), plays a particularly important role in constructing the coda consonant cluster, which occurs in word-final position. This means that there are restrictions on the relative sonority of consonants that can form part of a syllable coda cluster. The current study utilizes the Split-Margin Approach to the syllable (Baertsch, 2002; Baertsch & Davis, 2009) within the framework of Optimality Theory to analyze the sonority of coda clusters in the dialect.

The goal of this study is to determine the segment sonority scale in Hijazi Arabic, which necessitates a comprehensive phonetic and phonological investigation of guttural sounds in Arabic. Furthermore, it examines other constraints that play a role in shaping the coda cluster in the dialect.

One of the major findings of the study is that Hijazi Arabic does not allow rising-sonority coda clusters, but tolerates level-sonority coda clusters with restrictions. Moreover, there are high-ranked constraints in the dialect independent of the sonority hierarchy that prevent various other cluster types from comprising a coda.

In addition, the study offers a new approach to the analysis of vowel-glide coalescence in trilateral roots which consist of a medial glide and word-final glide vocalization in trilateral roots ending with a glide. The study also analyzes the status of coda geminates in Hijazi Arabic. Finally, vowel quality in sonority-driven epenthesis is analyzed in depth.

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## Table of Contents

Chapter 1: Preliminaries .....	1
Background and Goal of Study.....	1
1.1. Hijazi Arabic.....	3
1.1.1. Dialect Distribution and Name .....	3
1.1.2. Current Status.....	4
1.1.3. Variation of some consonants in HA .....	4
1.1.4. Data Collection .....	7
1.2. HA Segment Inventory .....	8
1.3. Syllable Structure in HA.....	11
1.3.1. Syllable Types and Distribution.....	11
1.3.2. Epenthesis and Word-Internal Super-Heavy and Extra-Super-Heavy Syllables .....	13
1.3.3. Vowel Shortening in Word-Internal CVVC Syllables .....	14
1.3.4. The Relationship between High Vowel Deletion and Word-Internal CVVC.....	15
1.4. Stress System in Hijazi Arabic .....	15
1.4.1. The Weight System in HA.....	16
1.4.2. Metrical System and Foot Types .....	16
1.4.3. Metrical Parsing .....	18
1.4.4. Extrametricality.....	18
1.4.5. Patterns of Transparent Stress.....	19
1.4.6. Stress and Some Phonological Alternations .....	22
1.4.7. The Interaction between Stress and Opacity.....	24
1.4.8. Conclusion .....	26
1.5. Optimality Theory.....	26
1.6. Conclusion and Structure of the Dissertation .....	31
Chapter 2: Sonority in Hijazi Arabic .....	32
2.1. Sonority scale (initial considerations).....	32
2.2. The status of gutturals in the sonority hierarchy.....	40
2.2.1. Phonetic evidence of gutturals as a natural class .....	41
2.2.2. Phonological evidence of gutturals as a natural class .....	44
2.2.3. The guttural class in the sonority scale .....	52
2.2.4. Subclass differentiation of gutturals in the sonority scale .....	53
2.2.5. Guttural subclasses in the sonority scale .....	68
2.3. Vowel quality in sonority-driven epenthesis .....	69

2.4. The role of sonority in Arabic dialects .....	73
2.5. The Sonority Sequencing Principle .....	78
2.6. Minimal Sonority Distance .....	83
2.7. The Obligatory Contour Principle in coda clusters of Hijazi Arabic.....	84
2.8. Discussion and Conclusion .....	97
Chapter 3: The Sonority of Sound Coda Clusters in HA.....	101
3.1. Constraints .....	102
3.1.1. The Split-Margin Approach.....	102
3.1.2. Faithfulness constraints.....	107
3.2. Falling sonority clusters.....	108
3.2.1. The typical case.....	108
3.2.2. OCP-[sonorant, coronal].....	111
3.3. Level sonority clusters .....	113
3.3.1. The typical case.....	113
3.3.2. OCP-[nasal].....	116
3.3.3. The effect of the verbal noun template (faʕil) on epenthesis.....	118
3.3.4. Lexical variation of vowel epenthesis in coda clusters.....	120
3.4. Rising-sonority clusters .....	122
3.5. Discussion and Conclusion .....	129
Chapter 4: The Role of Glides, ‘Ayn and Gemimates in Constructing the Coda Cluster of HA .....	137
4.1. The special status of glides .....	137
4.1.1. Weak roots .....	138
4.1.2. Hollow roots.....	143
4.1.3. Summary of glides in coda clusters .....	159
4.2. Coda Condition and OCP-[son] with ‘ayn in HA.....	160
4.3. Geminate status of Coda Clusters in HA .....	173
4.4. Discussion and Conclusion .....	197
Chapter 5: Sonority-driven Epenthesis, High vowel spreading, and Consonant-to-Vowel Harmony in HA.....	209
5.1. Quality of the epenthetic vowel .....	210
5.2. High vowel spreading .....	211
5.3. Coronal Consonant-to-Vowel Harmony .....	216
5.4. Pharyngeal consonant-to-vowel harmony.....	219
5.5. Nonrising Coda Clusters Surface Faithfully with No Harmonic Change.....	227

5.6. Final Plain [r] versus Emphatic [r <sup>s</sup> ] .....	229
5.7. Default Epenthetic Vowel Quality.....	241
5.8. Discussion and Conclusion.....	250
Chapter 6: Conclusion and Future Directions .....	258
6.1. Summary of Chapter 2: Sonority in Hijazi Arabic .....	258
6.2. Summary of Chapter 3: The Sonority of Sound Coda Clusters in HA.....	264
6.3. Summary of Chapter 4: The Role of Glides, ‘Ayn and Geminates in Constructing the Coda Cluster of HA.....	266
6.4. Summary of Chapter 5: Sonority-driven Epenthesis, High vowel spreading, and Consonant-to-Vowel Harmony in HA.....	270
6.5. General conclusion and directions for future research .....	274
Appendix A: Data for Hijazi Arabic Coda Clusters Types.....	279
Appendix B: Sonority-driven Epenthesis, High Vowel Spreading, and Consonant-to-Vowel Harmony in HA.....	295
Appendix C: OT Constraints .....	300
References.....	310
Curriculum Vita	

## Table of Figures

(1.1) Realization of Classical Arabic Interdentals in HA .....	5
(1.2) Consonant Inventory of HA .....	9
(1.3) Vowel Inventory of HA.....	10
(1.4) Moraic Representation of the Light Syllable .....	11
(1.5) Moraic Representation of Heavy Syllables .....	12
(1.6) Moraic Representation of Super-Heavy Syllables .....	12
(1.7) Moraic Representation of Extra-Super-Heavy Syllables .....	13
(1.8) Trochaic Foot .....	19
(1.9) Trochaic Foot + Extrametrical Syllable .....	19
(1.10) Bimoraic Foot with Heavy First Syllable.....	20
(1.11) Prominent First Foot in Trisyllabic Words .....	20
(1.12) Prominent Second Foot in Quadrisyllabic Words.....	20
(1.13) Bimoraic Foot with Heavy Last Syllable .....	20
(1.14) Bimoraic Foot with Heavy Medial Syllable.....	21
(1.15) Heavy Monosyllabic Foot .....	21
(1.16) Final Prominence in Words with HH Syllables .....	21
(1.17) Final Prominence in Words with HHH Syllables .....	22
(1.18) Derivation of Words with Dative Suffixes <i>-l</i> and <i>-b</i> .....	25
(1.19) Exceptional Stress Pattern with <i>-a:wi</i> .....	26
(1.20) Components of the OT Grammar (reproduced and modified from Kager 1999, p. 19) ....	28
(1.21) Constraint Domination .....	30
(1.22) No Strict Domination between C1 and C2.....	30

(2.1) Parker’s (2011, §4) Universal Sonority Scale.....	34
(2.2) Sonority Scale Based on Clements (1990, p. 294).....	34
(2.3) Principal Features used in Clements’ Sonority Hierarchy .....	35
(2.4) Zwicky’s (1972) Principles for the Sonority Hierarchy.....	35
(2.5) Sonority Hierarchy based on Zwicky’s (1972) Principles .....	36
(2.6) Working Universal Sonority Scale (cf. Blevins 1995, p. 211).....	36
(2.7) Complete Sonority Hierarchy Based on Zec (2007) .....	36
(2.8) Jespersen’s (1904) Sonority Scale (reproduced from Clements, 1990, p. 285).....	38
(2.9) Murray and Vennemann’s Sonority Scale (1983, p. 519).....	38
(2.10) The Root Medial Consonant is more Sonorous than the Final Consonant in HA .....	39
(2.11) The Root Medial Consonant is less Sonorous than the Final Consonant in HA.....	39
(2.12) Proposed Sonority Hierarchy for Hijazi Arabic (Initial).....	40
(2.13) Blocking of Vowel Raising by Gutturals in Bani-Hassan Arabic.....	45
(2.14) Vowel Lowering and Coarticulation across Gutturals in Jibbāli in CeCəC Verbs .....	48
(2.15) Imāla Blocked following Emphatic and Guttural Consonants.....	48
(2.16) Epenthesis in Sonorant + Guttural Coda Sequences (Farwaneh, 2016, p. 129).....	51
(2.17) Proposed Sonority Hierarchy for Hijazi Arabic (First Revision).....	52
(2.18) Bin-Muqbil’s Stricture Feature Specification for Guttural Subclasses.....	54
(2.19) Percentages of Realization Types from a Sample of 436 Tokens of ‘ <i>ayn</i> (reproduced from Heselwood, 2007, p. 25). .....	59
(2.20) Percentages of Phonotactic Distribution of Realization Types in the Sample of 436 Tokens of ‘ <i>ayn</i> (reproduced from Heselwood, 2007, p. 26).....	60
(2.21) Kelantan Malay (adapted from Lombardi, 2001, p. 18, citing Teoh, 1988) .....	66

(2.22) Glottal Stop in Coda Position in HA.....	67
(2.23) Sonority Hierarchy for Hijazi Arabic (Final).....	68
(2.24) Sonority Scale of PA (Farwaneh 2016).....	75
(2.25) Rhyme Tree of LA as presented by Haddad (1984a, p. 84).....	76
(2.26) Sonority Sequencing Principle (Parker, 2002).....	80
(2.27) Categories of Clusters based on Sonority (adapted from Morelli, 1999, p. 20).....	81
(2.28) The Obligatory Contour Principle (OCP) .....	85
(2.29) OCP Effect on Syllable Rhyme.....	85
(2.30) Representation of OCP Effect in the Syllable Coda .....	86
(2.31) Consonant Cooccurrence Restriction (McCarthy 1994, p. 204) .....	86
(2.32) Alternative Representation of Emphatics and Gutturals (Bin-Muqbil, 2006, pp. 253–254) .....	89
(2.33) Representation of Emphatics and Uvulars (Zawaydeh, 1999, p. 82).....	91
(2.34) Representation of Pharyngeals and Laryngeals (Zawaydeh, 1999, p. 82).....	92
(2.35) Herzallah’s representation of emphatics .....	93
(2.36) Herzallah’s (1990) Feature Representation of Pharyngeals and Laryngeals .....	94
(2.37) Herzallah’s (1990) Feature Representation for Uvulars (Back Velars).....	95
(2.38) Sonority Hierarchy for Hijazi Arabic (Final).....	98
(3.1) The Syllable under the Split-Margin Approach. ....	103
(3.2) Split-Margin Constraint Ranking of M <sub>1</sub> in HA.....	103
(3.3) Split-Margin Constraint Ranking of M <sub>2</sub> in HA.....	104
(3.4) *M <sub>1</sub> /Glide & *M <sub>2</sub> /Obs] <sub>σ</sub> .....	104
(3.5) Hasse Diagram of Conjoined *M <sub>2</sub> and *M <sub>1</sub> Hierarchies in Hijazi Arabic.....	106

(3.6) Additional Faithfulness Constraints for the Analysis .....	107
(3.7) Falling Sonority Clusters in HA.....	109
(3.8) OCP Effect in Codas with Sonorant Coronal Consonants .....	111
(3.9) OBLIGATORY CONTOUR PRINCIPLE – [SONORANT, CORONAL] (OCP-[SON, COR]) .....	111
(3.10) Level Sonority Coda Clusters in Hijazi Arabic.....	114
(3.11) OCP Effect in Codas with Nasal + Nasal Cluster .....	116
(3.12) OBLIGATORY CONTOUR PRINCIPLE – [NASAL] (OCP-[NAS]) .....	117
(3.13) Words in the Pattern of <i>faʕil</i> with Optional Epenthesis .....	118
(3.14) MASDAR-TEMPLATE-SATISFACTION and IDENT-IO-V.....	119
(3.15) Lexically Optional Epenthesis in Coda Clusters.....	120
(3.16) Epenthesis in Potential /ʕ/-Final Rising-Sonority Coda Clusters.....	123
(3.17) Epenthesis in Potential Liquid-Final Rising-Sonority Coda Clusters.....	124
(3.18) Epenthesis in Potential Nasal-Final Rising-Sonority Coda Clusters .....	124
(3.19) Epenthesis in Potential Voiced Fricative-Final Rising-Sonority Coda Clusters.....	125
(3.20) ANCHOR-IO-RIGHT (ANCHOR) .....	126
(3.21) IDENTITY[sonorant]-IO (ID-[son]) .....	128
(3.22) Final Sonority Hierarchy for Hijazi Arabic.....	130
(3.23) Hasse diagram of Split-Margin constraints for the sonority hierarchy of HA with the decisive DEP and CONTIG constraints. ....	131
(3.24) Hasse Diagram of the Sound Root Grammar of HA.....	134
(4.1) Final Glide Vocalization in Consonant + Glide Clusters.....	138
(4.2) OT Constraints for Final Glide Vocalization .....	139
(4.3) NOWEAKCLUSTER (*M <sub>2</sub> G <sub>1</sub> ] <sub>σ</sub> ) .....	142

(4.4) Vowel-Glide Coalescence in Hollow Noun and Adjective Roots .....	144
(4.5) Arabic Vowel Space.....	145
(4.6) Feature Geometry of Vowel-Glide Coalescence in Hollow Roots. ....	146
(4.7) Compensatory Lengthening with Glottal Stop.....	147
(4.8) Type VII Languages in Realization of Vowels and Glides (Levi, 2011, p. 359).....	149
(4.9) Verbal/Nominal Paradigm and the Realization of Underlying Medial Glides in HA and CA .....	150
(4.10) Verbal/Nominal Paradigm and the Realization of Underlying Final Glides in HA and CA .....	151
(4.11) OT Constraints for Medial Glide Coalescence .....	153
(4.12) NOHOLLOWCLUSTER (*G <sub>2</sub> M <sub>1</sub> ] <sub>σ</sub> ) .....	155
(4.13) Sonority Hierarchy for Hijazi Arabic (Final).....	161
(4.14) Potential ‘ <i>ayn</i> -Final Rising-Sonority Coda Clusters.....	161
(4.15) Underlying Coda Clusters with Medial [ʕ] in Hijazi Arabic .....	162
(4.16) Hebrew Coda Condition (McCarthy, 1994).....	164
(4.17) No Gutturals in Syllable Coda in BHA (McCarthy, 1994).....	164
(4.18) Examples of Coda Condition in Bedouin Hijazi Arabic (McCarthy, 1994) .....	165
(4.19) Nonapplication of Coda Condition with non-[ʕ] Gutturals in HA.....	165
(4.20) CODACONDITION (*ʕ] <sub>C<sub>o</sub></sub> ) .....	166
(4.21) *COMPLEX <sup>ONS</sup> (* <sub>o</sub> [CC]).....	166
(4.22) OBLIGATORY CONTOUR PRINCIPLE-[sonorant] (OCP-[son]) .....	168
(4.23) *ʕ] <sub>C<sub>o</sub></sub> & OCP-[son] .....	169
(4.24) Hume et al.’s Composite Representation of Gemimates (1997, p. 397).....	174

(4.25) Underlying Representation of Geminate in PA (adapted from Keer 1999, p. 192) .....	176
(4.26) Surface Form of the Geminate in HA .....	176
(4.27) Geminate Coda in HA .....	178
(4.28) Additional OT Constraints for the Analysis of Geminate Codas.....	179
(4.29) OCP and OCP-[NAS] .....	181
(4.30) Polysyllabic Word-Final Geminate in HA and MSA.....	187
(4.31) Additional OT Constraints for the Analysis of Final Geminate Glides in Polysyllabic Words .....	188
(4.32) MINIMUMWORD (MINWORD).....	192
(4.33) ONSET .....	195
(4.34) Hasse Diagram of Split-Margin Constraints with Cover Constraints NOWEAKCLUSTER and NOHOLLOWCLUSTER.....	197
(4.35) Hasse Diagram of the Subgrammar of Glides in HA (Hollow Roots and Weak Roots). 200	
(4.36) Hasse Diagram of the Subgrammar of [ʕ] in Coda Clusters .....	202
(4.37) Hasse Diagram of the Subgrammar of Geminates .....	206
(5.1) Herzallah’s (1990, p. 66), Figure 13: Arabic Vowel Feature Representations .....	210
(5.2) High Vowel Spreading in Potential Rising Coda Clusters in HA.....	211
(5.3) SPREAD-[F] Constraints adapted from Walker (2001, p. 845) and IDENT-IO(Vowel).....	212
(5.4) UNIFORM-[front]/[back] (adapted from Walker, 2001, p. 848).....	214
(5.5) Coronal Consonant-to-Vowel Harmony .....	216
(5.6) AGREE-FEAT-CORONAL (AGREE-F-COR) .....	218
(5.7) Potential Coda Clusters with Pharyngeal Consonant-to-Vowel Harmony .....	220
(5.8) Herzallah’s Representation of Emphatics .....	221

(5.9) Potential Coda Clusters with Plain [r] and Emphatic [r <sup>s</sup> ] .....	221
(5.10) The Constraints Necessary for Pharyngeal Consonant-to-Vowel Harmony.....	223
(5.11) IDENT-IO-PHONEME (IDENT-IO-PHON).....	227
(5.12) [r] / [r <sup>s</sup> ] Consonant-to-Vowel Harmony.....	231
(5.13) Synchronic Base Hypothesis (from Hutton, 1996; cited by Holt, 2015, p. 548) .....	232
(5.14) Constraints Motivating Dorsal Consonant-to-Vowel Harmony.....	235
(5.15) AGREE-FEAT-PHARYNGEAL-[r <sup>s</sup> ] (AGREE-F-PHAR-[r <sup>s</sup> ]) .....	238
(5.16) Default Sonority-Driven Epenthesis .....	245
(5.17) Universal Place of Articulation Hierarchy (de Lacy, 2006).....	246
(5.18) Incomplete Pharyngeal Consonant-to-Vowel Harmony .....	248
(5.19) Hasse Diagram of High Vowel Spreading. ....	251
(5.20) Hasse Diagram of Vowel Quality in Default Epenthesis and Consonant-to-Vowel Harmony Epenthesis. ....	256
(6.1) Initial Sonority Hierarchy for Hijazi Arabic (reproduced from Chapter 2, Section 2.1) ...	259
(6.2) Proposed Sonority Hierarchy for Hijazi Arabic (First Revision, reproduced from Section 2.2.3) .....	260
(6.3) Sonority Hierarchy for Hijazi Arabic (Final, reproduced from Chapter 2, Section 2.2.5)	262
(6.4) Hasse Diagram of Split-Margin Constraints for the Sonority Hierarchy of HA with the Decisive DEP and CONTIG Constraints .....	265

## List of Tables

Table 3.1 .....	135
Table 4.1 .....	201
Table 4.2 .....	203
Table 4.3 .....	207
Table 5.1 .....	251
Table 5.2 .....	257

## List of Tableaux

<i>Tableau 3.1.</i> Falling Sonority Coda without Epenthesis .....	110
<i>Tableau 3.2.</i> Falling Sonority Coda with Ungrammatical Epenthesis.....	110
<i>Tableau 3.3.</i> Falling Sonority Clusters with OCP-driven Epenthesis .....	112
<i>Tableau 3.4.</i> Ungrammatical Coda Cluster with Sonorant Coronals.....	112
<i>Tableau 3.5.</i> Faithful Sonority Plateau Cluster.....	115
<i>Tableau 3.6.</i> Ungrammatical Epenthesis in Sonority Plateau Clusters .....	115
<i>Tableau 3.7.</i> OCP Effect on Nasal Coda Clusters .....	117
<i>Tableau 3.8.</i> Ungrammatical Nasal + Nasal Coda Clusters.....	117
<i>Tableau 3.9.</i> <i>Masdar</i> -Triggered Epenthesis.....	119
<i>Tableau 3.10.</i> Epenthesis in Some Lexical Words .....	121
<i>Tableau 3.11.</i> Epenthesis in Rising-Sonority Coda Clusters (the Typical Case) .....	126
<i>Tableau 3.12.</i> No Epenthesis at the Right Edge of the Stem.....	127
<i>Tableau 3.13.</i> MAX is respected.....	127
<i>Tableau 3.14.</i> No Change in the Sonority of Coda Clusters.....	128
<i>Tableau 4.1a.</i> Final Glide Vocalization in G <sub>2</sub> G <sub>1</sub> Clusters. ....	140
<i>Tableau 4.1b.</i> Final Glide Vocalization in L <sub>2</sub> G <sub>1</sub> Clusters.....	141
<i>Tableau 4.2a.</i> [a]-[j] Coalescence in Underlyingly CVCC Words.....	154
<i>Tableau 4.2b.</i> [a]-[w] Coalescence in Underlyingly CVCC Words.....	156
<i>Tableau 4.3.</i> No Vowel-Glide Coalescence in Hollow and Weak Roots .....	158
<i>Tableau 4.4.</i> Single [ʕ] in a Coda is Protected.....	166
<i>Tableau 4.5a.</i> Spurious Underapplication of Epenthesis in ʕ <sub>2</sub> L <sub>1</sub> ]σ Clusters with *ʕ]C <sub>0</sub> .....	167
<i>Tableau 4.5b.</i> Spurious Underapplication of Epenthesis in ʕ <sub>2</sub> L <sub>1</sub> ]σ Clusters with OCP-[son].....	168

<i>Tableau 4.6.</i> Correct Vowel Epenthesis in $\zeta_2L_1]_\sigma$ Clusters with $*\zeta]_{Co}$ & OCP-[son].....	169
<i>Tableau 4.7.</i> Correct Prediction for $\zeta_2O_1]_\sigma$ Clusters with $*\zeta]_{Co}$ & OCP-[son] .....	170
<i>Tableau 4.8.</i> Correct Prediction for $L_2N_1]_\sigma$ Clusters with $*\zeta]_{Co}$ & OCP-[son].....	171
<i>Tableau 4.9.</i> Correct Prediction for $L_2\zeta_1]_\sigma$ Clusters with $*\zeta]_{Co}$ & OCP-[son].....	172
<i>Tableau 4.10.</i> Geminate Surfaces Faithfully .....	180
<i>Tableau 4.11.</i> Underlying Geminate Coda passes OCP Threshold .....	182
<i>Tableau 4.12.</i> No Vocalization or Medial Coalescence in a Monosyllabic Geminate Glide-Final Word .....	185
<i>Tableau 4.13.</i> Final Geminate Glide does not surface in a Polysyllabic Word in Isolation.....	189
<i>Tableau 4.14.</i> Polysyllabic Non-Glide Geminate Final Consonant does not delete.....	191
<i>Tableau 4.15.</i> Monosyllabic Word-Final Geminate Glide Revisited .....	193
<i>Tableau 4.16.</i> Final Geminate Glide does surface in a Suffixed Polysyllabic Root.....	195
<i>Tableau 4.17.</i> Final Geminate Glide does surface in a Suffixed Monosyllabic Root .....	196
<i>Tableau 5.1.</i> Feature [front] Spreading in Stems with a High Vowel .....	213
<i>Tableau 5.2a.</i> No Discrepancy in Vowel Height with UNIFORM-[front].....	214
<i>Tableau 5.2b.</i> High back vowel spreading with UNIFORM-[back].....	215
<i>Tableau 5.3.</i> AGREE-F-COR in Coronal-Final CaCC Words.....	218
<i>Tableau 5.4.</i> Pharyngeal and Laryngeal Consonant-to-Vowel Harmony.....	224
<i>Tableau 5.5.</i> Words with Coronal Harmony Win in Coronal-Final CaCC Words.....	226
<i>Tableau 5.6.</i> Faithful Coronal and Pharyngeal Consonants in Nonepenthetic CaCC Words.....	228
<i>Tableau 5.7a.</i> Dorsal Harmony with Emphatic [r <sup>s</sup> ] (Older Generation) .....	236
<i>Tableau 5.7b.</i> Coronal Harmony with Plain [r] (Younger Generation).....	237
<i>Tableau 5.8.</i> Dorsal over Pharyngeal Harmony with Emphatic [r <sup>s</sup> ] (Older Generation) .....	238

<i>Tableau 5.9.</i> [u] does not Surface after Pharyngeal and Laryngeal Segments .....	239
<i>Tableau 5.10.</i> Default Sonority-Driven [i]-Epenthesis .....	247
<i>Tableau 5.11.</i> Incomplete Pharyngeal Harmony Loses .....	249

## Chapter 1: Preliminaries

### Background and Goal of Study

The Arabic language and its dialects have attracted the attention of linguists in past decades. They have studied many aspects of different varieties of the language. Many studies have been done in the field of sociolinguistics, concerning issues such as the diglossic status between *fusha* and various colloquial varieties of Arabic, for example, Mitchel (1986), Abu-Melhim (1991), and others. Other studies deal with different issues in different fields, such as the syntax, phonology, and morphology of various Arabic dialects. Some of the main areas that have been the focus of many linguists are the areas of phonology and morphology. Some of the early studies include Brame (1970), who focused on the phonology of the Arabic language in general, and also shed light on some of the characteristic features of the dialects, and Al-Ani (1970) who studied the phonology and phonetics of the Arabic language with some focus on the Iraqi variety. These were followed by Broselow (1976) on the phonology of Egyptian Arabic, and McCarthy (1979), who studied the phonology and morphology of Arabic, relating it to other Semitic languages, and establishing the theory of nonconcatenative morphology. Many subsequent studies dealing with the phonology and morphology of various Arabic varieties were conducted. Among them are Bakalla (1979) on the morphology and phonology of Makkan Arabic, Al-Mozainy (1981) on the phonology of Bedouin Hijazi Arabic with a special focus on vowel alternations, Abu-Salim (1982) on the phonology of Palestinian Arabic, Haddad (1984b) on the phonology of Lebanese Arabic, Hamid (1984) on the phonology of Sudanese Arabic, Abu-Mansour (1987) on the phonology of Makkan Arabic with a special emphasis on a non-linear analysis of the syllable, Al-Mohanna (1998) on the phonology of syllabification and metrification in Urban Hijazi Arabic, Watson (2002) on the phonology and morphology of

San'ani and Cairene Arabic, Kabrah (2004) on the opacity and transparency in the phonology of Makkan Arabic in a Stratal OT analysis, and Bamakhramah (2009) on the phonology of superheavy syllables in Makkan and Hadhrami Arabic in comparison with Classical Arabic.

This study provides a comprehensive analysis of the role of sonority in constructing the coda cluster in Hijazi Arabic (HA), utilizing the Split-Margin Approach to the syllable within the framework of Optimality Theory. Besides contributing to the general understanding of the field of phonology by providing detailed, systematic data sets of coda cluster types in HA, the main goal of the study is to emphasize the significant role of sonority in constructing the coda cluster in HA. This is achieved by providing a detailed phonological and phonetic investigation of the sonority of the sounds in the language such as gutturals, which brings a new perspective to the field of phonology and can serve as a role model on how to construct a sonority hierarchy by way of studying the precise details of a certain sound group. In addition, this study aims for a new vision of the analysis of the phonological alternations resulting from the occurrence of underlying glides in syllable coda position. Furthermore, it adopts the dichotomy approach in the analysis of geminates in a syllable coda.

This study also deals with many phonological and morphological subjects in HA that interact with the formation of coda clusters, for example, the role of the nasal in coda clusters, the effect of the *masdar fa'il*, the effect of lexical variation, high vowel spreading, sonority-driven epenthesis, consonant-to-vowel harmony, etc.

Prior to beginning this study of the dissertation thematically, this chapter provides a general overview about the most important components of the phonology of HA that will be referred to in subsequent chapters. Section 1.1 provides a brief overview about the geographic and demographic information of HA, some segment variation in the dialect and the data

collection of the dialect. Section 1.2 lists the consonant and vowel inventory of HA. Section 1.3 summarizes the syllable structure and distribution in HA. Section 1.4 briefly describes the stress system of HA along with the most important relevant phonological alternations. Section 1.5 provides a brief introduction to the Optimality Theoretic framework, which is used in this dissertation. Section 1.6 concludes the chapter, states the goals of the study and provides an overview of the structure of the dissertation.

## **1.1. Hijazi Arabic**

### **1.1.1. Dialect Distribution and Name**

Hijazi Arabic (HA) is a well-known dialect spoken in the western region of Saudi Arabia, including the cities of Makkah, Jeddah, Madinah, to a lesser extent, Taif, and to an even lesser extent, Yanbu, Rabigh and Al Wajh. In the literature, there are other names used to indicate the dialect which is the focus of this study. These names are Makkan Arabic, referring to the city of Makkah and extending the term to the whole region of Hijaz, Urban Hijazi Arabic, to distinguish it from the rural Bedouin variety of Arabic spoken in the area, or in some studies, who focus on a particular city in the Hijaz region, Madinan Arabic. The dialect is known colloquially in other regions of Saudi Arabia as “Hijazi Arabic.” However, in the field of Linguistics, there are two names for the dialect: Urban Hijazi Arabic and Makkan Arabic. Throughout this dissertation, I prefer to use the term “Hijazi Arabic” for several reasons. This is because: one, HA is generally used by the people of Saudi Arabia to indicate the urban variety; two, the dissertation focuses on the general Hijazi Arabic rather than the specific differences between cities within the Hijaz region; three, the dissertation focuses on the most common and acceptable form of this dialect,

i.e. the standard form of the dialect, which is used in the media, avoiding very colloquial forms of speech.

### **1.1.2. Current Status**

Today, the urban population of the Hijaz region is approximately 6,645,491 (2010 Census), where HA is the main dialect.<sup>1</sup> Of course not all of this population are native speakers of HA, since the area is the most cosmopolitan area in Saudi Arabia and has people from different ethnic and linguistic backgrounds. However, this dialect is the main dialect in this area and is spoken generally by the original inhabitants of these four cities, who are referred to as sedentaries, differentiating them from non-sedenteries (Bedouins)<sup>2</sup> i.e. people originally from small towns and villages around these cities.<sup>3</sup> As the economy of Saudi Arabia has grown and these major cities have expanded, a lot of job opportunities have become available, encouraging migration from surrounding towns and villages or even from different regions of Saudi Arabia into these major cities. This migration increases the contact between HA and other dialects within Saudi Arabia, specifically Bedouin Hijazi Arabic.

### **1.1.3. Variation of some consonants in HA**

As one result of this migration, the dialect is in a state of flux, which has caused some variation in certain consonants, specifically, Classical Arabic interdental.<sup>4</sup> In HA, interdentals /θ ð ðˤ/ are realized as dentals, [t d dˤ], or as sibilants, [s z zˤ], according to the type of lexical

---

<sup>1</sup> The number here is based on the total population of the cities of Jeddah, Makkah, Madinah and Taif from the 2010 census. At the time that the dissertation was written in 2020, the population is expected to be significantly higher. The statistic excluded the population of the cities of Rabigh, Yanbu and Al Wajh, where the dialect is less commonly spoken.

<sup>2</sup> By non-sedenteries (Bedouins), I mean speakers of the Bedouin Hijazi Arabic variant. This might also include Bedouin varieties outside of the Hijaz region.

<sup>3</sup> For additional sociolinguistic information about contact between sedenteries and non-sedenteries in the largest city in Hijaz, Jeddah, see Al-Essa (2009). See also Al-Jehani (1985, p. 83) for the ethnic groups in Makkah.

<sup>4</sup> See also Bassiouney (2009, p. 122) for social factors which cause linguistic variation and change in the Arab world.

item.<sup>5</sup>

(1.1) Realization of Classical Arabic Interdentals in HA

	Classical Arabic	HA	Gloss
/θ/	[θaldʒ]	[taldʒ]	“ice”
	[θa:nijaf]	[sa:nijaf]	“second”
/ð/	[ðafab]	[dafab]	“gold”
	[ðanb]	[zanb]	“sin”
/ðˤ/	[ðˤafir]	[dˤafir]	“back (body part)”
	[ðˤan:]	[zˤan:]	“doubt”

As can be observed, interdentals are realized in some lexical items as dentals and in others as sibilants. According to Al-Jehani (1985, pp. 16-18), the realization of interdentals as stops, sibilants or even fricatives varies from one lexical item to another and in some lexical items depending on the person and the situation, i.e. the style,<sup>6</sup> any of the above variants may be realized. In addition, one variant could be used more than the other in the speech of some Makkan/HA speakers. Furthermore, Al-Jehani (1985, p. 50) summarizes Yushmanov’s (1961, p. 11) claim as “the sibilant variants <s, z, Z> are pronounced in words borrowed from the Standard, while in words derived historically from the colloquial the correspondence is the stop variants <t, d, D>.” Although, according to Al-Jehani (1985, p. 50), there is no etymological dictionary for the colloquial lexical items in Makkan Arabic, his data do provide some support for Yushmanov’s (1961) claim. In the literary lexical items in Al-Jehani’s (1985) study, Classical Arabic /θ ð ðˤ/ are categorically realized as sibilants, [s z zˤ], whereas in the non-literary lexical items, Classical Arabic /θ ð ðˤ/ are realized as stops, [t d dˤ], in the majority of cases (see Al-Jehani 1985, p. 51, Figure 3.1). In addition, he indicates that the nine variants of the three

<sup>5</sup> See also Ingham (1971, p. 274) for the sibilant and stop realization of the Classical Arabic interdentals in Makkan/HA.

<sup>6</sup> Al-Jehani (1985, pp. 26-27) defines four different styles in his study: casual style i.e. everyday speech style, careful style i.e. the speech norm when speakers talk to strangers, reading style such as reading from a printed page in a formal occasion etc., and word list style.

variables /θ ð ð<sup>s</sup>/ correlate with ethnic background of an MA/HA speaker. The fricative variants i.e. [θ ð ð<sup>s</sup>] indicate a nomad background of the speaker, whereas the sibilant variants, [s z z<sup>s</sup>], or the stop variants, [t d d<sup>s</sup>], indicate a sedentary background of the MA/HA speaker (see Al-Jehani 1985, p. 96). He elaborates on the relationship between use of the variants with regard to the ethnic background of the speaker and the style of speech as follows:

This is clearer in the least formal than in the most formal styles, since the fricative variants are at the same time the Standard realization of the variables. The function of the fricative variants as the nomad ethnic identity markers is being replaced by the stop variants, while the sibilant variants remain as sharp identifiers of sedentaries (Al-Jehani 1985, p. 96).

Although I agree with Al-Jehani (1985) about his ethnic distinction in the stop and sibilant realizations of the fricatives /θ ð ð<sup>s</sup>/, I would say that with the dense migration into the city, the strong contact between people with sedentary and non-sedentary backgrounds and the significant increase in access to education in which the standard fricative variants are realized in the years since Al-Jehani's (1985) study, the standard variants are becoming more dominant in HA nowadays, even in the less formal styles among sedentaries. This dichotomy has become looser and the standard variants are on the way to becoming more dominant. Besides the well-known variation in interdentals in HA, I have observed that there is another variation that is not as common as the case for fricatives, which is the realization of affricate /dʒ/ as [ʒ]. Ingham (1971, p. 277) has indicated several environments in which the affricate /dʒ/ is realized faithfully as [dʒ]. These environments are word-initially, for example [dʒʌ:] "he came", word-finally, for example [bur<sup>s</sup>dʒ] "tower", and preceding the fricatives /ħ h s f/, for example [ʔʌdʒħʌl] "more ignorant." However, according to him /dʒ/ surfaces sometimes as the fricative [ʒ] before /b t d/,

for example [ʔʌʒdʌr] “more worthy.”<sup>7</sup> I assume that the fricative realization of the affricate /dʒ/ is due to the factor of ethnic background between sedentary and non-sedentary people and within the sedentary speakers, those who have a different heritage.<sup>8</sup> However, I will disregard this variation in the segment inventory of HA, since it is not a common variant, it is not noticed by the speakers themselves and the sound is mostly realized as the affricate [dʒ]. Finally, there are types of /r/ in HA: the typical, plain [r] and the atypical, emphatic [r<sup>ɕ</sup>], which is associated more with the speech of the old generation of HA speakers. Since both types of /r/ have a significant phonological role in the type of vowel in sonority-driven epenthesis, I will analyze these in detail in Chapter 5, Section 5.6. Having provided a brief overview about the geographical and demographic information where HA is spoken, and the variation of some consonants in HA, I will now discuss the process of data collection.

#### 1.1.4. Data Collection

Data collection for this dissertation has been derived from several sources. One major source is the author himself, who is a native speaker of HA, was born in Makkah and spent most of his life between Makkah and Jeddah, having also visited Madinah and Taif on a regular basis. In addition, other native speakers of HA originally from Makkah, Jeddah, Madinah and Taif have been consulted. Furthermore, the speech of several people from these cities has been observed during the collection of the data. Additional data from previous work in the literature

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<sup>7</sup> Al-Khattib (1988, p. 152) confirms the correlation between the [ʒ] variant of the affricate /dʒ/ preceding dentals and bilabials in Jordanian Arabic.

<sup>8</sup> For example, I have noticed that HA speakers of Levantine heritage usually pronounce /dʒ/ as [ʒ] (see also Al-Khattib 1988, p. 148), whereas groups originally from Southern Arabia such as Yemeni and Hadhrami pronounce it with slight retroflexion as [dʒ̣]; others pronounce it as [dʒ]. I assume this is due to the original realization of this consonant in their heritage dialect/language.

e.g. Abu Mansour (1987) and Kabrah (2004) have been considered. Beyond that, spoken media in the Hijazi dialect has been considered in the collection of the data.

## **1.2. HA Segment Inventory**

This section presents the segment inventory for HA. It will start with the consonant inventory in Figure (1.2) followed by the vowel inventory in Figure (1.3).<sup>9</sup>

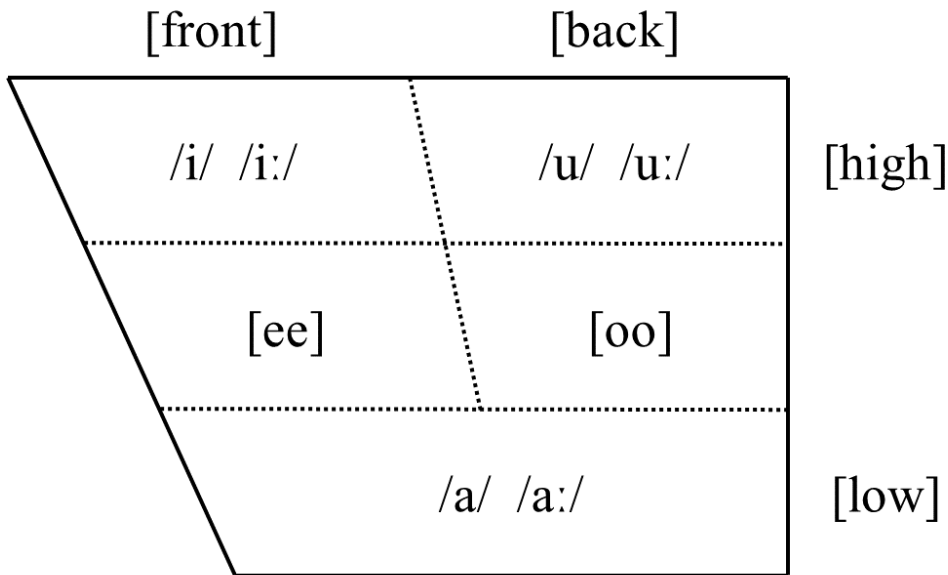
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<sup>9</sup> This study follows the consonant and vowel inventory used in this section to present the data from HA. With regard to data reported from other sources, segments will be transcribed as they are in the original source.

(1.2) Consonant Inventory of HA

	Bilabial	Labio-dental	Dental	Post-alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	b		t d			k g			ʔ
Emphatic Plosive			tʰ dʰ						
Affricate				ɖʒ					
Nasal	m		n	ɲ					
Trill			r						
Emphatic Trill			rʰ						
Fricative		f	s z				χ ʁ	ħ ʕ	ħ <sup>10</sup>
Emphatic Fricative			sʰ zʰ						
Approx.	w				j				
Lateral Approx.			l						
Emphatic Lateral Approx.			lʰ						

<sup>10</sup> See Abu-Mansour (1996, p. 226) for acoustic evidence of voicing in HA/MA glottal fricative.



### (1.3) Vowel Inventory of HA

As can be noticed from Figure (1.2), the uvular stop, /q/, is not present in the chart, since it is only used in stylistic, literary speech items such as [qur<sup>s</sup>. 'ʔa:n] “Quran” and [qi.'ra:.ʔa] “reading.” The chart presents other rarely used consonants such as /l<sup>s</sup>/, which is only used in the name of the God, [ʔal<sup>s</sup>.l<sup>s</sup>afi]. Furthermore, the emphatic /r<sup>s</sup>/ is presented in the chart because it is the underlying form of the rhotic for some of the older generation. With regard to the consonants /ʃ ʤ/, I prefer to follow the IPA convention in categorizing them as postalveolar, although they are categorized as palatal in the literature on Arabic phonology. In addition, the glides /j w/ are listed as approximants, typical to the IPA chart.

With regard to Figure (1.3), HA has three short vowels, /i a u/, and three corresponding long vowels, /i: a: u:/. The mid vowels [ee] and [oo] are not underlying in the dialect and are phonologically derived, as will be detailed in Chapter 4, Section 4.1.2. Having presented the

consonant and vowel inventories for HA, the following section will give a brief overview about the syllable structure and types in HA.

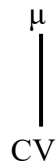
### 1.3. Syllable Structure in HA

This section provides a brief overview about syllable structures and their distribution in HA. It also sheds light on some of the main phonological alternations relevant to syllable structure. Section 1.3.1 describes the light, heavy, and super-heavy syllable types and their distribution. Section 1.3.2 provides an overview of word-internal super-heavy syllables and the phonological alternation related to these syllable types. Section 1.3.3 illustrates the vowel shortening process of hollow verbs. Section 1.3.4 demonstrates the relationship of high vowel deletion, which results in word-internal CVVC syllables.

#### 1.3.1. Syllable Types and Distribution

HA has the following types of syllables: CV, CVV, CVC, CVVC, CVCC, CVG, CVVG.<sup>11</sup> CV, the light syllable, is the basic syllable type with one mora, and it occurs without restriction word-internally and word-finally, for example, the word [sa.ma.ka] “fish, SG” and [ka.ta.bu] “they wrote.”

#### (1.4) Moraic Representation of the Light Syllable



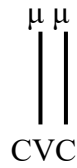
A heavy syllable, CVC and CV:, is a syllable with two moras in the rhyme.

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<sup>11</sup> C = Consonant, V = Vowel, G = Geminate.

### (1.5) Moraic Representation of Heavy Syllables

a.



b.



Like CV, the CVC syllable type occurs word-internally and word-finally with no restriction, for example the word [mak.tab] “office, SG” and [daħ.raḍʒ] “he rolled down.”<sup>12</sup> However, the CVV syllable type shortens word-finally e.g., /sama:/ → [sa.ma] “sky, SG.” ~ [sa.ma.na] “our sky” and occurs without any restriction word-internally e.g., /mana:di:l/ → [ma.na:di:l] “napkin, PL.”<sup>13</sup>

The next syllable type is the super-heavy syllable. The first type of super-heavy syllable is the CVVC type. The long vowel of this syllable is connected with two moras followed by a consonant, which does not get a mora due to the undominated constraint \*3μ (Kager 1999, p. 268; Kabrah 2004, p. 71; Bamakhramah 2009, p. 50) e.g., [ḍʒa:m.ʕa] “university” and [ma.sa:r] “track, path.”<sup>14</sup> The second type of super-heavy syllable is the CVCC type, in which the vowel and the first consonant of the coda each get a mora, and the last consonant of the coda does not get a mora due to the EXTRAMETRICALITY restriction e.g., [ka.tabt] “I wrote.”

### (1.6) Moraic Representation of Super-Heavy Syllables

a.



b.



<sup>12</sup> CVC word-finally is light, due to the EXTRAMETRICALITY CONSTRAINT. In Arabic, the word-final consonant is extrametrical; therefore, it does not receive a mora. As a result, the last consonant of word-final CVC, CVVC and CVCC syllables does not carry a mora, so these syllable types do not exceed two moras (see Hayes 1985, 1995).

<sup>13</sup> For word-final long vowel shortening in Arabic, see McCarthy (2005).

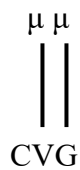
<sup>14</sup> A coda consonant gets its weight through the WEIGHT-BY-POSITION constraint, which assigns a mora to the syllable coda. In the first example above, WEIGHT-BY-POSITION is dominated by \*3μ, which prevents a syllable from having more than two moras. In the second example, EXTRAMETRICALITY outranks WEIGHT-BY-POSITION preventing the final C from having moraic weight.

CVVC and CVCC occur word-finally with no restriction; however, some phonological alternations operate to avoid occurrence of these syllable types word-internally. These phonological alternations will be explained in more detail in §1.4.3.

Finally, the last syllable type is the extra-super-heavy syllable. This type of syllable has a geminate coda in which one underlyingly moraic consonant occupies two timing slots and is preceded by either a short vowel (CVG, e.g., [ma.fad:] “bandage, SG.”) or a long vowel (CV:G, e.g., [fa:b:] “young person, SG.”).

### (1.7) Moraic Representation of Extra-Super-Heavy Syllables

a.



b.



CVG and CVVG occur with no restriction word-finally; however, they trigger vowel epenthesis when they would occur word-internally, for example /mafad:-na/ → [ma.fad.da.na] “our bandage;” and /fa:b:-na/ → [fa:b.ba.na] “our young person.”<sup>15</sup> The relationship between epenthesis and word-internal CVG and CVVG will be detailed more in §1.3.2.

### 1.3.2. Epenthesis and Word-Internal Super-Heavy and Extra-Super-Heavy Syllables

The main tendency of HA is to avoid word-internal super-heavy syllables. This can be achieved in two ways: vowel epenthesis with nominal and adjectival lexical items and vowel shortening with hollow verbs. This section will deal with vowel epenthesis; vowel shortening will be detailed in §1.3.3.

---

<sup>15</sup> Only vowels and geminate consonants are underlyingly moraic.

The underlying CVVC syllable type does not surface word-internally in HA. Instead, vowel epenthesis occurs to break up this syllable type. This happens with nominal and adjectival forms. The coda of the CVVC syllable type would resyllabify to form the onset of the new syllable with the epenthetic vowel, for example, the word /ba:b-na/ → [ba:.ba.na] “our door.”

Similarly, the CVCC syllable type does not occur word-internally, and the same phonological alternation of vowel epenthesis would occur to avoid such a syllable, for example, /kalb-na/ → [kal.ba.na] “our dog.”

Similar to the super-heavy syllable, when extra-super-heavy syllables, CVG and CVVG, occur word-internally, they trigger the phonological alternation of vowel epenthesis. The geminate consonant of the coda additionally forms the onset of a new syllable with the epenthetic vowel, for example, /ḍʒad:-na/ → [ḍʒad.da.na] “our grandfather” and /ḍʒa:d:-na/ → [ḍʒa:d.da.na] “our serious person.” The underlying mora of the geminate consonant in the word-internal CVVG of [ḍʒa:d.da.na] is not parsed in the first syllable due to the undominated \*3μ.

### 1.3.3. Vowel Shortening in Word-Internal CVVC Syllables

Word-internal CVVC syllables shorten in HA in the derived environment, especially when adding the dative suffixes /-l/ “for, to” and /-b/ “with.” This vowel shortening occurs only with hollow verbs, in which the underlying medial consonant is a glide. This medial glide /w j/ vocalizes to a long [a:] in the perfect form. For example, the underlying /fawaf/ vocalizes to [ʃa:f] “he saw.” When adding the dative suffix /-l/ and the first-person plural object suffix /-na/, the long vowel shortens, becoming [ʃaf.la.na] “he saw for us.” The vowel after the dative suffix /-l/ is epenthesized to avoid the occurrence of word-internal CVCC syllables. Although the main tendency of HA to avoid word-internal CVVC and CVCC syllable types is phonological epenthesis, this does not hold for the long vowel of the hollow verb. In this case, the

phonological alternation in HA, and in many other dialects, will be vowel shortening. See also Abu-Mansour (1987, p. 124), Kabrah (2004, p. 13) and Bamakhramah (2009, p. 98).

#### **1.3.4. The Relationship between High Vowel Deletion and Word-Internal CVVC**

As mentioned above, underlying word-internal CVVC syllables are not allowed to surface in HA, and the phonology of HA makes sure to avoid this type of syllable mainly by phonological epenthesis or by vowel shortening with hollow verbs. However, the CVVC syllable type can surface as a result of the deletion of the high vowel /i/ of the short unstressed syllable and the resyllabification of its onset to form the coda of the preceding syllable. For example, the word /s<sup>ʕ</sup>a:ħibatu/ becomes [s<sup>ʕ</sup>a:ħ.ba.tu] “his girlfriend.” The high vowel of the unstressed syllable /hi/ deletes, causing the /ħ/ to resyllabify with the preceding syllable, which yields the word-internal CVVC syllable. The coda of this syllable will not receive moraic weight due to the undominated constraint \*3 $\mu$  which prevents syllables with three moras, as mentioned in §1.3.1.<sup>16</sup> The high-vowel deletion of the short unstressed syllable is a common process in HA and many other Arabic dialects, and it interacts with the stress rule of such dialects, as will be elaborated more in §1.4.

#### **1.4. Stress System in Hijazi Arabic**

The aim of this section is to give a brief overview about the stress pattern in HA and account for some phonological and morphological rules that lead to stress opacity. The section discusses the weight system of HA, relates it to foot structure, and gives an overview of some common patterns of stress and how they interact with some phonological alternations.<sup>17</sup> Section

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<sup>16</sup> See also Abu-Mansour (1987, p. 129) and Kabrah (2004, p. 123) for nonfinal phonologically driven CVVC syllables in Makkan Arabic.

<sup>17</sup> For a detailed analysis of the stress system of Makkan/HA, see Kabrah (2004) and Bamakhramah (2009).

1.4.1 describes the weight system; §1.4.2 describes the dialect's metrical system and foot types; §1.4.3 describes the parsing of syllables and feet and defines the stress window; §1.4.4 explains aspects of extrametricality in the dialect; §1.4.5 presents common patterns of stress; §1.4.6 discusses some phonological alternations that interact with stress; §1.4.7 introduces the notion of opacity and presents some examples of morphological rules which lead to opacity; and §1.4.8 concludes.<sup>18</sup>

#### **1.4.1. The Weight System in HA**

The weight system in HA, as in many other Arabic dialects, prevents the syllable from exceeding two moras. Therefore, the light syllable carries one mora and the heavy syllable carries two moras. A syllable with three moras is not possible in most Arabic dialects, and it is very rare typologically in languages (Hayes, 1995). The only light syllable in HA is CV, and the other syllable types CVC, CVV, CVVC, CVCC, CVG, and CVVG are all heavy and bimoraic. It is worth mentioning that the coda consonant gets its mora through the WEIGHT-BY-POSITION constraint (Kager, 1999), which just states that coda consonants are moraic. A word-final consonant does not receive a mora due to the EXTRAMETRICALITY CONSTRAINT; this means a word-final syllable such as CVC is monomoraic—that is, light (Hayes, 1995). Briefly laying out the weight system in HA leads to consideration of the prosodic and metrical system of the dialect.

#### **1.4.2. Metrical System and Foot Types**

The prosodic phonology assigns different layers to the prosodic phrase. In hierarchical order from top to bottom, these layers are phonological phrase ( $\varphi$ ), phonological word ( $\omega$ ), foot

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<sup>18</sup> This section provides a brief summary of the stress system in HA. For a detailed OT analysis of the stress system in HA, see Al-Mohanna (1998, 2008), Kabrah (2004) and Bamakhramah (2009).

(F), syllable ( $\sigma$ ) and mora ( $\mu$ ). Not all of these layers were considered equally in the analysis of this dialect in the phonological literature. Most of the phonological literature of HA considers the layers under the phonological word—specifically foot, syllable and mora structure.

The metrical phonology requires that the stressed syllable should be parsed into a foot. This foot can consist of one light syllable, which is referred to in the literature as a degenerate foot. Degenerate feet are not common in the world's languages and they are prohibited in most Arabic dialects. The most common foot in the world's languages, as well as in HA, is the binary foot, which consists of either two moras or two syllables. This binary foot can be divided into two main types: head-initial, which is a trochee, and head-final, which is an iamb. This section presents the basic types of feet in HA, with a primary focus on moraic trochees, and gives a basic definition of the iambic foot type, which occurs in many Arabic dialects.

**1.4.2.1. Trochaic.** The trochaic foot requires that the initial syllable or mora will be the prominent part of the foot. This means that in the bisyllabic foot, the first syllable will be the stressed syllable, for example, the word /baka/ → ('ba.ka)<sub>F</sub> “he cried.” The ideal trochee requires that both syllables are equal in weight (i.e., even). This means that both syllables should be light. There are some types of trochee which consist of a heavy and light syllable, but this is not the preferred type. In HA, as well as in many Arabic dialects, the stress system is heavily dependent upon the moraic trochee, which consists of either two light syllables (e.g., /ʃaka/ → ('ʃa.ka)<sub>F</sub> “he complained”) or one heavy bimoraic syllable (e.g., /marma/ → ('mar)<sub>F</sub>.ma “goal”).

**1.4.2.2. Iambic.** The iambic foot type is also present in Arabic dialects, especially in the formation of the hypocoristic name, and it is the most common syllable type used in Arabic broken plurals. The ideal iambic foot is a bisyllabic uneven foot in which the second syllable is heavier than the first syllable, for example the word /nufu:s/ → (nu.'fu:s)<sub>F</sub> “soul, PL.” This type

of iamb is the most common iamb in Arabic. However, there are dispreferred types of an iamb in which both syllables are equal in weight or the iamb consists of one heavy syllable in which the second mora is prominent; these even iambs are uncommon in the world's languages.

### 1.4.3. Metrical Parsing

Parsing segments into syllables and syllables into feet requires an analysis that considers the direction and limit of parsing.

**1.4.3.1. Syllabification and Footing.** Syllable parsing in HA is from left to right, as in the word /samakat+kum/ → (sa)<sub>σ</sub>.(ma)<sub>σ</sub>.(kat)<sub>σ</sub>.(ku)<sub>σ</sub>m “your-PL fish, SG,” where the rightmost consonant is extrametrical.

Footing in HA is an iterative process, and the direction of parsing syllables into feet proceeds from right to left, for example, the word /musteffet+ik/ → mus.(ʔeʃ)<sub>F</sub>.(fe.ti)<sub>Fk</sub> “your-f. hospital,” where footing from right to left leaves the leftmost heavy foot unparsed.

**1.4.3.2. Stress Window.** Stress is assigned from right to left, targeting heavy syllables. If the rightmost syllable of the word is heavy, it will be stressed. If the final syllable is light, stress falls on the heavy penult. Otherwise, the antepenult will be stressed regardless of weight. This means that stress assignment in HA does not exceed the third syllable from the right, which defines the stress window. See also Kabrah (2004, p. 32) for the role of the stress window in Makkan Arabic and other Arabic dialects.

### 1.4.4. Extrametricality

HA distinguishes between two types of extrametricality: segmental and syllabic.

Like many Arabic dialects, the final consonant of the word in HA is extrametrical—that is, it does not receive a mora, as shown in the process of syllabification (§1.4.3.1).

Syllables can also be extrametrical in HA. When the last syllable of the word is light, and does not meet the minimum requirement of the binary foot, the stress falls in the first syllable, because all of the syllables in the word are light, for example, the word /ʃabaka/ → (ʃa.ba)<sub>F</sub>.ka “net.” The stressed syllable and the syllable following it will form a trochaic foot. This leaves the final syllable in the word unfooted, therefore it will be extrametrical, because it is a light syllable and carries one mora.

#### 1.4.5. Patterns of Transparent Stress

This section illustrates some of the common transparent patterns of stress in HA.<sup>19</sup> Geminates with transparent stress are included to demonstrate their similarity to any other heavy syllable. The presentation of the data is organized according to syllable weight types and their positions in the word.

In the LL pattern, the whole word comprises one trochee.

##### (1.8) Trochaic Foot

a. /baka/ → (ʔa.ka)<sub>F</sub> “he cried”

b. /ʃaka/ → (ʃa.ka)<sub>F</sub> “he complained”

In the LLL pattern, the first two syllables form a trochaic foot, leaving the last syllable to be extrametrical.

##### (1.9) Trochaic Foot + Extrametrical Syllable

a. /ʃabaka/ → (ʃa.ba)<sub>F</sub>.ka “net”

b. /katabu/ → (ka.ta)<sub>F</sub>.bu “they wrote”

In the HL pattern, the first syllable forms a foot by itself, since it has two moras, and the last syllable is not footed.

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<sup>19</sup> This list of transparent stress patterns is not exhaustive. It does not include very long words, which require exhaustive footing. However, for more discussion of the types of stress patterns, see Kabrah (2004, Chapter 2, §2.3).

(1.10) Bimoraic Foot with Heavy First Syllable

- a. /marma/ → ('mar)<sub>F</sub>.ma “goal”      b. /maʕna/ → ('maʕ)<sub>F</sub>.na “meaning”

In the pattern of HLL, the first syllable forms a foot by itself, and the second and third light syllables will be parsed into another foot; however, only the first foot will be stressed, and the second foot will be unstressed due to the nonfinality constraint, which prevents the prominent foot of the word from being at the right edge.

(1.11) Prominent First Foot in Trisyllabic Words

- a. /madrasa/ → ('mad)<sub>F</sub>.(ra.sa)<sub>F</sub> “school”      b. /maktaba/ → ('mak)<sub>F</sub>.(ta.ba)<sub>F</sub> “library”

In the HLLL pattern, the first syllable forms a foot by itself, the second and third syllables form another foot, and the last syllable is extrametrical; however, the second foot is the prominent foot, because stress in HA does not exceed three syllables from the right (§1.5.3.2).

(1.12) Prominent Second Foot in Quadrisyllabic Words

- a. /ʔaftakaru/ → (ʔaf)<sub>F</sub>.(ʔa.ka)<sub>F</sub>.r<sup>s</sup>u “he remembered him”  
b. /ʔaftarasu/ → (ʔaf)<sub>F</sub>.(ʔa.ra)<sub>F</sub>.su “it preyed upon it”

If the word contains two syllables in which the last one is heavy, stress falls on the heavy syllable, and this syllable forms a moraic trochee by itself.

(1.13) Bimoraic Foot with Heavy Last Syllable

- a. /mana:l/ → ma.(ʔna:l)<sub>F</sub> “woman’s proper name”  
b. /katabt/ → ka.(ʔabt)<sub>F</sub> “I wrote”  
c. /mafab:/ → ma.(ʔfab:)<sub>F</sub> “fireplace”

If the word contains three syllables, in which the medial syllable is heavy, this heavy syllable attracts the stress and forms a trochaic foot by itself, leaving the first and final syllables unparsed, because they do not meet the requirement of foot binarity.

(1.14) Bimoraic Foot with Heavy Medial Syllable

- a. /mana:ra/ → ma.(ˈna:)<sub>F</sub>.ra “minaret”
- b. /mutarḍẓim/ → mu.(ˈtar)<sub>F</sub>.ḍẓim “translator”
- c. /muχad:a/ → mu.(ˈχad)<sub>F</sub>.da “pillow”

In HA and most Arabic dialects, the heavy syllable forms a trochee by itself.

(1.15) Heavy Monosyllabic Foot

- a. /bard/ → (ˈbard)<sub>F</sub> “cold”
- b. /ba:b/ → (ˈba:b)<sub>F</sub> “door”
- c. /ʕam:/ → (ˈʕam:)<sub>F</sub> “uncle”
- d. /ʕa:m:/ → (ˈʕa:m:)<sub>F</sub> “public, general, common”

In words which include two or more heavy syllables, stress falls on the rightmost syllable. This is regardless of the type of heavy syllable, whether it is CVVC (1.16a–b) or CVCC (1.16c–d). As shown in (1.16e), the stress will fall on the final heavy syllable, even if the preceding syllable is heavy with a geminate consonant.

(1.16) Final Prominence in Words with HH Syllables

- a. /musma:r/ → (mus)<sub>F</sub>.(ˈma:r)<sub>F</sub> “nail”
- b. /muzma:r/ → (muz)<sub>F</sub>.(ˈma:r)<sub>F</sub> “type of cane”
- c. /tarḍẓamt/ → (tar)<sub>F</sub>.(ˈḍẓamt)<sub>F</sub> “I translated”
- d. /masmart/ → (mas)<sub>F</sub>.(ˈmart)<sub>F</sub> “I nailed”
- e. /ʕad:e:t/ → (ʕad)<sub>F</sub>.(ˈde:t)<sub>F</sub> “I counted”

The stress pattern of three heavy syllables in a sequence will be similar to the stress pattern of two heavy syllables, in which the last syllable attracts the stress, as shown in (1.17). This is regardless of the type of the final syllable or the penultimate syllable (c–d).

(1.17) Final Prominence in Words with HHH Syllables

- a. /murta:hi:n/ → (mur<sup>s</sup>)<sub>F</sub>.(ta:)<sub>F</sub>.('hi:n)<sub>F</sub> “we/they are comfortable”
- b. /mufta:gi:n/ → (muʃ)<sub>F</sub>.(ta:)<sub>F</sub>.('gi:n)<sub>F</sub> “we/they are missing”
- c. /ʔastakrabt/ → (ʔas)<sub>F</sub>.(takʁ)<sub>F</sub>.('rabt)<sub>F</sub> “I surprised”
- d. /daħradʒna:k/ → (daħ)<sub>F</sub>.(radʒ)<sub>F</sub>.('na:k)<sub>F</sub> “we rolled you down”

#### 1.4.6. Stress and Some Phonological Alternations

The stress system in HA interacts with many phonological alternations such as syncope, epenthesis, and vowel shortening. This section gives a brief overview of these processes that occur in HA.

**1.4.6.1. Stress and Syncope.** In HA, the short unstressed high vowel /i/ deletes in open syllables in the environment between two vowels, if the vowel preceding /i/ is short. The unstressed /i/ will delete to create a word-internal CVC syllable, for example, the word /kibiru/ → ['ki.bi.r<sup>s</sup>u] → ['kib.r<sup>s</sup>u] “they grow up,” especially when it is in a sentence, for example, /ʔalʔawla:d kibir<sup>s</sup>u/ → [ʔal.ʔaw.la:d kib.r<sup>s</sup>u] “the kids grow up” (see Abu-Mansour 1987, p. 130). In addition, when the vowel preceding the /i/ is long, /i/ also deletes to create the undesired word-internal CVVC syllable, for example, /t<sup>ʕ</sup>a:liba/ → [t<sup>ʕ</sup>a:.li.ba] → [t<sup>ʕ</sup>a:l.ba] “female student.” In both previous examples, unstressed /i/ is deleted after the assignment of the stress in HA (see also Kabrah 2004, p. 129). However, unstressed /i/ does not delete in the environment where the deletion process would yield unwanted syllable structure in HA, for example, the word /fihim+na/ → [fi.'fim.na] → [fi.'fim.na] “we understood” and not \*[f<sup>h</sup>im.na]. In this example,

the vowel /i/ of the first syllable is unstressed, but it does not delete, because the deletion of this high vowel would create an onset cluster, which is prohibited by the phonology of HA (see also Bamakhramah 2009, p. 96). The deletion of this vowel does occur in other Arabic dialects, which allow onset clusters, for example, Palestinian Arabic (Abu-Salim, 1982). Furthermore, the high vowel /i/ does not delete in HA if it is preceded by a CVC syllable in the word. This is because the deletion of the high vowel would result in a word-internal CVCC syllable, which does not occur in the dialect, for example, the word /ʔadaʔd̪iʔo/ → [ʔa.'daʔ.d̪i.ʔo] → [ʔa.'daʔ.d̪i.ʔo] “I tickle him,” does not surface as \*[ʔa.'daʔd̪.ʔo]

**1.4.6.2. Stress and Epenthesis.** In HA, epenthesis does not affect the stress placement of the syllable, and the epenthetic vowel is not stressed. This is different than some other Arabic dialects, such as the Cairene dialect, in which the epenthetic vowel is stressed. There are two types of epenthetic processes in HA: syllabic epenthesis to avoid undesired syllable structure in the word and sonority-driven epenthesis to repair undesired coda clusters which have rising sonority. Each case has a different epenthetic vowel. The low central vowel /a/ is the epenthetic vowel in syllabic epenthesis, whereas mostly the high front vowel /i/ is epenthesized to break rising sonority clusters.<sup>20</sup> As examples of syllabic epenthesis, consider the words /bint+na/ → ['bint.na] → ['bin.ta.na] “our daughter,” and /ba:b+na/ → ['ba:b.na] → ['ba:.ba.na] “our door,” in which the vowel /a/ is epenthesized to avoid word-internal CVCC or CVVC syllables, and it does not change the stress location, which stays in the first syllable. As an example of epenthesis which repairs a rising sonority coda in HA, consider the word /gidr/ → ['gi.dir] “pot,” without changing the stress location of the word.

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<sup>20</sup> For a detailed account of the difference between syllabic epenthesis and sonority-driven epenthesis, see Chapter 5 §5.7.

**1.4.6.3. Stress and Vowel Shortening.** In some Arabic dialects, such as Cairene Arabic, the long unstressed vowel is susceptible to a shortening process in a phonological word; however, this is not the case in HA, for example, in the word /mana:di:la+na/ → ma.(na:)F.(di:)F.la.na → ma.(na:)F.(di:)F.la.na “our napkins,” the preantepenult syllable has a long vowel and it is not stressed. This long vowel does not shorten even after the assignment of the stress location in the phonological word. However, in the phonological phrase, an unstressed long vowel may shorten, especially in rapid speech, for example, /ma: na:m/ → ('ma:)ω('na:m)ω → (ma:'na:m)φ → (ma'na:m)φ “he did not sleep.”

### 1.4.7. The Interaction between Stress and Opacity

Phonological opacity has attracted the attention of many linguists who study Arabic dialects, especially when dealing with stress assignment. There are many phonological and morphological rules which result in this opacity. Some of the opacity cases in stress assignment of certain Arabic dialects occur because several phonological rules apply in a certain order relative to each other, such as counterfeeding and counterbleeding rule orders, and interact with the stress rule. Others occur because after the application of the stress rule, some morpheme concatenation is affixed to the word, which completely undermines the stress rule of a certain dialect. Opacity as a result of certain morpheme concatenations which change stress assignment is briefly discussed in the following section.

**1.4.7.1. Stress and the Feminine Singular –at.** In HA, there are some morphemes that attract the stress regardless of the stress rule of the dialect, for example, the word /martab+at+i/ → [mar.'ta.ba.ti] → [mar.ta.'ba.ti] “my mattress.” According to the stress rule of HA, stress should fall on the second syllable of the word, since all syllables of the word are light; however,

when the feminine singular morpheme *-at* is affixed to the word, the vowel of this morpheme attracts the stress, undermining the regular stress rule (see Kabrah 2004, §2.3.5, p. 60).

**1.4.7.2. Stress and the Dative Suffixes *-l* and *-b*.** The dative suffixes *-l* and *-b* have special status in HA. When these morphemes affix to the word, they undergo gemination, especially if they are preceded by a short vowel. As a result of gemination of these prepositions, they attract the stress of the word, for example, the derivations presented in (1.18).

According to the stress rules in HA, in both examples the stress should fall in the antepenult syllable [.tab.], since it is the heavy syllable in the word; however, the dative suffixes *-l* and *-b* geminate, forming another CVC syllable which attracts the stress.<sup>21</sup>

(1.18) Derivation of Words with Dative Suffixes *-l* and *-b*

<b>Underlying Form</b>	/katab/	“to write”	/katab/	“to write”
<b>Affixation</b>	katab+t+l+u		katab+t+b+u	
<b>Epenthesis</b>	katabt <u>l</u> u		katabt <u>b</u> u	
<b>Stress</b>	ka.'tab.ta.lu		ka.'tab.ta.bu	
<b>Gemination</b>	ka.'tab.ta <u>ll</u> u		ka.'tab.ta <u>bb</u> u	
<b>Stress Reassignment</b>	ka.tab.'tal.lu	“I wrote for/to him”	ka.tab.'tab.bu	“I wrote by means of it (masc.)”

**1.4.7.3. Stress and the Relational Adjectival suffix *-a:wi*.** The relational adjectival morpheme (*nisba*) *-a:wi* is suffixed to the noun, attracting stress to the morpheme’s long vowel, as shown in (1.19).<sup>22</sup>

<sup>21</sup> In both examples, the resyllabification derivation steps are omitted for brevity. It is assumed that resyllabification occurs whenever affixation to the base occurs.

<sup>22</sup> The final vowel of the noun /mak:a/ is deleted upon affixation of the relational adjectival suffix *-a:wi*.

### (1.19) Exceptional Stress Pattern with *-a:wi*

	Underlying		Stress Rule		Affixation		Stress Reassignment	
a.	/mak:a/ “Makkah”	→	'mak.ka	→	'mak.ka+a:.wi	→	mak.'ka:.wi	“person from Makkah”
b.	/nas <sup>s</sup> r/ “soccer team”	→	'na. s <sup>s</sup> ir	→	'na.s <sup>s</sup> r+a:.wi	→	nas <sup>s</sup> .'ra:.wi	“soccer team fan”

### 1.4.8. Conclusion

This section has briefly summarized some of the main stress patterns in HA and some phonological alternations, such as vowel syncope and morphological concatenation, that interact with the stress rule. For a detailed analysis of the stress rule in HA, see Kabrah (2004), who studied the stress of Makkan/HA in the framework of Stratal OT theory.

The next section will give a brief introduction into Optimality Theory, which is the main theoretical framework for this dissertation.

### 1.5. Optimality Theory







This section provides a brief summary for the operative mechanics of Optimality Theory. Optimality Theory, which is the most prominent theoretical framework in the field of phonology over the last quarter century, is based on converting the universal linguistic conditions, which themselves are a result of the work of the former generative linguistics of rewrite rules and representations, into linguistic constraints. These universal conditions/ constraints are developed from two main linguistic subfields: language typology and language acquisition. The universal linguistic constraints are divided into two types: markedness constraints and faithfulness constraints. Markedness constraints are concerned with the most basic and universal linguistic

form for the output, militating against marked structures in the output. The criteria determining basicness are external to the grammar and come from language perception and articulation. The other type of constraints are faithfulness constraints, which are constraints about preserving lexical contrasts and forcing identity between input and output. These two types of universal constraints form *CON*, the set of universal potentially-conflicting constraints and a setting parameter of *EVAL*, which is one of the major components of the OT theory. The second component of OT theory is the lexicon, which is the storage of all lexical forms and provides *GEN* with the input forms. The third major component of the operative mechanics of OT is *GEN* (*Generator*), which generates an infinite number of outputs for some input given by the lexicon and feeds these to *EVAL* (*Evaluator*). *EVAL* evaluates the output candidates produced by *GEN* in a parallel manner<sup>23</sup> and chooses the most optimal/ harmonic candidate based on the set of the constraints given by *CON*. The operative mechanics of OT will be illustrated in Figure (1.20), reproduced and modified from Kager (1999).

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<sup>23</sup> This type of OT approach is called Parallel OT. This is the most common type of OT grammar. Another type of OT approach is Statal OT, in which *EVAL* selects the most optimal candidate, which itself is the input for another stage of OT analysis. Each evaluation stage is concerned with a certain morphological level, e.g. stem, word, phrase. In this type of grammar, markedness constraints are fixed, whereas faithfulness constraints change from one stratum to another (see Kiparsky 2000). Another type of OT approach is harmonic serialism, in which *EVAL* chooses the most harmonic candidate with one phonological change and feeds it as the input for another level, which itself is fed as an input to another level in a serial and circular manner until it reaches the desired output form. Each level of evaluation achieves one phonological change. In this type of OT grammar, the same constraint ranking holds for all evaluation stages (see McCarthy 2016 and 2018). However, this dissertation utilizes the parallel OT approach for the analysis of sonority of coda clusters in HA.

(1.20) Components of the OT Grammar (reproduced and modified from Kager 1999, p. 19)

Lexicon	Generator	Evaluator	Output
<p>contains lexical representations (or underlying forms) of morphemes, which form the input to:</p> 	<p>generates output candidates for some input, and submits these to:</p>  <p>Candidates A, B, C...</p> 	<p>the set of ranked constraints, which evaluates output candidates as to their harmonic values, and selects the optimal candidate.</p>  	<p>the optimal winning candidate</p> 
<p>“Storage”</p>		<p>“Filter”</p>	

The optimal winning candidate is the candidate which has the least serious violations of the constraint set. If faithfulness constraints dominate markedness constraints, the output will surface with no or little linguistic change, whereas if markedness constraints dominate faithfulness constraints, the output will surface with linguistic change. In other words, according to Kager (1999), “when markedness dominates faithfulness, the language achieves outputs that are minimally marked, at the expense of a neutralization of lexical contrasts. But when faithfulness dominates markedness, the language makes the reverse choice, realizing its input contrasts at the expense of output markedness” (Kager 1999, p. 29). The OT analysis is done by means of illustrative analytical tableaux. All input candidates are listed on the y-axis from top to bottom, starting from the underlying input in the left column of the tableau. The constraint ranking is listed on the x-axis on the top row, with the highest-ranking constraint on the left to the lowest ranked constraint on the right. A solid line is placed between constraints to show domination, whereas a dashed line is placed between constraints to indicate that they have the same constraint ranking. One or more constraints may have the same ranking, with dashed lines separating between them. Constraint violation is marked by the “\*” symbol. It is placed under the relative constraints and in front of the violating candidates. If the violation is fatal, then the exclamation symbol is placed after the asterisk, “\*!” A pointing hand is placed on the left side of the winning candidate. If the decision has been made by higher-ranked constraints, shading is used in the cells that have no direct significance in the decision. In other words, according to McCarthy (2008, p. 45), “...cells that are shaded are those that can have no effect on the outcome because the competition has been decided by higher-ranking constraints.” Two constraints are in a

domination relationship if the satisfaction of  $C_1$  occurs at the expense of the violation of  $C_2$ , which will be illustrated in Figure (1.21).

(1.21) Constraint Domination

	$C_1$	$C_2$
a. Candidate A		*
b. Candidate B	*!	

As we indicated above, two constraints may have the same ranking if there is no conflict between  $C_1$  and  $C_2$ . In other words, the violation of either constraint has the same result. This will be illustrated in Figure (1.22).

(1.22) No Strict Domination between  $C_1$  and  $C_2$

	$C_1$	$C_2$	$C_3$
a. Candidate A			*
b. Candidate B		*!	
c. Candidate C	*!		

The notion of strict domination in OT also extends to domination by transitivity. That is, if Constraint A dominates Constraint B and Constraint B dominates Constraint C, then Constraint A also dominates Constraint C by transitivity (see also Kager 1999, p. 21). This section briefly identifies the important components of the OT theory and explains that with some illustrative tableaux. For a detailed account of OT, see Prince & Smolensky (1993), Kager (1999) and McCarthy (2008). The next section concludes the chapter and provides a general overview for the rest of the chapters of the dissertation.

## 1.6. Conclusion and Structure of the Dissertation

I have started this chapter by providing a general overview about HA. Then, I have shed light on the most important phonological components of the dialect by listing the segment inventory. I have provided a brief summary for the syllable structure and distribution of HA, followed by a brief overview of the stress system of the dialect. Finally, I have pointed out the most important components of the OT theory, which is the theoretical framework used for the analysis in this study.

The structure of the dissertation will be as follows. Chapter 2 lays out the most important components of the study of sonority in HA such as the sonority scale, the investigation of the sonority of gutturals, the Sonority Sequencing Principle, the role of the Obligatory Contour Principle in constructing the coda cluster in HA, etc. Chapter 3 provides the OT analysis of the sound coda cluster of HA introducing the Split-Margin Approach to the syllable. In addition, it accounts for the role of nasals, template satisfaction and lexical variation. Chapter 4 provides a detailed OT analysis of the role of glides, the role of *'Ayn* and the role of geminates in the coda cluster of HA. Chapter 5 analyzes high vowel spreading, sonority-driven epenthesis and consonant-to-vowel harmony in the coda cluster of HA. Chapter 6 summarizes the study and provides future directions for research.

## **Chapter 2: Sonority in Hijazi Arabic**

The aim of this chapter is to establish a theoretical background by way of investigating the role of sonority in the syllable structure of Hijazi Arabic (HA) and other Arabic dialects and to present the first known detailed investigation of the sonority of gutturals in HA. This chapter lays out the most important factors related to the sonority of the coda cluster in HA, which will be necessary for the OT analysis of the coda cluster presented in subsequent chapters. Section 2.1 presents the initial considerations of the sonority scale in HA. Section 2.2 details the important elements which play a role in the explanation of the status of gutturals in HA. Section 2.3 discusses the vowel quality in sonority-driven epenthesis in HA. Section 2.4 provides a brief typological survey of the sonority of coda clusters in Arabic dialects. Sections 2.5, 2.6, and 2.7 lay out the most important principles for the explanation of HA phonotactics related to the coda cluster, including the Sonority Sequencing Principle (SSP), Minimal Sonority Distance (MSD), and the Obligatory Contour Principle (OCP), respectively. Section 2.8 discusses and concludes.

### **2.1. Sonority scale (initial considerations)**

Sonority plays a significant role in structuring the syllable. In HA, which lacks onset clusters, sonority plays a particularly important role in characterizing the syllable coda. Any single consonant, regardless of its sonority profile, can occur in the onset of the syllable in HA. Hijazi Arabic, like many other languages, allows only vowels to serve as the nucleus of the syllable. With regard to coda clusters, HA does not allow rising sonority in the coda.

Sonority is usually defined as a scalar classificatory division of speech sounds based on something like loudness or intensity. According to Reetz and Jongman (2008, p. 210), “the two primary contributors to the perception of sonority are degree of opening of the vocal tract (the

more open the tract, the louder the sound is) and voicing.” Ladefoged and Johnson (2010, p. 245) claim that “the sonority of a sound is its loudness relative to that of other sounds with the same length, stress, and pitch.” In English, the voiced stops are more sonorous than voiceless stops, and the same is true with voiced fricatives, which are more sonorous than their voiceless counterparts, due to the voicing feature, which adds to its loudness (p. 246). Parker (2002, pp. 41, 218, 242), provides an experimental definition of sonority as a function of “a single, uniform acoustic property (intensity) as well as a single aerodynamic property (intraoral air pressure).” Through his study, Parker determined that intensity has a consistent and near-perfect positive correlation with sonority, and that air pressure measurements have a strong negative correlation with sonority. He claims the advantages of his definition to be that it is less arbitrary; grounded in universal phonetics; empirically replicable; relatively stable across speakers, genders, and languages; and theory-neutral (pp. 218–219). Phonologically, Parker defines sonority as “a unique type of relative, n-ary (non-binary) feature-like phonological element that potentially categorizes all speech sounds into a hierarchical scale” (2011, p. 1160). As a result of his study, he posits an exhaustive universal scale of sonority, which he revised and updated in subsequent work (Parker, 2008, 2011). Parker (2011, §4) argues for a universal 17-element sonority scale, as shown in Figure (2.1).

### (2.1) Parker's (2011, §4) Universal Sonority Scale

<i>Natural class</i>	<i>Sonority index</i>
low vowels	17
mid peripheral vowels (not [ə])	16
high peripheral vowels (not [i])	15
mid interior vowels ([ə])	14
high interior vowels ([i])	13
Glides	12
rhotic approximants ([ɹ])	11
Flaps	10
Laterals	9
Trills	8
Nasals	7
voiced fricatives	6
voiced affricates	5
voiced stops	4
voiceless fricatives (including [h])	3
voiceless affricates	2
voiceless stops (including [ʔ])	1

He states that languages may collapse adjacent levels to arrive at a “minimal” sonority hierarchy, such as in Figure (2.2), similar to that proposed elsewhere in the literature, including Clements (1990).

### (2.2) Sonority Scale Based on Clements (1990, p. 294)

Vowels > Glides > Liquids > Nasals > Obstruents

Clements used four main features to set up the sonority scale of segments. These features are illustrated in Figure (2.3).

### (2.3) Principal Features used in Clements' Sonority Hierarchy

O	N	L	G	
-	-	-	-	'Syllabic'
-	-	-	+	Vocoid
-	-	+	+	Approximant
-	+	+	+	Sonorant
0	1	2	3	Rank (relative sonority)

Each of the major classes can be assigned a number, such as 4 for vowels, 3 for glides, 2 for liquids, 1 for nasals, and 0 for obstruents.<sup>24</sup> These major natural classes can be further divided by other distinctive features. For example, the feature [approximant] distinguishes the liquids ([+approximant]) from the nasals ([-approximant]). Even further distinction can be made among the obstruents by using the laryngeal feature [voice] and the manner feature [continuant], and the latter feature can be used to make a similar distinction between /l/ and /r/. Zwicky (1972) proposes a set of principles to establish the sonority hierarchy.

### (2.4) Zwicky's (1972) Principles for the Sonority Hierarchy

- (a) (i) [-cons] precedes [+cons]
- (ii) [-obst] precedes [+obst]
- (b) (i) [+voc] precedes [-voc]
- (ii) [+cont] precedes [-cont]

According to Hankamer and Aissen (1974, p. 143), this derives the following sonority hierarchy.

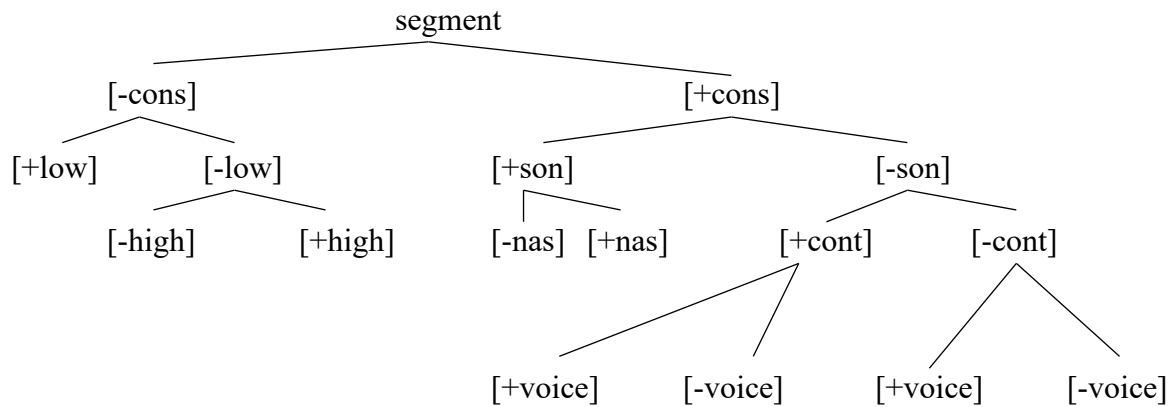
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<sup>24</sup> Clements (1990, p. 292) did not list vowels in his table, because the feature specification, [+syllabic], which distinguishes vowels from other segments, is not limited only to vowels in the world's languages. Sonorants or any consonant including obstruents can be [syllabic], depending on the language.

(2.5) Sonority Hierarchy based on Zwicky's (1972) Principles

Vowels > Glides > Liquids > Nasals > Fricatives > Stops

Blevins (1995) proposes a working universal sonority scale based on hierarchical constituencies to decide the sonority level of individual segments.



(2.6) Working Universal Sonority Scale (cf. Blevins 1995, p. 211)

In Figure (2.6), every left branch in the tree is higher in sonority than its sister node on the right. For example, [+son] segments such as liquids and nasals on the left are more sonorous than their sister [-son] segments on the right. In addition, any higher non-terminal node branches to two classes of sounds, which themselves differ in sonority ranking. For example, [+son] branches into [-nas] and [+nas], in which [-nas] sounds i.e. liquids are more sonorous than [+nas] sounds.

Zec (2007, p. 178) proposes a more granular sonority hierarchy, given in Figure (2.7).

(2.7) Complete Sonority Hierarchy Based on Zec (2007)

V	L	N	O
Low Vowels	Rhotics	Nasals	Voiced Fricatives
Mid Vowels	Laterals		Voiced Stops
High Vowels			Voiceless Fricatives
			Voiceless Stops

The differences between Zec's and Clements's sonority scales are that Zec does not consider the glides in her sonority scale, and that Zec provides lists of subclasses based on distinctive features such as voicing and continuancy, which could be used to subdivide the classes of obstruents and liquids, and the height feature, which could be used to subdivide the class of vowels. Although Zec considers the distinctive features as a main factor to subdivide natural classes, she considers all the classes of obstruents as being in the same sonority level. However, the voiced fricative obstruent does not pattern with the other obstruents in HA. Kabrah (2004) considers sonority-driven epenthesis to be a postlexical process, adopting Clements's (1990) general sonority scale. However, she makes a slight clarification on the sonority of obstruents, stating that "voiced consonants are higher in sonority than voiceless consonants" (p. 167, fn. 17). Other sonority scales which separate voiced fricatives from other obstruents based on continuancy and voicing are needed.

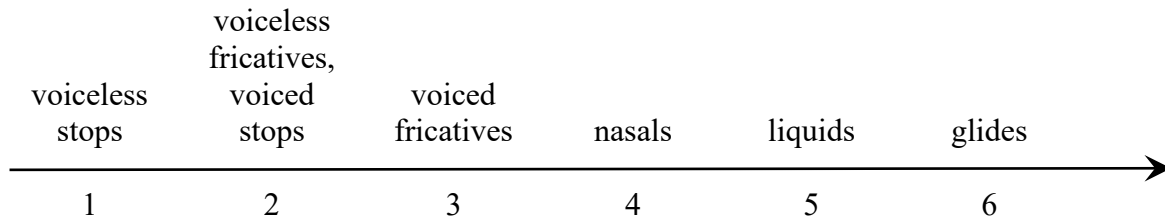
Jespersen (1904) provides a more differentiated sonority scale, which considers voiced fricatives as having higher sonority than other obstruents. He also considers the voiced stops to have a separate sonority level from voiceless obstruents and voiced fricatives, as shown in Figure (2.8). Jespersen bases his division among obstruents mainly on the voicing feature, which is on its own not relevant for the study in this chapter. He also places nasals and laterals on the same sonority level, which conflicts with Clements and Zec, and with the facts of HA, as will be demonstrated.

(2.8) Jespersen's (1904) Sonority Scale (reproduced from Clements, 1990, p. 285)

1. (a) voiceless stops, (b) voiceless fricatives
2. voiced stops
3. voiced fricatives
4. (a) voiced nasals, (b) voiced laterals
5. voiced r-sounds
6. voiced high vowels
7. voiced mid vowels
8. voiced low vowels

Murray and Vennemann (1983) propose a sonority scale which seems to be more compatible with the HA sonority profile, in which voiced fricatives are also more sonorant than other obstruents and the voiced stops and voiceless fricatives are together in the same position on the sonority scale, as shown in Figure (2.9). With regard to voiceless stops, Murray and Vennemann list them as the least sonorant segments; this condition is vacuously satisfied in HA.

(2.9) Murray and Vennemann's Sonority Scale (1983, p. 519)<sup>25</sup>



Murray and Vennemann's scale is more compatible with the HA data, because it proposes discrete levels for liquids and nasals, a point on which most later scales agree. Consider the examples in Figure (2.10).

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<sup>25</sup> This sonority scale is a transposition of the Consonantal Strength scale (Murray & Vennemann, 1983, p. 519), which was an early stage of the development of sonority theory.

(2.10) The Root Medial Consonant is more Sonorous than the Final Consonant in HA

Underlying Form	Gloss	Surface Form	Possessive Form (1 <sup>st</sup> singular Masc.)
a. /χurm/	“hole”	[χur <sup>s</sup> m]	[χur <sup>s</sup> .mu]
/ʕilm/	“knowledge”	[ʕilm]	[ʕil.mu]
b. /kanz/	“treasure”	[kanz]	[kan.zu]
/ramz/	“symbol”	[ramz]	[ram.zu]
c. /nazf/	“hemorrhage”	[nazf]	[naz.fu]
/hizb/	“(political) party”	[hizb]	[hiz.bu]

(2.11) The Root Medial Consonant is less Sonorous than the Final Consonant in HA

Underlying Form	Gloss	Surface Form	Possessive Form (1 <sup>st</sup> singular Masc.)
a. /tamr/	“date”	[tamir]	[tam.r <sup>s</sup> u]
/naml/	“ants”	[namil]	[nam.lu]
b. /huzn/	“sadness”	[huzun]	[huz.nu]
/ʕazm/	“determination”	[ʕazim]	[ʕaz.mu]
c. /χubz/	“bread”	[χubuz]	[χub.zu]
/gafz/	“jumping”	[gafiz]	[gaf.zu]

The vowel between the second and third consonant in the data in Figure (2.11) is an epenthetic vowel. These words do not receive an epenthetic vowel in morpho-phonological environment in suffixation. For example, in the 3<sup>rd</sup> person singular masculine possessive /tamr-u/ becomes [tam.ru], /huzn-u/ becomes [huz.nu] and /χubz-u/ becomes [χub.zu]. The vowel epenthesis occurs in these words when they are in isolation i.e. before suffixation to prevent an unallowed rising-sonority coda cluster from surfacing.

According to Parker (2011), adjacent sonority scale levels may be collapsed to fewer levels based on the sonority profile of segments in a certain language. This is done in Figure (2.12), which collapses all obstruents other than voiced fricatives (including the sole affricate /dʒ/) to form the lowest sonority level.<sup>26</sup>

(2.12) Proposed Sonority Hierarchy for Hijazi Arabic (Initial)

<i>Natural class</i>	<i>Sonority index</i>
Vowels	6
Glides	5
Liquids	4
Nasals	3
Voiced fricatives (including /z zʕ/)	2
Other obstruents (including /dʒ/)	1

The reason that the scale in Figure (2.12) is considered an initial proposal is because it separates voiced fricatives from other obstruents and collapses all other obstruents in one level. However, there are further details that this initial scale does not address: the actual status of gutturals, especially ‘ayn /ʕ/. The next section discusses the status of gutturals as segments and presents several pieces of phonetic and phonological evidence to demonstrate that they form a natural class by themselves.

## 2.2. The status of gutturals in the sonority hierarchy

In this section, I provide phonetic and phonological synchronic evidence that guttural consonants, which are very common in Semitic languages, constitute a natural class. This

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<sup>26</sup> There are different pronunciations of the voiced coronal affricate [dʒ] by some Hijazi speakers (not the author) when this consonant precedes a voiced fricative, e.g., [ħadʒiz] ~ [ħaʒz] “booking, reserving.” I assume that the sound [dʒ] is phonetically an affricate and phonologically a strident stop following Kehrein’s (2002) Strident Stop Approach. When the sound [dʒ] is pronounced by some speakers of Hijazi as a [ʒ] in this environment, it is the result of manner assimilation with the following fricative.

evidence is generally divisible into two types: phonetic, including articulatory and acoustical evidence, and phonological. These are followed by a preliminary sonority scale including gutturals in §2.2.3. Section 2.2.4 provides further discussion in differentiating between the subclasses of gutturals and relates this to sonority. Section 2.2.5 presents an exhaustive final scale of sonority in HA, including the subclasses of gutturals.

### **2.2.1. Phonetic evidence of gutturals as a natural class**

This section presents two types of phonetic evidence for gutturals as a natural class: articulatory and acoustical.

**2.2.1.1. Articulatory Evidence.** Throughout the literature, articulatory features of guttural consonants are a subject of controversy. Opinions within the field are largely divisible into two camps. The first view attempts to classify gutturals in the same way as other consonants, in terms of the active articulators, whereas the second view tries to classify gutturals according to the zone of the vocal tract in which they are articulated. This section outlines the most prominent articulatory evidence for gutturals as a natural class.

The old Arabic grammarians, such as Sibawayh and Ibn Jinni, describe all gutturals as being consonants produced from the throat. They further differentiated between subclasses of gutturals as being produced in different regions of the throat. For example, Sibawayh described the laryngeals as being the consonants produced furthest back in the throat. For pharyngeals, Sibawayh and Ibn Jinni describe them as being articulated in the middle of the throat. For uvulars, Sibawayh describes them as being articulated in the upper part of the throat, close to the mouth (Bin-Muqbil, 2006, pp. 62, 67).<sup>27</sup> This indicates that the old grammarians had the notion of guttural consonants as all being produced from the throat, which corresponds with modern

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<sup>27</sup> According to Bin-Muqbil (2006), Ibn Sina provided a surprisingly accurate description of the place and manner of articulation of the laryngeals /ʔ fi/. See Bin-Muqbil (2006, p. 73).

descriptions of the class of guttural consonants. They also further divided the gutturals into subclasses according to their place of articulation in the throat.

Hayward and Hayward (1989), McCarthy (1991, 1994) and Zawaydeh (1999) refer to all guttural consonants as being characterized by the feature [pharyngeal], since they are all produced within a broad region from the larynx to the upper pharynx. This means that the gutturals are defined by the broad zone in which they are produced, in contrast to other natural classes, such as [labial], [coronal], and [dorsal], which are defined by their active, rather than passive, articulator (Hayward & Hayward, 1989) and are produced within the comparatively narrower and more orosensitive anterior region. McCarthy (1994) defines his proposed feature [pharyngeal] as “the orosensory pattern of constriction anywhere in the broad region of the pharynx” (p. 199). Three different active articulators have access to the relevant region of the vocal tract, these being the larynx, the tongue root, and the tongue body, specifically the dorsum of the tongue. The laryngeal consonants are produced with a glottal gesture in the larynx, which can consist of either complete constriction, in the case of the glottal stop, or spreading, in the case of [h]; the pharyngeal consonants are produced with an approximation between the tongue root and epiglottis with the posterior wall of the pharynx; uvular fricatives are produced by the superior movement of the tongue dorsum toward the pharynx wall (McCarthy 1994, p. 196; Bin-Muqbil 2006, p. 264).

Although all gutturals are defined by the broad rear region of the vocal tract, they can be further differentiated from each other by the specific region within that area and the active articulators which are involved in their production (McCarthy, 1994; Zawaydeh, 1999).

McCarthy concludes that all six gutturals are characterized by stricture in the vocal tract, which

adds to the phonetic evidence for gutturals as a natural class. This stricture also differs between types of gutturals and between the voiced and voiceless members of a pair.

Zawaydeh (1999), who conducted an endoscopic acoustic study on a speaker of Amani Jordanian Arabic, states that all guttural consonants, including emphatics, constitute a natural class. She also argues that the back of the tongue is involved in the articulation of uvulars and emphatics and the pharynx is an active articulator for all gutturals except laryngeals, as the last group lacks a pharyngeal constriction. She states that the tongue root is involved in the articulation of pharyngeal consonants, which makes these consonants distinct from uvulars and emphatics, which are articulated with the tongue dorsum.

Zawaydeh (1999) proposes a slightly different point of view from that of McCarthy, by stating that the pharynx is an active articulator for all gutturals except laryngeals, including emphatics. One difference between Zawaydeh's view and that of McCarthy (1994) and Hayward and Hayward (1989) is that McCarthy considers the pharynx to be merely the zone in which the gutturals are articulated, and not an active articulator in its own right, as described by Zawaydeh. The other difference is that Zawaydeh groups the emphatics into the class of gutturals.

In addition to the articulatory evidence presented in this section, gutturals also exhibit common acoustical features, presented in the following paragraph.

**2.2.1.2. Acoustical Evidence.** All gutturals share a prominent acoustic feature—that is, a high F1.<sup>28</sup> This accounts for the “distinctive sound producing state” of gutturals (McCarthy, 1994, p. 199, citing Perkell, 1980, p. 338; Zawaydeh, 1999, p. 38). The articulatory gestures involved in the production of the gutturals correlate with the F1 value of each type of this class.

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<sup>28</sup> Reetz and Jongman (2008, p. 184) state that “Vowel height is inversely correlated with the frequency of the first formant: the higher the vowel (and the higher the tongue position), the lower the F1.” According to Ladefoged and Johnson (2010, p. 307), a formant is defined as “A resonating frequency of the air in the vocal tract.”

According to McCarthy, laryngeals have the theoretically highest F1 value of all the gutturals. They are followed by pharyngeals, which have the second highest value, and uvular fricatives have the lowest F1 value among gutturals, but still higher than consonants of other classes. Thus, all gutturals have a high F1 value, but this value differs between subclasses.

### **2.2.2. Phonological evidence of gutturals as a natural class**

This section provides a wealth of phonological evidence for gutturals as a natural class. These pieces of evidence are derived from different sources, including Hayward and Hayward (1989), McCarthy (1991; 1994), Rose (1996), Zawaydeh (1999), Bin-Muqbil (2006), and Walker and Rose (2015), among others.

Before laying out this evidence, it is worth defining what is meant by a natural class. According to McCarthy (1991, p. 63), “a natural class is a set of sounds that are recurrently treated as a group by different phonological rules.” Therefore, by this definition, McCarthy provides examples that the group of guttural sounds is targeted by certain phonological rules. Furthermore, he claims that the evidence for gutturals as a natural class is not derived from diachronic change, but rather, the universality of the class is demonstrated by independent synchronic processes.

The ample phonological evidence laid out by McCarthy includes the following: first, root-consonant co-occurrence restrictions on gutturals prevent roots from containing two homorganic consonants. This restriction is not just for triliteral roots but extends to include quadriliteral and biliteral roots (McCarthy, 1991, p. 66). He lists six types of consonant classes which cannot occur together within the same root (to be presented in §2.7). Among them is the class of gutturals. Second, he provides examples of vowel lowering in guttural contexts in Semitic. One example of this phenomenon occurs in the ablaut classes of verb conjugation in

Arabic, in which there is a historical lowering of the last vowel in the imperfect to [a] when this vowel is preceded by a guttural consonant. For example, [katab] ~ [jaktub] “write” belongs to the a/u ablaut class, [χadam] ~ [jaχdim] “serve” belongs to the a/i ablaut class, and [faʕal] ~ [jaʕfal] “do” belongs to the a/a ablaut class.<sup>29</sup>

In addition to the vowel ablaut examples discussed by McCarthy, Irshied and Kenstowicz (1984, pp. 118–119) provide examples of vowel raising in nonfinal light open syllables in Bani-Hassan Arabic, “a bedouin dialect of northern Jordan” (Irshied and Kenstowicz 1984, p. 109). In the examples provided in (2.13), the vowel raising process does not occur if the vowel is preceded by a guttural consonant.

(2.13) Blocking of Vowel Raising by Gutturals in Bani-Hassan Arabic

a.	χadam	“he served”	c.	saħab	“he pulled”
	χdimat	“she served”		šabat	“she pulled”
b.	sarag	“he stole”	d.	daʕam	“he supported”
	srigat	“she stole”		dʕamat	“she supported”

Although the tendency of low vowels is to be adjacent to guttural consonants, these low vowels differ slightly in their backness features. The low vowel after uvulars and emphatics is more backed than the low vowel after pharyngeals and laryngeals (Card, 1983, p. 26; McCarthy, 1991, p. 82; Sylak-Glassman, 2014, p. 8). For example, compare the words [qa:l] “he said” and [tʕa:l] “became long” with [ħa:l] “condition” and [ʔa:l] “family, bloodline” in Modern Standard Arabic (MSA). In addition, the low vowel’s association with gutturals facilitates the articulation of the guttural consonants (Sylak-Glassman, 2014, p. 6). This may be due to the similar places of

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<sup>29</sup> McCarthy (1994, p. 207) found that 411 lexical roots in the a/a ablaut class include a guttural as the second consonant followed by a low vowel; however, there remain 25 roots in this class without a guttural consonant.

articulation shared by both the gutturals and low vowels as being segments produced in the low and back part of the vocal tract. In this case, the vowel production and guttural consonant articulation will be from a more adjacent place, which is easier than producing these segments from two disparate places of articulation.

McCarthy also discusses avoidance of syllable-final gutturals in Semitic languages, including Bedouin Hijazi Arabic. He provides examples in which a vowel is epenthesized to avoid the occurrence of a guttural in coda position—that is, CVGCV becomes CVGVCV, where G is a guttural consonant. For example, /gafɪwa/ “coffee” in Bedouin Hijazi Arabic becomes [ga.'fɪa.wa] → ['gɪa.wa] by epenthesizing a vowel after the guttural and deleting the unstressed first vowel, which yields an onset cluster.

However, this phenomenon of vowel epenthesis after a guttural in CVGCV does not occur in urban HA. For example, underlying /gafɪwa/ → ['gafɪ.wa] and /naχla/ → ['naχ.la] “palm tree” rather than \*[ga.'fɪa.wa] or \*['gɪa.wa] and \*[na.'χa.la] or \*['nχa.la].<sup>30</sup> This restriction does not apply to stem- or root-final guttural consonants. Finally, McCarthy concludes by providing examples of guttural degemination in some Semitic languages. For example, in Hebrew, guttural consonants cannot be geminated, even in those situations where non-guttural consonants occur as geminates (e.g., [dal.li:m] “weak ones” vs. [ra:.ʕi:m] “evil ones;” McCarthy, 1994, p. 217).

These phonological arguments discussed by McCarthy and others confirm that gutturals form a natural class in Semitic languages.

These pieces of evidence that gutturals form a natural class meet Mielke’s (2008) criteria for a “phonologically active class.” Members of a phonologically active class should exhibit at least one of the following criteria: “undergo a phonological process, trigger a phonological

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<sup>30</sup> In the examples given for Bedouin Hijazi Arabic, the surface form occurs with an onset cluster, which is tolerated in this variety; however, urban HA prohibits surface forms with onset clusters.

process, or exemplify a static distributional relation” (Mielke 2008, p. 13, cited in Sylak-Glassman, 2014). The Arabic ablaut example mentioned above fulfills the second criterion, in that the vowel is affected by adjacency to a guttural segment. Root consonant co-occurrence restrictions in Arabic fulfill the third criterion by preventing similar consonants, such as gutturals, from occurring adjacent to each other in the root. The final piece of evidence, guttural consonant degemination in Hebrew, meets Mielke’s first criterion, in that guttural consonants all undergo a phonological degemination process.

Rose (1996) conducted a cross-linguistic study of guttural sounds, with special emphasis on the class of laryngeals. In this, she follows the claim of Avery and Rice’s (1989) “Modified contrastive specification” of speech sounds, that “a class node is underlyingly specified for a certain segment only if this segment contrasts with other segments in features that depend on the relevant node” (Rose, 1996, p. 78). Therefore, according to her, the class of laryngeal segments is grouped with other guttural sounds in languages such as Arabic, because they contrast with other sounds such as pharyngeals and uvulars.<sup>31</sup> However, in languages in which /h ʔ/ are not contrastive with other guttural sounds, these sounds do not pattern as gutturals. In addition, she considers emphatics, uvulars, and pharyngeals to have the feature [+RTR], to the exclusion of laryngeals. She provides much evidence that gutturals constitute a natural class, among such evidence being the transparency of gutturals to vowel-to-vowel coarticulation. For example, Rose (1996) and Walker and Rose (2015) provide examples from Hayward and Hayward (1989) discussing Jibbāli, “a modern South Arabian language spoken in Dhofar” (Hayward and Hayward, 1989, p. 181) involving gutturals systematically flanked by low vowels, which is

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<sup>31</sup> Although the laryngeals, pharyngeals, and uvulars group together in Arabic as a class of guttural consonants, which interact with some phonological alternations, they have different sonority levels, based on their distinctive features, as will be shown in §2.2.4.

interpreted by McCarthy (1991) as a process of vowel lowering before gutturals; then this low vowel spreads its features to the following vowel over the transparent guttural. However, vowels do not lower as significantly before laryngeals, being realized as [ɛ] and not as [a], as is the case with other gutturals. See examples in (2.14).

(2.14) Vowel Lowering and Coarticulation across Gutturals in Jibbāli in CeCəC Verbs

- |    |        |   |          |   |
|----|--------|---|----------|---|
| a. | ð'ehər | → | ð'ɛ.'hər | “be finished, run out”                  |
| b. | tɛʕəs  | → | ta.'ʕəs  | “be stubborn/awkward”                   |
| c. | zɛʕəf  | → | za.'ʕəf  | “pour/spill liquid in large quantities” |

In addition, the process of Imāla, the raising of the low vowel in the feminine suffix /-a/, is blocked in vowels following emphatics and guttural consonants in certain Syrian dialects as well as several Levantine dialects, as mentioned by Cowell (1964, pp. 138-139).<sup>32</sup> Compare the following examples, in which the hyphen represents a morpheme boundary.

(2.15) Imāla Blocked following Emphatic and Guttural Consonants

- | <u>Imāla</u>             | <u>Imāla blocked</u>   |
|--------------------------|------------------------|
| a. [ʕa:sʕf-e] ‘storm’    | e. [ʒabh-a] ‘front’    |
| b. [raʔb-e] ‘neck’       | f. [sʕa:nʕ-a] ‘maid’   |
| c. [zi:n-e] ‘decoration’ | g. [sʕi:ʕ-a] ‘jewelry’ |
| d. [səkk-e] ‘track’      | h. [ʔəsʕ:-a] ‘story’   |

In the examples in (2.15), the feminine suffix /-a/ does not raise in the Syrian dialect if it is preceded by emphatics or guttural consonants. This happens because of the coarticulation of the

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<sup>32</sup> Cowell notes that there are some exceptions to this blocking, particularly involving /t/, for example [ʔəbre] “needle.” I assume that this is due to the controversial status of /t/ as emphatic or non-emphatic in some Arabic dialects.

suffix /-a/, which is inherently [pharyngeal], and the preceding segment which shares the feature [pharyngeal].

In addition to the above evidence presented by McCarthy and Rose, Sylak-Glassman (2014), following a similar approach to that of Rose (1996), conducted a major typological study of the feature [guttural] in the languages of the world, using the P-Base database (Mielke, 2008), which includes phonemic inventories, phonological processes, and distributional constraints from 628 languages. He found that typologically the likelihood of guttural consonants forming a natural class depends heavily on the existence of pharyngeal consonants within that language.

Bin-Muqbil (2006) also conducted an experimental study, using spectral moments and multi-band spectra, of the guttural sounds in MSA. One of his findings is that the laryngeals, pharyngeals, and uvulars all constitute a natural class as guttural consonants (p. 83). However, they are distinguishable in terms of their distinctive feature specifications, with laryngeals and pharyngeals being [+approximant] and [+continuant], and the uvular fricatives being [+continuant], [-approximant]. A detailed discussion of Bin-Muqbil's feature representation will be presented in §2.2.4. I proceed now to a discussion of the status of gutturals in coda clusters in other Arabic dialects.

Haddad (1984a) describes the status of guttural consonants in the coda clusters of Lebanese Arabic (LA) as behaving differently than other obstruents with regard to sonority. A consonant+guttural coda sequence will always induce epenthesis (/manʕ/ → [manVʕ] “prevention”); however, when gutturals precede other consonants, there are cases of mandatory and optional epenthesis, depending on the manner of the guttural consonant and the consonant that follows. Haddad describes an unusual sonority hierarchy based on the behavior of coda clusters in LA by classifying /m/ to be more sonorous than both /r/ and /n/ and less sonorous than

/l/, and by describing /r/ and /n/ to be of equal sonority (compare Haddad, 1984a, p. 84). He also describes gutturals as being more sonorous than other obstruents and divides the other obstruents based on place and manner of articulation.<sup>33</sup> The full sonority scale of LA will be presented in section 2.4.

Following Haddad (1984a), Farwaneh (2016) provides several examples of deverbal and nominalized lexical forms in Palestinian Arabic (PA) in which the second consonant of the potential coda cluster is a guttural and is preceded by a sonorant. All of these codas require an epenthetic vowel in the surface form, regardless of the general predictions made by the SSP, which state that the coda sequence sonorant + obstruent should be permissible without epenthesis, as it contains falling sonority. Since all of the forms in which a sonorant consonant is followed by a guttural obstruent undergo epenthesis in the surface form, Farwaneh considers this to be evidence that all guttural segments pattern together and have a higher sonority profile than other obstruents, placing all of them on the same sonority level as that of the nasals, except for /ʕ/, which patterns even higher to have the same sonority as glides. Therefore, epenthesis in potential coda clusters containing sonorant + guttural is due to the high-ranked OCP constraint against having two sonorant segments in a coda cluster, according to Farwaneh (2016, p. 130).

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<sup>33</sup> Another example of a language-specific sonority scale is given by Suzuki (1989), who argues that in West Germanic /w/ is less sonorous than /r/ and /l/ and “not markedly different” than nasals in sonority (p. 32). In addition, Hankamer and Aissen (1974, p. 132), following Geiger’s (1916) analysis of the consonant assimilation rule, propose an unusual sonority scale for Pali, placing /r/ as the most sonorant consonant and higher in the scale than glides. In addition, the place of /v/ is more sonorous than /l/ but less sonorous than /j/. Haddad, Suzuki, and Hankamer and Aissen all argue for language-specific sonority hierarchies. Hankamer and Aissen (1974) interpret the variation in sonority hierarchies between languages in the following way:

...in the region of the sonority scale between nasals and vowels, each language defines its own natural classes. Since the sonority ranking of liquids and glides is not universally fixed, we expect that the natural classes in this region will vary from language to language, but will be determined by the language-particular articulatory nature of the segments (p. 141).

This dissertation does not adopt this approach.

The sonority scale of PA as we can conclude from Farwaneh (2016) will be presented in section 2.4.

(2.16) Epenthesis in Sonorant + Guttural Coda Sequences (Farwaneh, 2016, p. 129)

- |    |        |          |       |               |
|----|--------|----------|-------|---------------|
| a. | /manʕ/ | [ma.niʕ] | *manʕ | “prohibition” |
| b. | /salχ/ | [sa.liχ] | *salχ | “skinning”    |
| c. | /ħarʔ/ | [ħa.riʔ] | *ħarʔ | “burning”     |

Yet, one principle that plays a role in determining the epenthesis process in the codas of CVCC syllables is the Semitic Coda Condition, which restricts the occurrence of pharyngeal consonants (i.e., gutturals) in coda position. According to Kabrah (2004), pharyngeal segments are treated as approximants in the literature on Arabic (Frisch, Pierrehumbert, & Broe, 2004; McCarthy, 1994; Zawaydeh, 1999) and have a higher level of sonority than nonpharyngeal obstruents. However, Kabrah (2004) is not explicit about their position on the sonority scale. She assumes:

“...when the pharyngeal is the third member of the root, preceded by an obstruent, it follows that epenthesis is sonority-driven. In contrast, a second radical pharyngeal invokes epenthesis because of a restriction imposed by the Coda Condition, prohibiting pharyngeals from being codas of syllables” (p. 192).

She displays several OT tableaux which demonstrate that when a pharyngeal would fall as the first member of the coda cluster in Makkan Arabic (MA), it undergoes epenthesis, causing the pharyngeal to resyllabify as the onset of a new syllable, motivated by a high-ranked constraint ALIGN-L ([pharyngeal], σ) and low-ranked DEP-V. However, if the pharyngeal is the last segment in the word, epenthesis and resyllabification motivated by the alignment constraint is blocked by a higher-ranking RIGHT-ANCHOR constraint and the SSP, although sonority-driven epenthesis is

still possible. The HOMONYMY constraint, which penalizes outputs that are homonymous with other lexical items, such as verbs, may also block epenthesis in some nominal forms.

With regard to pharyngeal consonants, some do not occur freely in coda position, unlike other obstruents. This thought is echoed also by Abu-Mansour (1987), who states that epenthesis could be triggered to resolve clusters with pharyngeal segments, but rejects this proposal, providing examples with pharyngeal coda clusters and no epenthesis. She also notes some coda clusters that would respect the sonority profile in MA and undergo epenthesis, which she proposes to be lexically marked to do so.<sup>34</sup> These cases include *sʕubuħ* “morning,” *baʕad* “after,” *mufuʕ* “comb,” *liʕib* “playing.”

### 2.2.3. The guttural class in the sonority scale

Based on what has been discussed up to this point, I propose the provisional sonority hierarchy of HA, including gutturals, illustrated in Figure (2.17).

(2.17) Proposed Sonority Hierarchy for Hijazi Arabic (First Revision)

<i>Natural class</i>	<i>Sonority index</i>
Vowels	7
Glides	6
Gutturals	5
Liquids	4
Nasals	3
Voiced fricatives (including /z zʕ/)	2
Other obstruents (including /dʒ/)	1

In this scale, gutturals are placed between liquids and glides based on the phonological and phonetic motivations that suggest that gutturals behave like approximants, and phonologically, these gutturals do not pattern with other sonorants, and not even entirely with the glides.

However, this provisional sonority hierarchy of HA will be revised in §2.2.5 on the basis of the

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<sup>34</sup> Makkan is a part of the dialect of Hijazi Arabic that this dissertation deals with.

specific behavior of each guttural segment. The next section discusses the position of the subclasses of gutturals within the sonority scale of HA.

#### **2.2.4. Subclass differentiation of gutturals in the sonority scale**

In recent years, many phonetic and laboratory studies have sought to investigate the sonority of segments based on their inherent phonetic characteristics rather than through their patterning in the syllable or other distributional constraints (Parker, 2002). This section aims to differentiate between the subclasses of gutturals and the two pharyngeal consonants /ħ/ and /ʕ/, based not only on the phonological evidence, but also on perceptual, acoustic, and articulatory phonetic evidence. One of the goals of this section is to carefully examine the manner of the articulation of the guttural consonants, among them /ʕ/ and /ħ/, in the hope of shedding some light on these disparate analyses. Then, it will relate this evidence to the different sonority levels of these segments in HA, by highlighting the relevant phonetic features of each and by analyzing the phonological patterning of these segments in coda position.

Rahilly (2016) argues that the most successful way of indicating the sonority of segments is based on a saliency model, which can be motivated by the insights of both OT and articulatory and acoustic phonetics and phonology (p. 9). Thus, according to Rahilly's prediction, we can further differentiate between the subclasses of gutturals and the consonants within these subclasses, such as /ħ/ and /ʕ/, in terms of sonority based on both phonological and articulatory and acoustic phonetic features.

Bin-Muqbil (2006) studied the guttural consonants in MSA and confirms that they constitute a natural class, as mentioned in §2.2.2. However, they differ in their feature representation, based on the constriction involved in the production of these consonants, with pharyngeals and laryngeals being approximants and continuants and /ʕ χ/ being only continuants.

He bases his classification of pharyngeals as approximants on the behavior of these sounds in the power spectra data of his first experiment (pp. 166, 257). With regard to laryngeals, he notes that they trivially meet the definition of approximants given by Clements (1990), as they lack an oral constriction. Uvulars, on the other hand, he considers to be fricatives based on the substantial airflow turbulence involved in their production (Bin-Muqbil, 2006, pp. 157, 162, 166, 257, 294).

<sup>35</sup> Figure (2.18) shows the featural representations of the guttural subclasses in terms of stricture proposed by Bin-Muqbil (p. 282).

(2.18) Bin-Muqbil’s Stricture Feature Specification for Guttural Subclasses

Feature	Stricture features specifications for Arabic gutturals			
	q	χ ʁ	ħ ʕ	h ʔ
[approx]	-	-	+	+
[cont]	-	+	+	+

One can conclude from the figure above that, according to Bin-Muqbil, uvulars are not approximants; instead they are fricatives, in the case of /χ ʁ/, or stops, in the case of /q/, and belong to the class of obstruents. The other guttural classes, pharyngeals and laryngeals, he considers to be approximant. While I largely agree with Bin-Muqbil, I will argue further on that only pharyngeals meaningfully and precisely fulfill the definition of approximants, according to his findings. With regard to laryngeals, I propose that they are articulated similarly to other obstruents, though they lack oral constriction. This is because the vocal folds are the active

<sup>35</sup> Bin-Muqbil (2006) refers to uvulars /χ ʁ/ as being fricatives, with regard to /q/, it is a stop uvular consonant and is realized as [g] or [ʔ] in many Arabic dialects. In HA, /q/ is realized as [g], except for literary words such as *qur’an*. Therefore, this dissertation will not deal with the status of /q/ in HA as being a guttural consonant, since it is not present in the dialect.

articulator for these two consonants, with full closure and a sudden release for /ʔ/ and a vibrating constriction, creating voicing with air turbulence for /ɦ/. See also Harris (1990, p. 263) for a description of the articulation and the air turbulence for the sound /h/.<sup>36</sup>

Further support for pharyngeals as approximants comes from Catford (1977, p. 163) and Ladefoged and Maddieson (1996), who consider /ʕ/ and /ħ/ to be approximants and not fricatives, although Ladefoged and Maddieson consider these segments to be epiglottal and not pharyngeal. Laufer (1996) suggests that the symbol /ʕ/ be used to indicate a pharyngeal approximant rather than a fricative (cited by Heselwood, 2007, pp. 5–6).

Having illustrated the difference between the subclasses of gutturals, in which only the pharyngeals are considered to be true approximants, we now turn to a closer examination of the differences between the two pharyngeal consonants. Throughout the literature, the two pharyngeal consonants, /ʕ/ and /ħ/, have been observed to exhibit a different manner of articulation, with implications for sonority-based patterning, depending primarily on the language or dialect in which they are analyzed.

A major factor which has been considered in the past as a correlate of sonority level is the degree of constriction in the vocal tract, with degree of constriction inversely correlating with level of sonority. According to McCarthy (1994) and Ghazeli (1977, p. 37) the constriction of /ħ/ is narrower than that of /ʕ/. In addition to the degree of constriction, other factors may play a role in determining the sonority of segments, especially those segments which are traditionally classified together. Furthermore, McCarthy (1994) notes, following Delattre (1971, p. 131), that the increased friction of the voiceless pharyngeal compensates for its low amplitude. In

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<sup>36</sup> Harris (1990) describes the voiceless fricative /h/. However, in HA, as well as most Arabic dialects, /ɦ/ is voiced.

addition, Klatt and Stevens (1969),<sup>37</sup> who studied guttural consonants in Arabic, confirm that both /ʕ/ and /ʁ/ do not have frication noise during their production, which according to them can be evidence for their status as sonorant consonants with the slight difference between these consonants and other sonorant segments being that /ʕ/ and /ʁ/ do not have the same laryngeal status as other sonorant segments.

The definition given by McCarthy, Ghazeli, and Delattre matches the sonority definition provided by Parker (2002, see §2.1, pp. 1–2), in which sonority is strongly correlated with two physical properties, showing a positive correlation with intensity and a negative correlation with intraoral air pressure. The /ħ/ is produced with a narrower constriction, which results in airflow turbulence that decreases its amplitude, and the vocal folds do not vibrate in the production of this consonant, whereas /ʕ/ is produced with a wider passage than that of /ħ/, and the vocal folds vibrate during the production of this consonant. Therefore, there are two phonetic features differentiating between these two segments: a wider passage and voicing for /ʕ/ and a narrower passage and no voicing for /ħ/. If /ʕ/ is indeed the voiced counterpart of /ħ/, as it is casually (and frequently, especially in non-phonetic studies) claimed to be, then it is expected to have the same degree of constriction as that of /ħ/. In fact, most of the detailed phonetic studies that describe the physical components of the production of these two consonants prove that /ʕ/ is an approximant, because the obstruction of the airflow passage is wider than that of /ħ/ and there is no airflow turbulence. This is also true if we consider the description of /ħ/ and /ʕ/ as presented by Butcher and Ahmad (1987), who studied these consonants in the Iraqi dialect of Arabic, and state that

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<sup>37</sup> Both /ʕ/ and /ʁ/ are the most sonorous consonants among their class. Regarding the status of the sonority of the voiced uvular fricative, /ʁ/, it will be illustrated in subsequent paragraphs that discuss the sonority of uvular gutturals.

“the voiceless pharyngeal in Arabic is a fricative and ... the voiced pharyngeal can be regarded as an approximant, sometimes accompanied by a stop” (p. 166).<sup>38</sup>

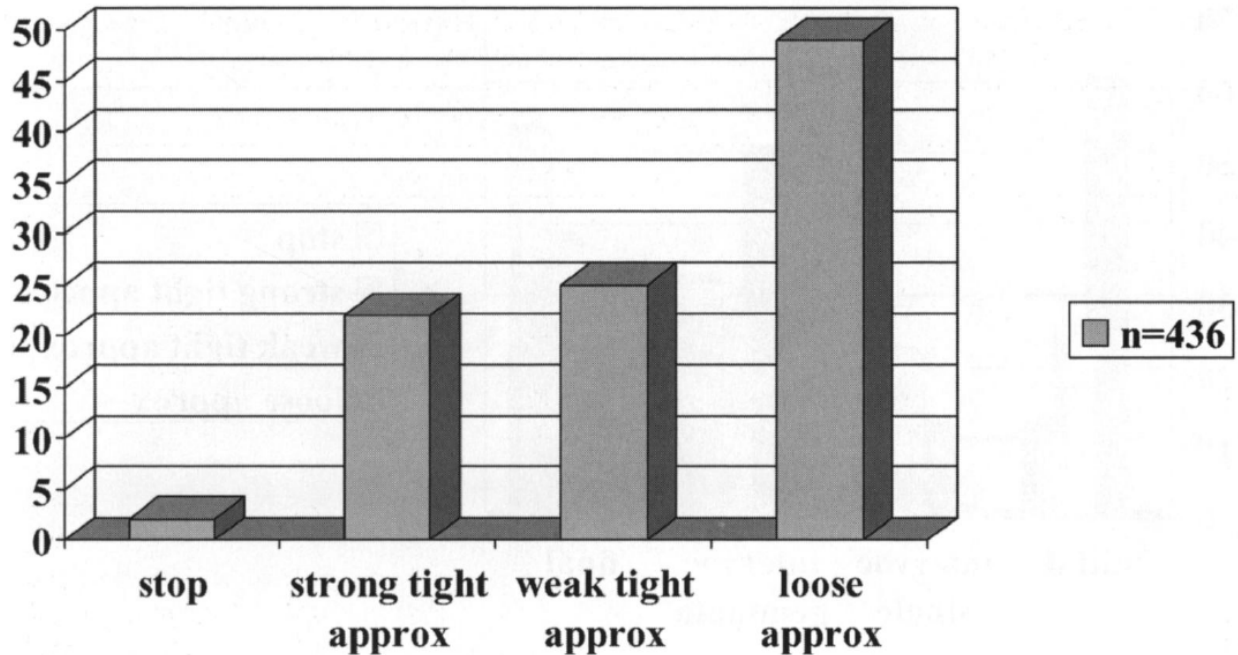
In addition, my argument finds further support from Alkhairy (1999), who provides convincing evidence that /ʕ/ is approximant and /ħ/ is a fricative consonant. He argues that /ʕ/ is an approximant consonant, defining approximants as those consonants which are produced with two articulators relatively close to one another, but without a narrow enough constriction to generate turbulence, a definition which /ħ/ does not meet. Therefore, /ʕ/ is not the voiced counterpart of /ħ/, as there is a clear difference between them in terms of constriction. According to Heselwood (2007, p. 5), the motivation behind classifying /ʕ/ as a fricative by some linguists “most likely comes from pairing it phonologically with /ħ/ which is typically realized as a voiceless fricative in all varieties, based on their shared place of articulation.”<sup>39</sup> Furthermore, an approximant consonant, such as /ʕ/, has higher energy than that of voiceless fricatives, such as /ħ/, due to the less obstructive constriction in the vocal tract. Thus, we can conclude from the arguments provided above that both pharyngeals exhibit a kind of constriction in their production; however, the constriction in /ʕ/ is less narrow than that of /ħ/, which leads to the clear classification of /ʕ/ as an approximant.

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<sup>38</sup> Their description of /ʕ/ as sometimes being realized as a stop is specific to some Arabic dialects, such as the Iraqi dialect, and does not occur in all environments. It is primarily when this consonant happens to be in the intervocalic environment or word final, as described mainly by Al-Ani (1970) for Iraqi, which has met with some disagreement in the literature. Further discussion of this issue will be presented later in this section. In addition, Shahin (2011) refers to *ʕyn* as an approximant consonant. Furthermore, Heselwood (2007, p. 3) notes that “[i]nstrumental studies have concluded that the Arabic *ʕyn*, usually represented by the IPA symbol [ʕ], exhibits extensive cross-dialectal, intra-dialectal, inter-speaker and intra-speaker variation in place and manner of articulation, and in phonation type.”

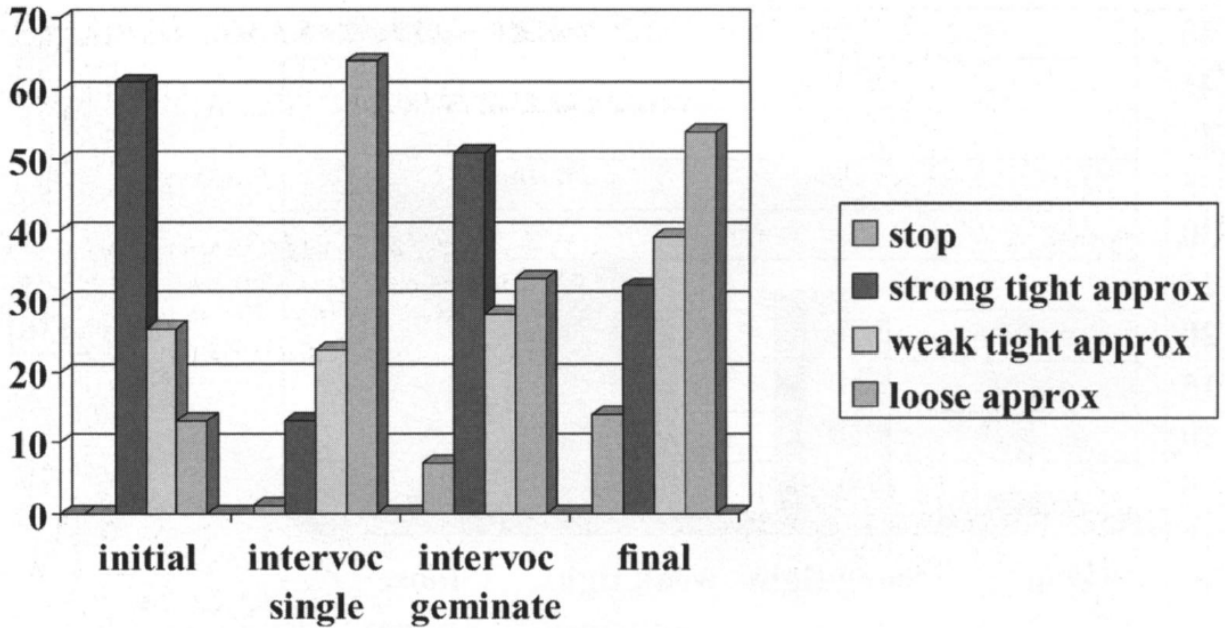
<sup>39</sup> There is some basis for regarding /ʕ/ as the voiced counterpart of /ħ/ in the phonological sense in some dialects, such as Egyptian, based on phonological alternations between the two of them. For example, the underlying /ʕ/ in the word /kaʕk/ “pastry” devoices to [ħ] before a voiceless stop in an assimilation process, i.e., [kaħk]. This alternation is not observed between /ʕ/ and /ħ/ in HA, i.e., [kaʕk], leaving little basis for postulating the two segments as phonological counterparts.

The description of the pharyngeal consonants as approximants proposed by Butcher and Ahmad (1987), Catford (1977), Ladefoged and Maddieson (1996), and others brought the attention of some linguists to carefully investigate their manner of articulation, particularly that of [ʕ], in order to determine its degree of approximation. Heselwood (2007) conducted an acoustic and laryngographic study of 436 tokens of [ʕ] in different prosodic environments produced by 21 native speakers of Arabic from the Middle East and North Africa. The main goal of his study is to prove the common realization of [ʕ] as a tight approximant, by which he means, in articulatory terms, compression of laryngopharyngeal structures which results in the approximation between the aryepiglottal folds and the epiglottis on the one hand, and the epiglottis and rear pharyngeal wall on the other, to create an approximation which generates an airflow similar to that of fricatives, but which does not reach the same turbulence threshold (pp. 1–2). Acoustically, he describes the tight approximant as “the impression that a high degree of constriction is present in the articulatory mechanism, higher than is normally associated with strictures of open approximation” (p. 9). His findings across positions are summarized in Figure (2.19). The least frequent realization of [ʕ] is the stop.



(2.19) Percentages of Realization Types from a Sample of 436 Tokens of 'ayn (reproduced from Heselwood, 2007, p. 25).

We can conclude from this figure that the realization of [ʃ] is divided into two main types: stop and approximant. The stop realization occurs only about 2–3% of the time. Heselwood further divides the approximant realization into three types: strong tight approximant (the nearest to a fricative), weak tight approximant, and loose approximant (with the widest approximation). As the width of the approximation increases, the frequency of [ʃ] realization increases concomitantly, with the loose approximant having the highest frequency. His study examined four different positions of [ʃ] in the prosodic word: word-initial, word-final, intervocalic singleton, and intervocalic geminate, as shown in Figure (2.20).



(2.20) Percentages of Phonotactic Distribution of Realization Types in the Sample of 436 Tokens of 'ayn (reproduced from Heselwood, 2007, p. 26).

Although the realization of [ʃ] as a stop is quite infrequent overall, the highest relative frequency of this realization is in the final position of the prosodic word, followed by the intervocalic geminate, and it is least frequent as the intervocalic singleton and absent in initial position. The most frequent realization of the strong tight approximant is word-initially, followed by the intervocalic geminate. The least frequent occurrence of the strong tight approximant is the intervocalic singleton, followed by final position, where it exceeds 30%. The weak tight approximant realization is moderate in all positions except final position, which has a higher frequency. The loose realization of the approximant exhibits its lowest frequency in initial position, followed by its occurrence as an intervocalic geminate, where it is more than twice as frequent. This realization exhibits its highest frequency as an intervocalic singleton followed by its occurrence in final position.

The intervocalic singleton and word-final positions exhibit a clear, gradual bias toward the loose approximant, with the word-final position being more moderate in this pattern than the intervocalic singletons. Both the initial position and the intervocalic geminates exhibit a sharp rise from stop realization to strong tight realization, with the initial position falling sharply toward the loose approximant and a corresponding shallower fall for the intervocalic geminates.

However, although the degree of constriction alone is enough to differentiate between two consonants of the same class of segments, there are additional factors which also play a role in this differentiation. Proctor and Walker (2012), who performed an articulatory MRI study of American English liquids, argue that constriction must be considered in a more detailed way, not just in terms of degree of constriction, but in terms of “particular configurations in carefully defined articulatory regions” (as summarized by Rahilly, 2016, p. 9). These configurations may account for intrinsic feature differences between two consonants which are articulated in the same place. Proctor and Walker state that these intrinsic articulatory differences may exist within the same class of segments, for example between rhotics and laterals, which are represented within the same sonority class of liquids. In the same vein, this chapter proposes that these intrinsic differences, in addition to differences in degree of constriction, exist between /ʕ/ and /ħ/, even though they are both pharyngeal and [+RTR], as described by Bin-Muqbil (2006; see §2.2.2).

One of these inherent differences relates to the phonation type of following vowels. According to McCarthy (1994, p. 195) and Heselwood (2007, p. 6), [ʕ] is often accompanied by creaky voice. The creakiness of [ʕ] is another intrinsic phonetic feature which serves to distinguish it from [ħ].

Another type of support for the intrinsic differences between guttural consonants, such as the pharyngeals, comes from the perception of these consonants. The different degree of constriction between /ʕ/ and /ħ/, as described by McCarthy and Ghazeli, and the difference in voicing may affect their sonority degree in terms of perception. This is especially true when linking McCarthy’s and Ghazeli’s description with Reetz and Jongman’s (2008) primary contributors to perception of sonority, those being degree of constriction in the vocal tract and voicing. Furthermore, McCarthy’s and Heselwood’s descriptions of [ʕ] as being accompanied by creakiness, as mentioned above, may contribute to its perceptual salience, which differentiates it from [ħ]. In addition, the F1 value for /ʕ/ is higher than the F1 value for /ħ/ (McCarthy, 1994, p. 194).

Now we turn to the phonological patterning of /ʕ/ and /ħ/ in Arabic. Farwanah (2016) considers /ʕ/ to have higher sonority than other gutturals and classifies /ʕ/ with the glides in terms of sonority (see §2.2.2). She makes this claim based on the way in which /ʕ/ patterns in the coda clusters of PA. She also makes the claim that other gutturals, including /ħ/, pattern with the nasals in terms of sonority.<sup>40</sup> For example, the word /manʕ/ “prohibition” becomes [ma.niʕ] and the word /samʕ/ “glue” becomes [sa.miʕ]. Epenthesis in these words is due to the effects of the constraint OCP-SONORANT in PA, as will be discussed in more detail in §2.7.

Throughout the Hijazi data, /ħ/ behaves the same as any other voiceless fricatives in coda clusters; for example, compare /naħl/ → [na.ħil] “bee, PL.” with /nasl/ → [na.sil] “lineage” and

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<sup>40</sup> McCarthy (1994) states that the realization of the voiceless [ħ] may be some kind of fricative, approximant, or even a glide, and the realization of [ʕ] may be between a stop and an approximant or fricative. Yet another option for the realization of [ʕ] is as a trill. Ghali (1983, p. 441f.) interpreted Sibawayh’s description of [ʕ] as a frequentative consonant (*taraddudiyyah*) to mean that it was realized as a trill in the eighth century. I assume that Sibawayh may have been describing the [ʕ] as it was pronounced in his time as an epiglottal trill. The epiglottis is an organ susceptible to trilling, unlike the pharynx, which has a tube-like shape. My assumption of epiglottal place of [ʕ] in Sibawayh’s time is diachronically compatible with Ladefoged & Maddieson’s (1996) description of [ʕ] and [ħ] as epiglottal approximants in modern Iraqi Arabic, and this description of ‘*ayn* pronunciation in Iraq by Ladefoged & Maddieson is not necessarily reflective of the ‘*ayn* realization in other Arabic dialects.

/milħ/ → [milħ] “salt” with /fils/ → [fils] “1/100<sup>th</sup> of a *dinar*, smallest unit of currency.” With regard to /ʕ/, it requires vowel epenthesis when it occurs with another sonorant in coda position (e.g., /fiʕl/ → [fi.ʕil] “verb,” /dirʕ/ → [di.riʕ] “shield”) or when it is preceded by an obstruent in a potential coda cluster (e.g., /nabʕ/ → [na.biʕ] “spring [of water]”). Yet, when /ʕ/ is the first segment in the coda and is followed by an obstruent, epenthesis does not occur (e.g., /kaʕk/ → [kaʕk] “pastry”).<sup>41</sup> Thus, in HA it patterns like an approximant, on which basis I argue that /ʕ/ patterns as higher in sonority than liquids.

Consequently, we can conclude due to the intrinsic differences between /ʕ/ and /ħ/, as supported by the evidence throughout this chapter, that there is sufficient reason to separate these two segments in terms of sonority. One relevant difference between the two segments is a disparity in terms of degree of constriction, with /ʕ/ having less constriction than /ħ/—that is, a wider passage in the vocal tract, supporting the idea that it is realized as an approximant segment. This proximity feature finds further support from Heselwood’s (2007) study, which showed that an approximant is the most frequent realization in all positions of the prosodic word. Another difference is the saliency of /ʕ/ compared with /ħ/ due to the creakiness associated with the former. Yet another difference is the higher F1 of /ʕ/. Finally, the segments pattern differently in the coda clusters of HA, with /ħ/ patterning like other voiceless fricatives and /ʕ/ patterning with sonorant consonants.

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<sup>41</sup> There are some speakers of HA who epenthesize a schwa-like vowel in some coda clusters when [ʕ] is followed by an obstruent. This vowel is very difficult to perceive, and I do not consider the epenthesized vowel in ʕ+C clusters to be present at the phonological level; rather, it is a vowel-like gesture affected by the adjacency of the [ʕ] at the phonetic level. Thus, this intrusive vowel is not considered in the analysis of this chapter, because it is not consistent for all speakers and is very difficult to perceive. In addition, according to Card (1983, pp. 140-141), segments after emphatics and laryngeals especially /ʕ/ receive some transitional effects.

With regard to the uvulars /χ ʁ/, most of the studies refer to them as fricative consonants, as mentioned previously by Bin-Muqbil (2006).<sup>42</sup> In addition, according to Frisch et al. (2004, p. 190), “The uvulars {q, χ, ʁ} are assigned both [dorsal] and [pharyngeal] place, to account for the dual patterning of /χ/ and /ʁ/ with the dorsal and guttural sections.” Therefore, both /χ/ and /ʁ/ may pattern with other gutturals in some phonological alternations, as described in McCarthy (1994) and in terms of sonority by having a higher sonority status than the rest of the obstruents in some Arabic dialects, such as Palestinian, as described by Farwaneh (2016); however, this is not the case in most Arabic dialects, including Tunisian Arabic (Ghazeli, 1977, p. 54), in which /χ/ and /ʁ/ pattern as fricatives. In addition, Zawaydeh (1999) states that the /χ/ and /ʁ/ act as fricatives in Amani Jordanian Arabic. Furthermore, as we have already discussed, Bin-Muqbil (2006) argued that /χ/ and /ʁ/ are fricatives with both [guttural] and [continuant] features. This is also the case in Hijazi. In HA, both uvular fricatives act like other obstruents, with the difference that [ʁ] is voiced and hence patterns with the other voiced fricatives, having a higher sonority level than other obstruents; for example, compare /ruχs<sup>s</sup>/ → [r<sup>s</sup>uχs<sup>s</sup>] “cheapness” with /buks/ → [buks] “punch, blow” and /wækd/ → [wækd] “scoundrel” with /ħizb/ → [ħizb] “political party” but also /ladʁ/ → [la.diʁ] “snakebite, sting” and /χabz/ → [χa.biz] “baking.” We can see from the examples above that when /χ/ and /ʁ/ are followed by other obstruents, epenthesis does not occur; however, when the voiced fricative /ʁ/ is preceded by any other obstruent other than voiced fricatives, epenthesis occurs to break up the potential rising sonority coda cluster.

With regard to the laryngeals /ʔ fi/, McCarthy (1994) states that during the production of /fi/ the resonances of the vocalic context are weakly excited, creating a fricative-like noise, voiced intervocalically (p. 193). He also states that /ʔ/ is sometimes realized as a stop and other

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<sup>42</sup> McCarthy (1994) states that [χ] is realized as a fricative or approximant and [ʁ] is realized as a uvular trill. The exact realization of these segments is obviously specific to the language or dialect.

times as creaky voice. However, as we proposed at the beginning of this section, drawing on Bin-Muqbil's (2006) feature representation of guttural consonants in Figure (2.18), both /fi/ and /ʔ/ act as obstruent consonants. Regarding /fi/, first, from the articulatory perspective, there is a partial closure, which creates frication with vocal fold vibration and air turbulence, supporting the idea that it is a voiced fricative. Second, /fi/ behaves as a voiced fricative consonant in the coda clusters of HA. Compare the following examples: /nafid/ → [nafid] “chest, breast, bosom” with /rizg / → [rizg] “blessing” in medial position, and /wadʒfi/ → [wadʒifi] “face” with /χabz/ → [χabiz] “baking” in final position. From the above examples, we can conclude that /fi/ has the same sonority degree as other voiced fricatives such as /z/ and /ʁ/, being higher in sonority than other obstruents due to the presence of the features [voice] and [continuant]. This implies that the remaining obstruents occupy the lowest sonority level because they lack the features [voice] and [continuant].

The /ʔ/ does have the articulatory features of a stop; even though this articulation is described by Bin-Muqbil as lacking an oral constriction, it does contain a full closure and sudden release of the vocal folds in the larynx. Regarding the distribution of /ʔ/ in coda clusters, the situation is more complicated than with /fi/. Hijazi Arabic, like many other Arabic dialects, does not have many examples in which this sound occupies the coda position in a cluster. Most of the data including glottal stop as the first or second member of a coda are vocalized or assimilated historically if they are preceded by a vowel or a glide; for example, /raʔs/ → \*[raʔs] → [ra:s] “head” and /ʃajʔ/ → \*[ʃajʔ] → [ʃajj] “thing.” I argue that this diachronic vocalization and compensatory lengthening of the vocoids occurs due to the unmarked status of glottal consonants.

Throughout the literature, the glottal consonants are argued to be the most unmarked segments cross-linguistically, due to their Place (or lack of Place). Lombardi (2002, pp. 222–223) argues that although some studies claim that glottal stop is placeless, glottal consonants (including glottal stop) do have a Place ([pharyngeal]), which is the most unmarked place compared with other places of articulation, and they pattern with other gutturals. Evidence for the comparative unmarkedness of glottal consonants comes from their behavior with regard to transparency, neutralization, and epenthesis.<sup>43</sup> Place neutralization occurs in the Kelantan dialect of Malay, in which labial, coronal, and dorsal obstruents debuccalize to laryngeal place in coda, as shown in (2.21), adapted from Lombardi (2001, p. 18, citing Teoh, 1988).

(2.21) Kelantan Malay (adapted from Lombardi, 2001, p. 18, citing Teoh, 1988)

- |    |         |       |           |    |         |       |             |
|----|---------|-------|-----------|----|---------|-------|-------------|
| a. | /ikat/  | ikaʔ  | “tie”     | c. | /səsak/ | səsaʔ | “crowded”   |
| b. | /dakap/ | dakaʔ | “embrace” | d. | /tapis/ | tapɪh | “to filter” |

Another example of glottal stop as an unmarked consonant is glottal stop insertion in onset position in Arabic; for example, the word /st-ʕmil/ → [staʕ.mil] → [is.taʕ.mil] → [ʔis.taʕ.mil] “use, MASC.3P.SG.PASTPERF.” Therefore, I propose that the diachronic deletion of the glottal stop in Arabic constitutes further evidence of the unmarked patterning of the glottal stop, as unmarked segments tend diachronically to be more susceptible to deletion.

I assume that the reason behind the diachronic compensatory lengthening process is partly due to the minimal word requirement that a lexical word is bimoraic. There are two phonological steps in this process: first, glottal stop deletes in coda position; second,

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<sup>43</sup> For examples of transparency, see §2.2.2. data set (2.8) in this chapter, in which Jibbāli laryngeal consonants act as a weak trigger for vowel lowering and are completely transparent to spreading of vowel features. See also Rose (1996, p. 83, data set 22e–f) for vowel lowering across glottal stop in Thompson Salish (Nlaka'pamuctsin).

compensatory lengthening applies to the preceding glide or vowel. However, there are examples of glottal stop deletion in coda position that do not cause a lengthening in the preceding vowel, because the lexical word, even after the deletion of the glottal stop, is still bimoraic; for example, the word /sama:ʔ/ → [sa.ma:] → [sa.ma] “sky,” and /s<sup>ʕ</sup>aħra:ʔ/ → [s<sup>ʕ</sup>aħ.ra:] → [s<sup>ʕ</sup>aħ.ra] “desert.” The shortening of the vowel in the surface form is due to the general rule in Arabic dialects of shortening the final long vowel (McCarthy, 2005).<sup>44</sup> However, despite the historical vocalization and deletion of the glottal stop, there are a few examples which resisted the vocalization process, with vowel epenthesis occurring to break up the cluster. Consider the following examples:

(2.22) Glottal Stop in Coda Position in HA

- |   |  |
|---|--|
| a. /ʃuʔm/ → *[ʃuʔm] → [ʃu.ʔum] “bad luck, jinx” | c. /naʔʔ/ → [naʔʔ] “young generation”  |
| b. /luʔm/ → *[luʔm] → [lu.ʔum] “vileness”       | d. /but <sup>ʕ</sup> ʔ/ → [but <sup>ʕ</sup> ʔ] ~ [bu.t <sup>ʕ</sup> uʔ] “slowness” <sup>45</sup> |

These few synchronic examples provide evidence for the patterning of glottal stop in coda position adjacent to other consonants. When the glottal stop is followed by an obstruent, epenthesis does not occur, whereas epenthesis occurs when it is followed by a sonorant. This is consistent with typical patterning for obstruents in coda position; an obstruent followed by another obstruent creates a sonority plateau, which HA tolerates, whereas an obstruent followed by a sonorant creates a sonority rise, which must be repaired.

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<sup>44</sup> Abu-Haidar (2011) notes that Christian Baghdadi speakers preserve the final long /-a:/ in open position in feminine forms denoting color or defect, for example *ħamġā* ‘red’ and *amyā* ‘blind’. Jastrow (1978, p.86) makes the same observation for certain Mesopotamian dialects.

<sup>45</sup> I assume, following Lombardi (2002, p. 239, fn. 14), that the optional epenthesis in examples like [but<sup>ʕ</sup>uʔ] is due to the perceptual difficulty of the glottal stop in coda position; therefore, the vowel epenthesis eases perception of the glottal stop. In addition, the vowel epenthesis eases the production of the sequence.

In consideration of this evidence, I argue that the laryngeal consonants /ʔ fi/ in HA pattern with other obstruents in terms of sonority. In the following section, I provide the final sonority scale, incorporating all guttural consonants in their relative sonority levels.

### 2.2.5. Guttural subclasses in the sonority scale

After differentiating between the subclasses of gutturals and between the two pharyngeal consonants both phonetically and phonologically, now I propose the final, exhaustive sonority scale of HA in Figure (2.23), which incorporates all guttural consonants.

#### (2.23) Sonority Hierarchy for Hijazi Arabic (Final)

<i>Natural class</i>	<i>Sonority index</i>
Vowels	7
Glides	6
Voiced pharyngeal /ʕ/	5
Liquids	4
Nasals	3
Voiced fricatives, including /z, z <sup>h</sup> , ʁ, fi/	2
Other obstruents, including /ʔ, h, χ, dʒ/	1

This final scale distributes the gutturals into three levels, primarily based on their distinctive features, in such a way that all gutturals other than /ʕ/, /ʁ/ and /fi/ pattern as obstruents, with the features [-vocalic, -approximant, -sonorant]. With regard to /ʁ/ and /fi/, they pattern as higher in sonority purely by virtue of being voiced fricatives, similar to /z/ and /z<sup>h</sup>/. This adds a further two distinctive features to the list, [continuant] and [voice], with voiced fricatives then being [-vocalic, -approximant, -sonorant, +continuant, +voice]. This also leaves /ʕ/ as a member of its own sonority class, higher than the other approximants and lower than the glides. The justification behind placing /ʕ/ in this position in the scale and not among glides is due to its phonetic nature, and the way in which it behaves phonologically in the coda clusters of HA, as discussed in the previous section. The phonological behavior of /ʕ/ is different from that of a

glide in coda clusters, in which, when a glide is the second member of a potential coda cluster, it vocalizes, and when the glide is the first consonant in such a cluster, it coalesces with the preceding vowel; for example, the word /farw/ → [fa.r<sup>s</sup>u] “fur” and the word /bajt/ → [be:t] “house.”<sup>46</sup> These vocalization and coalescence processes are not seen with /ʕ/ in coda clusters. In phonological alternations ‘*ayn* acts as a true consonant which is different from other sonorants. When /ʕ/ is first in a coda cluster followed by another non-glide sonorant, vowel epenthesis occurs to prevent this cluster from surfacing even though it would exhibit a falling-sonority coda cluster. For example, /ʃiʕr/ “poetry” becomes [ʃiʕir]. /ʕ/ is proposed to have the features [-vocoid, +approximant, +sonorant, +continuant, +voice].<sup>47</sup>

Having finalized the sonority scale of Hijazi, considering the sonority profile of the gutturals within the scale, now we turn to discuss the quality of the sonority-driven epenthetic vowel in HA.

### 2.3. Vowel quality in sonority-driven epenthesis

In HA, when a rising sonority cluster occurs, a phonological repair by vowel epenthesis is the result. The quality of this vowel is highly dependent on the stem vowel, but sometimes the quality of this epenthetic vowel is affected by the quality of the coda consonants.

Abu-Mansour (1991, p. 139) argues that the epenthetic vowel is copied from the previous syllable, though she does note that this is not the case in all examples. She argues that epenthesis

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<sup>46</sup> The process of glide-final vocalization and glide-initial coalescence in coda clusters is common in most Arabic dialects. However, the coalescence does not occur in some Arabic dialects, such as Lebanese, in which /bajt/ → [bajt].

<sup>47</sup> One might argue that /ʕ/ acoustically is realized as a vowel and it is hard to distinguish /ʕ/ when it is surrounded by vowels especially /a/. I would say this is perceptually true for L2 speakers, however with regard to L1 speakers /ʕ/, is never perceived or realized as a vowel. In addition, others might argue /ʕ/ could be realized in some word- or syllable-positions as a glottal stop. I argue that this process of glottalization of /ʕ/ never happens in HA, even though it could happen in other dialects such as Iraqi Arabic.

is avoided when it collapses paradigms, for example, /ʔasr/ “capture” does not receive epenthesis, because it would result in a form identical to the verb [ʔa.sar] “to capture.” She argues that the rule she creates to deal with this epenthesis phenomenon, with all the nuances mentioned here, must apply at a different point in the derivation than other epenthesis rules she discusses.

Abu-Mansour’s (1991) account of epenthesis in HA is problematic for a number of reasons. First, the epenthetic vowel is not always identical to the initial vowel of the stem; Abu-Mansour (1991, p. 150) in fact provides an example where this is the case: /ʔakl/ surfaces as [ʔa.kil] “food,” one of many such examples attested in HA. Another problem is that /ʔasr/ “capture” does, in fact, undergo epenthesis in HA, as [ʔa.sir], and results in a form different from the verb stem [ʔa.sar] “to capture.” Finally, stems ending in two consonants of equal sonority do not undergo epenthesis, though this may be simply an overgeneralization of her rule, as Abu-Mansour (1991) does not provide any examples of level-sonority coda clusters, with or without epenthesis.

Kabrah (2004) elaborates on the factors which determine the quality of the epenthetic vowel used to break up coda clusters in MA monosyllabic CVCC words. According to Kabrah, in potential coda clusters with a rising sonority profile, the quality of the epenthetic vowel is related to the stem vowel. If the lexical vowel of the stem is high, the epenthetic vowel is high and copies the quality of the stem vowel; for example, /gism/ → [gi.sim] “department,” /rukɲ/ → [r<sup>h</sup>u.kun] “corner.” If the stem vowel is the low vowel /a/, variation can be found in the quality of the epenthetic vowel, depending on the process of consonant-to-vowel harmony. If the last consonant is /l, n/, the epenthetic vowel is [i], for example /baɲl/ → [ba.yil] “mule” and /laʃn/ → [la.ʃin] “cursing.” If the second consonant is a pharyngeal (guttural) and not followed by a

coronal sonorant or by [r<sup>s</sup>], then the epenthetic vowel is [a], as seen in the example /laħm/ → [la.ħam] “meat.” In addition, /r/ plays a role in the type of epenthetic vowel. If the third radical is non-emphatic [r] and it is preceded by a nonpharyngeal consonant, then the epenthetic vowel is [i], as in [ya.dir] “deception” and [ʕa.s<sup>s</sup>ir] “squeezing.” If [r<sup>s</sup>] is preceded by a pharyngeal (i.e., guttural) consonant, the epenthetic vowel is [a], as in [ba.ħar<sup>s</sup>] “sea, ocean” and [s<sup>s</sup>a.ħar<sup>s</sup>] “rock,” as a consequence of pharyngeal spreading. If the /r/ is emphatic and preceded by a plain consonant, the epenthetic vowel is [u], as in [s<sup>s</sup>a.dur<sup>s</sup>] “chest, breast” and [ʔa.mur<sup>s</sup>] “command,” as a consequence of emphasis spreading from the emphatic consonant to the epenthetic vowel (Kabrah, 2004, pp. 160–180, §§3.3.4.1–3.3.4.6).<sup>48</sup> In addition, Ingham (1971, p. 282) lists several examples of stems in which *ghen* ġ [ʁ] is the third radical that undergo [u]-epenthesis, as in [s<sup>s</sup>a.buʁ] “dye” and [da.buʁ] “tanning.” Ingham does not list underlying forms, however.

On the basis of the data to be presented in Chapter 5, I accept Kabrah’s (2004) analysis insofar as the quality of the epenthetic vowel is determined by a preceding high vowel /i, u/; for example, /bizr/ → [bi.zir] “seed,” and /ħukm/ → [ħu.kum] “verdict, ruling.” In these examples, the epenthetic vowels are copied from the stem vowels. Also, in words with a low stem vowel in which the third consonant is a nonemphatic coronal, the epenthetic vowel is [i]; for example, /ʕazl/ → [ʕa.zil] “separating.” According to Kabrah, when the stem vowel is low, the second consonant is pharyngeal, and the final consonant is not a coronal sonorant (recall [la.ħam] “meat”), then the epenthetic vowel is generally [a], due to pharyngeal consonant-to-vowel harmony. However, I argue that this is not in fact the typical case; rather, forms such as /laħm/

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<sup>48</sup> Despite Kabrah’s valuable discussion of the role of harmony in sonority-driven epenthesis in MA/HA, there are some inconsistencies and inaccuracies in her description of epenthesis in stems with low vowels. This includes references to her data points, the use of OT constraints, and differing representations of the underlying form of the rhotic as being emphatic or nonemphatic (cf. Kabrah, 2004, pp. 207–209). The summary presented here is my best attempt to represent her point of view related to this matter.

→ [la.ħim] “meat” and /faħm/ → [fa.ħim] “fat” are more common, reflecting the default epenthetic vowel in rising sonority clusters, which is [i]. I consider the [a]-epenthesis variants in the examples given by Kabrah to be incomplete pharyngeal-to-vowel harmony, in which [a] is epenthesized after a pharyngeal consonant and not followed by a segment with the same feature. In the data I have collected, pharyngeal consonant-to-vowel harmony occurs as agreement in the feature [pharyngeal] between the low epenthetic vowel [a] and surrounding consonants. There are examples in which the second consonant is pharyngeal /ħ/ or glottal /ʕ/ and the third consonant is nonemphatic /r/. In these cluster types, the epenthetic vowel is the low [a]; for example, /baħr/ → [ba.ħar<sup>s</sup>] “sea, ocean,” /naħr/ → [na.ħar<sup>s</sup>] “river,” and /faħr/ → [fa.ħar<sup>s</sup>] “hair.” I assume that the environment for the insertion of the low vowel when it is followed by /r/ occurs only after pharyngeal and laryngeal consonants, while /r/ emphaticizes to agree with the preceding low vowel in the feature [pharyngeal], as will be analyzed in Chapter 5. This is in contrast to Kabrah’s claim that the low vowel is inserted before the emphatic /r<sup>s</sup>/ and after any dorsal (i.e., guttural) consonant; for example, the epenthetic vowel after the dorsal /χ/ is [i]: /s<sup>s</sup>aχr/ → [s<sup>s</sup>a.χir], “rock,” with the high vowel, rather than \*[s<sup>s</sup>a.χar<sup>s</sup>], as Kabrah claims.

Kabrah also lists some words with a low stem vowel and potential rising sonority coda clusters in which the third radical is emphatic [r<sup>s</sup>]. According to her, these words undergo [u]-epenthesis due to the emphasis spreading from the emphatic [r<sup>s</sup>] to the epenthetic vowel; for example, /s<sup>s</sup>adr/ → [s<sup>s</sup>adr<sup>s</sup>] → [s<sup>s</sup>a.dur<sup>s</sup>] “chest, breast” and /badr/ → [badr<sup>s</sup>] → [ba.dur<sup>s</sup>] “full moon / Proper Name.” I propose that there is lexical restructuring of the rhotic in HA, such that the rhotic is underlyingly emphatic for the older generation of HA speakers (atypical) and underlyingly plain for the younger generation (typical). Each phoneme imposes a requirement on the quality of the preceding epenthetic vowel. For example, I maintain that both [ba.dir] and

[ba.dur<sup>s</sup>] have the same meaning (“full moon / Proper Name”). In fact, most HA speakers do not emphaticize the /r/, so in this case the epenthetic vowel is most often [i]. In addition, in a stem with a low vowel in which the third radical is *ghen* ġ /ʁ/ and the second radical is the labial /b/, [u] is epenthesized in a potential rising sonority coda cluster by some speakers, for example [s<sup>s</sup>a.buʁ] “dye” and [da.buʁ] “tanning.”<sup>49</sup>

To summarize, the epenthetic vowel in potential rising-sonority coda clusters in HA is a high vowel if the stem contains a high vowel, by the process of high vowel spreading. When the stem vowel is low, consonant-to-vowel harmony often plays a role in determining the quality of the epenthetic vowel. If the epenthetic vowel is preceded by a pharyngeal or laryngeal consonant and followed by [r<sup>s</sup>], then it is [a]. When the final consonant in the cluster is a nonemphatic coronal, the epenthetic vowel is [i]. When the final consonant of the cluster is [r<sup>s</sup>] (atypical), then the epenthetic vowel is [u]. If none of the preceding conditions applies, the default epenthetic vowel is [i]. The detailed OT analysis of the quality of the vowel in sonority-driven epenthesis will be presented in Chapter 5. Next, I provide a brief typological survey of sonority in Arabic dialects.

## 2.4. The role of sonority in Arabic dialects

Many of the typological properties noted in the preceding sections can be seen in the syllable structure of many Arabic dialects. Although a lot of Arabic dialects disallow onset

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<sup>49</sup> There are two observed pronunciations in HA for each of the above examples: one is with the common epenthetic [i] and the other is with the uncommon epenthetic [u]. I assume, following Padgett (2011, p. 3), that “labialized consonants can cause a neighboring vowel to be round.” Therefore, the uncommon [u]-Epenthesis in these two examples by some speakers of HA may be affected by the medial labial consonant, not through harmony between [ʁ] and the preceding epenthetic vowel. This will be elaborated with more detail in Chapter 5.

clusters, almost all of them allow coda clusters, with few exceptions. These coda clusters can vary in their degree of adherence to sonority restrictions.

Abu-Salim (1982) briefly discusses the role of sonority in coda clusters in PA, finding that epenthesis is mandatory to break potential rising- and level-sonority coda clusters—for example, /tamr/ → [ta.mir] “dates,” and /ʕabd/ → [ʕa.bid] “slave.” He also describes coda clusters of falling sonority, which may require epenthesis (/ʕilm/ → [ʕi.lim] “knowledge”), have optional epenthesis (/dars/ → [dars] ~ [da.ris] “lesson”), or have no epenthesis (/ʔuχt/ → [ʔuχt] “sister”). According to Abu-Salim’s description, sonority does play a role in coda cluster epenthesis in PA, but the exact nature of that role is not clear. Farwaneh (2016) addresses the gap left by Abu-Salim by indicating the role of the OCP (§2.7) and markedness beside sonority to explain the coda types of PA. She argues that markedness constraints, which are a part of syllabic well-formedness, rule out any ill-formed coda cluster type, including Voiceless+Voiced (e.g., \*[rakd<sup>s</sup>] ~ [ra.kid<sup>s</sup>] “running”), Stop+Fricative (e.g., \*[kitf] ~ [ki.tif] “shoulder”), Coronal+Non-Coronal (e.g., \*[nadb] ~ [na.dib] “mourning”), and Non-Coronal+Non-Coronal (e.g., \*[ħabk] ~ [ħa.bik] “weaving”). In addition, she provides several examples where a coda cluster contains two obstruents in which epenthesis is optional, even though these obstruents are well-formed according to the markedness constraints. For example, /mazd/ → [mazd] ~ [mazid] “glory”, /darast/ → [darast] ~ [darasit] “I studied”, /ʕabd/ → [ʕabd] ~ [ʕabid] “slave”, and /naħt/ → [naħt] ~ [naħit] “sculpture.” Thus Abu-Salim’s study was the first step in accounting for the role of sonority in PA, but Farwaneh provides a full account of the principles that regulate the coda clusters of PA. Figure (2.24) is the sonority scale for PA as can be concluded from Farwaneh (2016):

## (2.24) Sonority Scale of PA (Farwaneh 2016)

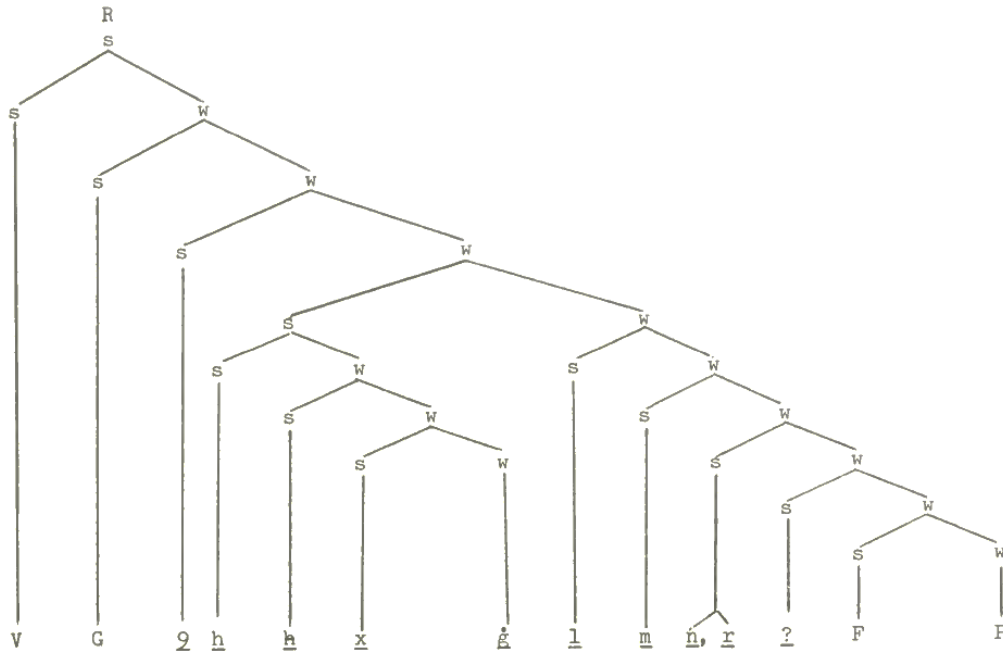
Vowels > Glides (including /ʕ/) > Liquids > Nasals (and other gutturals) > Obstruents

Farwaneh (2016) adheres to the basic sonority scale given by Clements (1990), in which he divided the sonority scale according to the natural classes of the segments. Therefore, one can notice that she split the class of gutturals among already existing levels of the scale by having /ʕ/ grouped with glides and the other gutturals grouped with nasals in terms of sonority.<sup>50</sup>

Haddad (1984a) describes the role of sonority in coda cluster epenthesis in LA. He found that falling sonority coda clusters surface faithfully with no epenthetic vowel, for example, /bint/ → [bint] “girl,” but clusters of rising sonority must be repaired by epenthesis, for example, /ʔism/ → [ʔi.sVm] “name.” According to Haddad, clusters of level sonority may or may not get an epenthetic vowel. This depends on the sonority level and place of articulation of the coda consonants. Figure (2.25) is the sonority scale of LA as presented by Haddad (1984a).

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<sup>50</sup> The scale given in Figure (2.24) is not presented in Farwaneh (2016). Rather, it is my conclusion based on what is described in Farwaneh (2016) about the sonority of PA segments.



(2.25) Rhyme Tree of LA as presented by Haddad (1984a, p. 84)

As mentioned in section 2.2.2, the sonority tree of LA proposed by Haddad is unusual because he deconstructs the natural classes of liquids, nasals, and gutturals in terms of sonority. In his tree, /m/ is higher in sonority than both /r/ and /n/, which pattern together. /l/ does not pattern with /r/ but instead is higher in sonority than /m/. In addition, he places the guttural consonants in three different positions by having 'aʔn in the highest position of sonorants, following the glides, which in turn are higher than gutturals, except for glottal stop, which is between /r/, /n/ and fricatives. Finally, there is the unusual division among the class of obstruents by placing fricatives, regardless of [voice] feature specification, above the rest of plosives, which are the

lowest segments in the tree.<sup>51 52</sup>

Al-Tamimi and Al-Shboul (2013) claim that relative sonority does not play a role in determining which two consonants can occur together in a coda in MSA, and Abu-Mansour (1987, p. 125) and Ragheb and Davis (2014) claim the same for Cairene Arabic. For example, underlying /ʔatl/ in Cairene Arabic, with a rising-sonority coda, surfaces faithfully as [ʔatl] “killing.”

Bamakhramah (2009, pp. 146-147) states that coda clusters are disallowed in Hadhrami Arabic. This is because the dialect does not allow CVCC syllables to surface faithfully, except for geminates. Therefore, epenthesis occurs to break up the potential coda cluster, regardless of its sonority. The same can be said for Muslim Baghdadi Arabic, which does not permit CVCC to surface faithfully, except for geminates (see Abu-Haidar 2011 for discussion). This stands in contrast to Jastrow’s (1978, p. 89) observations about Jewish Baghdadi Arabic, which allows coda clusters. Jastrow provides examples of falling and level sonority clusters, but doesn’t specify the exact role of sonority in these clusters. Next, I turn to the role of sonority in HA as discussed in the literature.

Abu-Mansour (1991, p. 139) notes an epenthesis phenomenon in MA/HA, which causes some coda cluster types that would occur to be unattested on the surface.<sup>53</sup> She offers an analysis of epenthesis in CVCC stems in HA as part of her analysis of three different types of epenthesis. “Prepausal epenthesis,” according to her, occurs when the last two consonants of a CVC<sub>1</sub>C<sub>2</sub> stem

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<sup>51</sup> This study of the role of sonority in LA by Haddad in 1984 is the first thorough study of its kind, although there are several factors that he does not explicitly touch upon, such as the role of the OCP in the coda cluster and the relative place and manner markedness of constituent segments.

<sup>52</sup> Recall that this study follows the consonant and vowel inventory that is presented in Chapter 1, §1.2 to transcribe the data from HA. With regard to data reported from other sources, segments will be transcribed as they are in the original source. For example, Haddad’s /ħ ħ 9 x ġ/ correspond to /ħ ħ ʕ χ ʁ/ in HA.

<sup>53</sup> Abdoh (2010, p. 87) also briefly describes the same phenomenon in HA when dealing with child language acquisition.

“violate the sonority hierarchy,” or, more specifically, when C<sub>2</sub> is of greater or equal sonority to C<sub>1</sub> on the sonority scale (p. 144).

Bamakhramah (2009) briefly mentions that sonority plays a role in coda clusters in MA in which falling- and level-sonority clusters are tolerated but rising-sonority clusters are not. He does not discuss the relative sonority levels of different consonants.

Having illustrated the role of sonority in a variety of Arabic dialects by way of introduction, the next section will discuss the SSP.

## **2.5. The Sonority Sequencing Principle**

Sonority plays a crucial role in the sequencing of segments within the syllable (Clements, 1990; Parker, 2011; Selkirk, 1984; Zec, 1995, 2007). Segments of higher sonority within the syllable tend to occupy the nucleus, while segments of lower sonority tend toward the margins. Most languages place a minimum sonority requirement on the nucleus, with only segments above a certain sonority threshold allowed to occupy the nucleus. Zec (1995) attempts to delineate this threshold in terms of the binary values of the major class features, such as [-cons] [+son] (vowels), [+cons] [+son] (sonorants), and [+cons] [-son] (obstruents).

Selkirk (1984) does not necessarily share this view, instead regarding the sonority of segments as a grammatical primitive, not derived from other parts of the grammar. She notes the importance of the Sonority Sequencing Generalization (SSG) as a condition filtering the possible sequences of segments of the syllable. She defines the SSG as the stipulation that “[i]n any syllable, there is a segment constituting a sonority peak that is preceded and/or followed by a sequence of segments with progressively decreasing sonority values” (p. 116). She proposes three important characterizations of a theory of syllable phonotactics. The first is the

“characterization of possible syllable structures,”—that is, the possible syllable templates permitted in a given language. For example, in HA, the maximal syllable is one with a single onset and three slots in the rhyme—that is, CVVC or CVCC.<sup>54</sup> The second characterization is that of “possible (or impossible) sequences on the melody tier;” this characterization is regulated by the SSG, which places certain minimum sonority requirements on particular positions within the syllable, with these varying by language. Selkirk recognizes two parts of the syllable, onset and rhyme, with a maximum of two positions in the onset and a maximum of three positions in the rhyme. However, she does not divide the rhyme into nucleus and coda, instead differentiating between them according to the sonority indices associated with them in a given language.

The third characterization of Selkirk (1984) is the range of “possible associations between the two,” requiring another type of condition, this being that certain segments cannot be associated with certain positions in the syllable. I illustrate one possible example of this, that being the coda condition in Arabic, as mentioned by McCarthy (1994). This refers to the tendency of the gutturals to avoid occupying the coda position in certain dialects; when a guttural appears in coda position, it triggers vowel epenthesis, forcing the segment to resyllabify as the onset of the syllable containing the epenthetic vowel. For example, in Bedouin Hijazi Arabic, /naχla/ → [na.χa.la] → [ˈnχa.la] “plum tree.”

Parker (2002, p. 8) synthesizes the definition of the SSP based on Selkirk (1984), and also Hooper (1976), Harris (1983), Clements (1990), Blevins (1995), and others, as presented in (2.26).

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<sup>54</sup> Yet another syllable type exists which is controversial in Hijazi and other Arabic dialects as being part of the syllabic structure, namely CVVG, where G represents a geminate. This syllable type consists of four timing slots in the rhyme.

(2.26) Sonority Sequencing Principle (Parker, 2002)

- 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.

The SSP, as defined by Clements (1990), requires that the ideal syllable should exhibit a maximal sonority rise from the onset to the nucleus and a minimal drop in sonority from the nucleus to the coda, in what he calls the “Dispersion Principle.” This principle is based on the concept of the demisyllable, which divides the syllable into two asymmetrical parts: onset and nucleus on the one hand and nucleus and coda (i.e., rhyme) on the other. The onset and nucleus should exhibit a maximal rise in sonority relative to one another, whereas the nucleus and coda should exhibit a minimal fall in sonority, such that the ideal syllable is an open syllable, ending in a vowel. In addition, if there is more than one segment in the onset, these segments should be organized in such a way as to exhibit an equal distance from one another in sonority; for example, an OLV<sup>55</sup> sequence is the ideal initial demisyllable (Parker, 2011; Clements, 1990).

Morelli (1999), following Clements (1990), divides consonant clusters into three categories: core clusters, which exhibit rising sonority toward the nucleus; sonority reversals, which exhibit falling sonority toward the nucleus; and sonority plateaus, which exhibit level sonority. Figure (2.27) shows the cluster types proposed by Morelli.

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<sup>55</sup> O refers here to obstruents, L to liquids, and V to vowels.

(a) Onsets	Second Segment			
First Segment	Obstruent	Nasal	Liquid	Glide
Obstruent	OO [pt]	ON [pn]	OL [pl]	OG [pj]
Nasal	NO [np]	NN [mn]	NL [ml]	NG [nj]
Liquid	LO [lp]	LN [lm]	LL [lr]	LG [lj]
Glide	GO [jp]	GN [jn]	GL [jl]	GG [jw]
(b) Codas	Second Segment			
First Segment	Glide	Liquid	Nasal	Obstruent
Glide	GG [jw]	GL [jl]	GN [jn]	GO [jp]
Liquid	LG [lj]	LL [lr]	LN [lm]	LO [lp]
Nasal	NG [nj]	NL [ml]	NN [mn]	NO [np]
Obstruent	OG [pj]	OL [pl]	ON [pn]	OO [pt]

(2.27) Categories of Clusters based on Sonority (adapted from Morelli, 1999, p. 20).

Part (a) displays the onset clusters, and (b) displays the coda clusters. The diagonal represents the plateau clusters (shaded). Cells above and to the right of the diagonal.

Clements (1990) proposes the SSP as a single, positively stated violable constraint, which is rankable in specific languages. Morelli (1999, p. 22) provides an OT-compatible definition of the SSP: “Sonority increases towards the syllable peak and decreases towards the syllable margins.” Following Clements’s (1990) framework, core clusters satisfy the SSP constraint proposed by Morelli, whereas both sonority reversals and sonority plateaus violate this constraint. When the SSP is violated, either in an onset cluster or a coda cluster, five universal repair options are logically possible. The first is vowel epenthesis, for example in HA /ʔism/ → [ʔi.sim] “name.” The second repair strategy is assimilation, for example in HA, consonants may assimilate in coda clusters, as in /ʕadʒz/ → [ʕaʒz] “disability,” in which the first consonant of the coda cluster

assimilates to the manner of the second (see also Farwaneh, 2016, p. 128). The third repair strategy is consonant deletion, or *stray erasure*, in which one of the consonants in an onset or coda cluster deletes in order to avoid violating the SSP. In Arabic, examples of this repair strategy may only be available at an early stage in child language development. For example, in children acquiring HA, the word /kalb/ “dog” may become [kab] (Abdoh, 2010, p. 176).<sup>56</sup> The fourth option is metathesis, which is not a common repair strategy for SSP violations. One example given by Parker (2011) is diachronic metathesis in coda clusters in Persian. In the change from Old Persian to Modern Persian, metathesis occurred after an apocope process created coda clusters with rising sonority; for example,  $\widehat{t}\widehat{f}\widehat{a}xra > [t\widehat{f}\widehat{a}xr] > [t\widehat{f}\widehat{a}rx]$  “wheel.” The fifth option is to create a syllabic consonant; when two consonants are adjacent and the second is a sonorant, the sonorant may be syllabified as the nucleus of its own syllable, as seen in English [ba.rɪ] “bottle.” As represented here, when SSP violation occurs in either syllable margin, several repair strategies are possible; however, the use (or nonuse) of these strategies differs from language to language.<sup>57</sup>

Kabrah (2004) incorporates the SSP into her OT analysis of sonority-driven epenthesis in the coda clusters of MA. She states that level sonority is allowed in coda clusters in MA, and that MA generally restricts the occurrence of glides, glottal stops, or pharyngeal consonants in the coda of monosyllabic CVCC words.<sup>58</sup>

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<sup>56</sup> Other cluster simplifications by deletion occur in some dialects such as the Shukriiya dialect spoken in Sudan, in which CVCC surfaces as CVC if the final consonant cannot be resyllabified as an onset for the following syllable (Ali, 2014, pp. 161–166). Consider these examples: [sa.'ʕe:-t] “I/you looked after” vs. [ri.'kib] “I/you rode,” but nonoccurring \*[ri.'kib-t]. The motivation for consonant deletion in Shukriiya is not the SSP but rather the syllable structure of this dialect, which does not tolerate the CVCC syllable.

<sup>57</sup> Some languages do exhibit SSP violation and tolerate reversals and plateaus in margins, whereas others analyze these segments which exhibit rising or plateau sonority as an appendix or a degenerate syllable.

<sup>58</sup> It appears to me that this is not always the case. A historical glottal stop in the coda of a CVCC syllable is typically vocalized synchronically. However, there are some examples in which it does not vocalize in the first position of the coda cluster, e.g., /ʃuʔm, luʔm/ → [ʃu.ʔum, lu.ʔum], or the second position, e.g., /butʕʔ/ → [butʕʔ] or [bu.tʕuʔ]--these are resolved by epenthesis. See §2.2.4 for more detail.

Farwaneh (2016) argues that the SSP plays an important role in determining coda cluster types in PA by ruling out potential rising coda clusters; however, it is not sufficient to predict all types of permitted coda clusters on its own. She argues for a conspiracy of three constraints, including the SSP, the OCP, and markedness to predict the coda cluster types of PA.

We can conclude from all the above that there is a strong relationship between syllable structure and the sonority of segments. Segments with higher sonority, such as vowels, more readily occupy the nucleus, with some cross-linguistic variation allowing sonorants to occupy the nucleus, as in English, or any segment to occupy the nucleus depending on its contextual relationship with other segments, as in Tashlhiyt Berber (Goldsmith, 1995, p. 176). Segments with a low sonority profile tend to occupy the syllable edges; the SSP, as illustrated above, requires the syllable to have a sharp rise towards the nucleus and little to no fall from the nucleus towards the coda. This means that there is an asymmetric relationship between the two syllable edges, with a singleton onset showing a preference for lower-sonority segments and a singleton coda showing a preference for higher-sonority segments.<sup>59</sup>

## **2.6. Minimal Sonority Distance**

The necessary sonority of a particular segment depends not only on its position within the syllable, but also on the relative sonority of adjacent sounds; in other words, sonority is crucially “relational” (Zec, 2007). For example, in languages which allow complex syllable margins, there is typically a Minimum Sonority Distance (MSD) between two adjacent segments occurring at either edge of the syllable, with the lower-sonority segment typically occurring at the edge. For example, Spanish requires a MSD of two levels between the first member of an onset and the

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<sup>59</sup> In Hijazi, as in many Arabic dialects, any consonant can occupy the onset, regardless of its sonority profile.

second (obstruent-liquid or nasal-glide).<sup>60</sup> Hence, [pl] and [pr] are acceptable onsets, whereas an Obstruent+Nasal cluster like [pn] is not; however, some languages do exhibit exceptions, such as onset clusters in Russian, which may allow falling sonority (Gouskova, 2001), or coda clusters in Cairene Arabic, which allow any two segments, regardless of their sonority, to appear in a coda cluster (Abu-Mansour, 1987, p. 125, Ragheb & Davis, 2014). In HA, MSD plays a role in determining the coda consonants. The minimal distance between the first consonant in the coda and the following consonant is 0—that is, HA allows a plateau coda cluster if the coda cluster does not lead to an OCP violation (see §2.7) or if the coda cluster does not include [ʕ] with another sonorant consonant. This also implies that it allows falling coda clusters, but it does not tolerate rising coda clusters. For example, the words /ʕabd/ → [ʕabd] “slave” and /bint/ → [bint] “girl”, undergo no repair, but /wazn/ → [wa.zin] “weight” does.<sup>61</sup> Having demonstrated the role of the SSP and MSD in determining the types of coda clusters in HA, I will next turn to discuss another factor which plays a role in the conspiracy that shapes the coda cluster: the Obligatory Contour Principle.

## 2.7. The Obligatory Contour Principle in coda clusters of Hijazi Arabic

One factor that affects the coda cluster in HA is the Obligatory Contour Principle (OCP; Leben, 1973), which necessitates vowel epenthesis in order to separate the offending segments, even if the coda cluster would adhere to the SSP. Throughout the literature, the OCP is discussed as being a constraint upon the occurrence of two adjacent similar tones in tone languages (Leben,

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<sup>60</sup> Zec (1995, 2007) does not distinguish glides as a separate category in terms of sonority, unlike Clements (1990). With regard to Spanish, another alternative analysis for the nasal-glide sequence is common by syllabifying the glide as a part of the nucleus.

<sup>61</sup> Hijazi Arabic, like other Arabic varieties, does not exhibit any restriction on rising sonority across a syllable boundary.

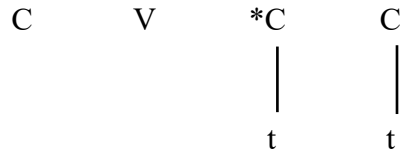
1973). Then the notion is extended to prevent two similar segments or features adjacent to each other (Yip, 1988). Formally, McCarthy (1979, 1981, 1986, p. 208) defines the OCP as in (2.28).

(2.28) The Obligatory Contour Principle (OCP)

At the melodic level, adjacent identical elements are prohibited.

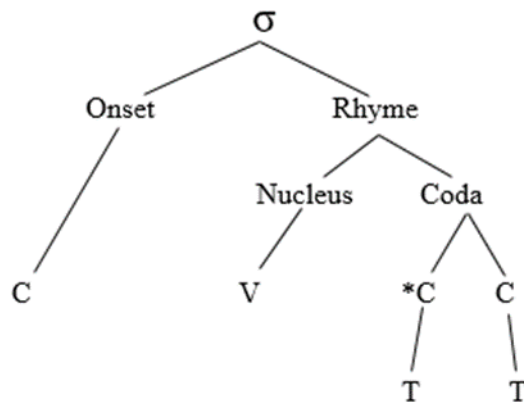
For example, in an underlying CVCC syllable, two similar consonants cannot be adjacent in the coda cluster, as shown in Figure (2.29).

(2.29) OCP Effect on Syllable Rhyme



Farwaneh, following McCarthy (1981, 1988) and Itô and Mester (1986) states that the domain in which the OCP holds could be the root, the morpheme, or a subsyllabic constituent. In this chapter, the domain of the OCP effect is a subconstituent of the rhyme (itself a subconstituent of the syllable), that being the syllable coda.

(2.30) Representation of OCP Effect in the Syllable Coda



McCarthy (1994) observes that Arabic roots containing homorganic consonants are not allowed, with certain qualifications. These consonant types are as follows, reproduced from McCarthy (1994, p. 204), his Figure 4. He states that this co-occurrence restriction is statistical, not categorical.

(2.31) Consonant Cooccurrence Restriction (McCarthy 1994, p. 204)

- a. Labials = {f, b, m}
- b. Coronal sonorants = {l, r, n}
- c. Coronal stops = {t, d, t<sup>ʕ</sup>, d<sup>ʕ</sup>}
- d. Coronal fricatives = {θ, ð, s, z, s<sup>ʕ</sup>, z<sup>ʕ</sup>, ʃ}
- e. Velars = {g, k, q}
- f. Gutturals = {χ, ʁ, ħ, ʕ, h, ʔ}

The root consonant co-occurrence restriction, given by McCarthy (1994), can also be extended to the subsyllabic constituent which is the rhyme, explaining why consonant types from the same group do not occur in coda clusters in Arabic.

Farwaneh (2016) explains the significant role of the OCP in determining the type of coda clusters which cannot be predicted by the mechanism of the SSP. She states that the OCP constraint holds in coda clusters of PA if both consonants in the coda are sonorant; for example, the word /ħilm/ → [ħi.lim] “dream,” even though the SSP predicts that this cluster type is allowed, since it is a liquid followed by a nasal, which is falling in sonority. The second type of OCP in PA applies to the manner of articulation among obstruents. According to her, two stop consonants within the same coda are permitted, for example /sabt/ → [sabt] “Saturday,” although optional epenthesis is possible (→ [sa.bit]). However, OCP-[cont] prevents two fricatives from occurring together within the same coda cluster, for example, /lafz<sup>s</sup>/ → [la.fiz<sup>s</sup>] “pronunciation.” With regard to OCP-[Place], PA allows homorganic clusters of two coronals, labials, or velars; for example, /zanb/ → [zamb] “side,” /ʕind/ → [ʕind] “with,” /bank/ → [baŋk] “bank.” All of the examples that she provides include the underlying /n/, which assimilates to the following consonant in its Place. By her account, this does not violate the OCP, since it is only one Place feature in the coda cluster, which spreads to the adjacent nasal. Similarly, the OCP does not prohibit two adjacent voiced consonants occurring in coda clusters of PA, because a single voicing specification of one consonant spreads the feature [voice] to the adjacent consonant, for example, [nabd<sup>s</sup>] “pulse” and [waʔt] “time.”

Kabrah (2004) elaborates on the role of the OCP effect in the codas of HA. She points out that the OCP plays a role in epenthesis in potential coda clusters in monosyllabic CVCC words. She states that restrictions occur on adjacent segments with similar features. In particular, HA avoids potential coda clusters with multiple nasals and with multiple sonorant coronal segments; for example, epenthesis is used to break up a nasal cluster /mn/ and to break up a sequence of

two coronal sonorants /rn/, but not the cluster /rm/, since /m/ is not coronal and /r/ is not nasal.<sup>62</sup>

Note also that the OCP constraint can hold not only between two homorganic segments, but also between two segments which have similar feature representations or belong to the same class. One example of this is gutturals. As discussed in §2.2, gutturals constitute a natural class, which trigger an OCP effect when they occur adjacent to one another.

McCarthy argues that OCP effects hold between guttural consonants but not between gutturals and emphatics, because gutturals have the features [approximant] and [pharyngeal], whereas emphatics only have [pharyngeal], and hence the feature specification differs.<sup>63</sup> Bin-Muqbil (2006) argues that uvulars are not approximants, as McCarthy claims, but that this is not necessary to explain the disparate OCP effects between emphatics and gutturals, because the emphatics in fact have a secondary [dorsal] specification and not [pharyngeal], and hence are not subject to OCP restrictions adjacent to gutturals. Bin-Muqbil reviews McCarthy's Table 12.1 "roots combining adjacent consonants" (1994, p. 204) and agrees with McCarthy that the two uvular fricatives /χ, ʁ/ cannot occur with pharyngeal and laryngeal consonants, because they all belong to the natural class of gutturals. However, his analysis of this fact differs from that of McCarthy, in that McCarthy proposes that the co-occurrence restriction holds between these consonants because all of them are marked by both the feature [pharyngeal] and the feature [approximant], an analysis which he proposes to explain the patterning of these consonants with emphatics, which in McCarthy's point of view have the feature [pharyngeal] but not the feature [approximant]. As Bin-Muqbil has a different representation for emphatics, he is able to explain

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<sup>62</sup> This also explains, in general, why Arabic does not have clusters of /rl/, /lr/, or /ln/. See McCarthy (1994, p. 204) and Frisch et al. (2004, p. 192) on the restriction of these clusters.

<sup>63</sup> Bin-Muqbil (2006) notes that McCarthy bases his definition of the feature [approximant] on Clement's (1990) interpretation of the definition given in Catford (1977), this being that all non-approximants require oral stricture.

the co-occurrence restriction between the gutturals merely through their common guttural features, without the need for a feature [approximant]. Bin-Muqbil states that:

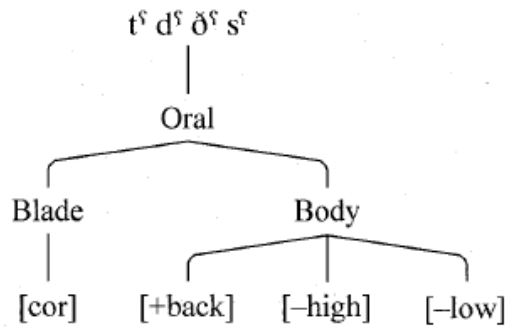
[e]mphatics are argued to include a dorsal component in their representation, but no pharyngeal component. Uvulars are argued to include both dorsal and pharyngeal components. Pharyngeals and laryngeals should include pharyngeal components only. (Bin-Muqbil, 2006, p. 296).

According to Bin-Muqbil, both uvulars and emphatics are secondarily dorsal (i.e., have tongue body features), but are differentiated in that uvulars are primarily guttural, whereas emphatics are primarily coronal (p. 274).

(2.32) Alternative Representation of Emphatics and Gutturals (Bin-Muqbil, 2006, pp. 253–254)

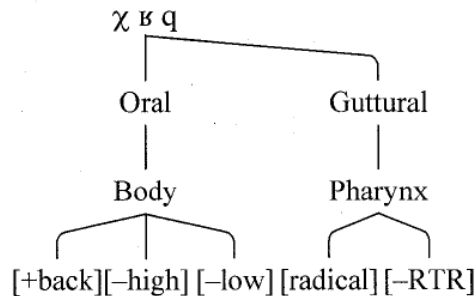
a.

Emphatics



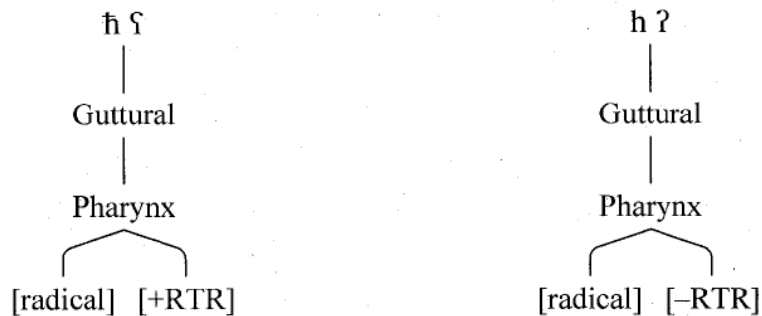
b.

Uvulars



c.

Pharyngeals and Laryngeals



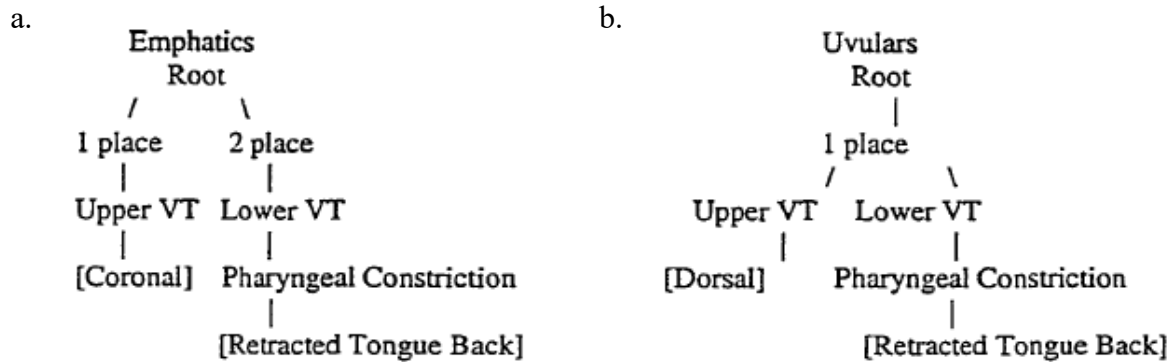
We can conclude from Figure (2.32) that Bin-Muqbil provides a two-dimensional differentiation between the subclasses of gutturals. The first differentiation is in terms of the primary and secondary articulations, with uvulars having a primary pharyngeal articulation and a secondary oral constriction in the dorsum, whereas laryngeals and pharyngeals have only a primary pharyngeal articulation. The second dimension of the differentiation is between pharyngeals and the other two subclasses of gutturals, with pharyngeals having a [+RTR] value and laryngeals and uvulars having a [-RTR] value. For laryngeals, this is because there is no tongue involvement in their production. For the uvulars, his second experiment confirms the finding of McCarthy (1994) and Zawaydeh (1999) that the tongue dorsum is involved in the production of uvulars and emphatics, and not the tongue root (Bin-Muqbil, 2006, p. 259).

Bin-Muqbil uses SPE distinctive feature representations to represent the dorsal feature of the uvulars and emphatics. Furthermore, unlike uvulars, emphatics have two places of articulation within the oral cavity, with coronal being the primary place of articulation and dorsal being the secondary place of articulation, whereas uvulars have a primary guttural-pharyngeal place of articulation and a secondary oral-dorsal place of articulation.

Zawaydeh (1999), in her description of the featural representation of guttural consonants, divides the place features into those of the Upper Vocal Tract (UVT, i.e., oral constriction),

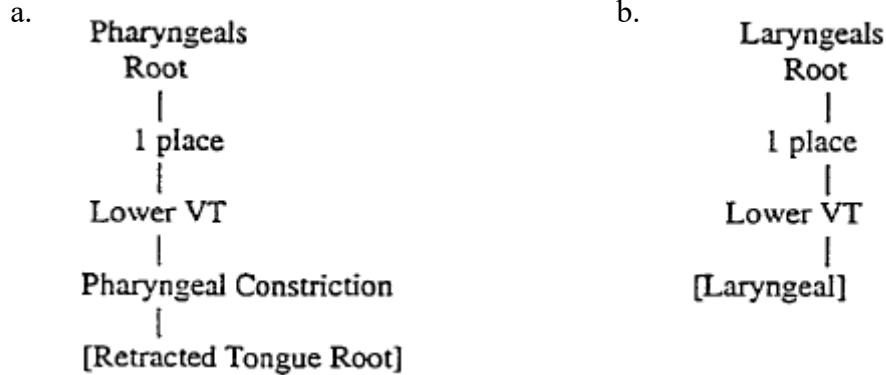
which is associated with the oral place of articulation, and those of the Lower Vocal Tract (LVT, i.e., guttural constriction), which is the place feature of gutturals. In addition, she describes emphatics as having two places of articulation: the primarily coronal place of articulation and a secondary dorsal place of articulation. She represents the uvulars, on the other hand, with a comparatively complex feature tree, in which these segments have only one place of articulation, but this articulation spans both the UVT and the LVT. These two feature geometric representations are depicted in Figure (2.33).

(2.33) Representation of Emphatics and Uvulars (Zawaydeh, 1999, p. 82)



Furthermore, she presents the feature representation of pharyngeals and laryngeals as guttural consonants with one common place of articulation, which is the lower vocal tract, with pharyngeals having more featural structure than laryngeals, as depicted in Figure (2.34).

(2.34) Representation of Pharyngeals and Laryngeals (Zawaydeh, 1999, p. 82)



Both Bin-Muqbil and Zawaydeh agree that emphatics have two places of articulation, in which coronal is the main place of articulation. However, they disagree about the secondary place of articulation. Bin-Muqbil argues it to be the tongue dorsum, and Zawaydeh argues it to be the pharynx, which constricts, with retraction of the tongue dorsum. Furthermore, Bin-Muqbil represents the uvulars as having two places of articulation: a primary guttural place of articulation and a secondary dorsal place of articulation, whereas Zawaydeh represents the uvulars as having one place of articulation divisible between the UVT including the dorsal place and the LVT, which includes the pharyngeal place and the tongue dorsum.<sup>64</sup>

With regard to pharyngeal and laryngeal consonants, Bin-Muqbil describes both types of these consonants as having an articulation in the pharynx, with a [+RTR] feature for pharyngeals and a [-RTR] feature for laryngeals. Zawaydeh, on the other hand, uses a privative [RTR] feature along with a pharyngeal constriction to describe the pharyngeals only, this being distinct from the laryngeal consonants, which lack an [RTR] feature, instead having their own independent [laryngeal] place feature. The difference between Bin-Muqbil and Zawaydeh in their

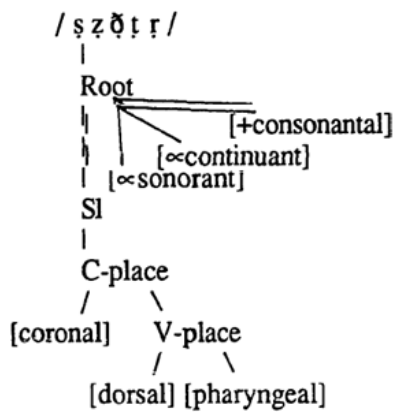
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<sup>64</sup> I assume that the complex feature representation for uvulars proposed by Zawaydeh is because uvular consonants are articulated at the most anterior area of the guttural zone, therefore even though these sounds are dorsal, they are inherently guttural.

representations of pharyngeals and laryngeals is that, in Zawaydeh’s representations, laryngeals are represented as an independent class of gutturals, not sharing any features with the other subclasses other than articulation in the LVT, whereas Bin-Muqbil represents laryngeals as differing from pharyngeals only in their [-RTR] feature and as sharing other features with the other guttural subclasses.

Herzallah (1990) studied the gutturals and emphatic consonants in PA. She argues that emphatics have two places of articulation: a primary place of articulation represented by C-Place, and a secondary place of articulation represented by V-Place, which itself includes [dorsal] and [pharyngeal] places of articulation. Figure (2.35) depicts the feature representation of emphatics as presented by Herzallah (1990, p. 61):

(2.35) Herzallah’s representation of emphatics<sup>65</sup>

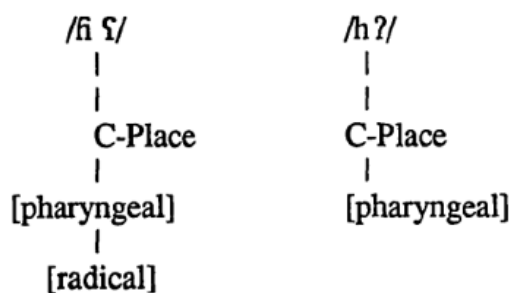


<sup>65</sup> According to Herzallah, C-place indicates primary articulation in consonants and V-place dominates vowel features in vowels and secondary articulation in consonants (Herzallah, 1990, p. 61). The reason that the secondary place of articulation is represented by V-place is, as Padgett (2011, p. 2) indicates, that secondary articulations are of an essentially vocalic or glide-like nature, produced along with a consonant’s primary place of articulation. With regard to Sl, Herzallah did not explicitly mention what this notation indicates. However, throughout her feature representation, this notation is present in feature geometry describing non-guttural consonants. Therefore, I assume that Sl indicates supralaryngeal segments, i.e., segments which are articulated farther to the front in the vocal tract than the larynx. See also Rice (1992, p. 62, Figure 1) for the full representation of the segment structure with its two major components constituency and dependency.

One can note from Herzallah's feature representation that it is somewhat close to the feature representation of emphatics presented by Zawaydeh (1999). However, Herzallah includes /r/ among the emphatic consonants, which is rarely proposed by other authors.<sup>66</sup> In addition, the emphatic feature representation given by Herzallah includes other features such as [continuant] and [sonorant], which are not discussed by other authors. Note also that the articulatory feature representations of emphatics, proposed by Herzallah and Zawaydeh, agree on the primary place of articulation as being coronal and the secondary articulation as being pharyngeal and dorsal. This is with an explicit [dorsal] feature in Herzallah's feature representation and expressed implicitly with a Retracted Tongue Back feature in Zawaydeh's representation. Therefore, the class of emphatic consonants in Arabic is not necessarily limited to the primary four emphatic consonants, /s<sup>ʕ</sup>, d<sup>ʕ</sup>, t<sup>ʕ</sup>, ð<sup>ʕ</sup>/; based on interdialectal variation and phonological environment, it may additionally include /r<sup>ʕ</sup>/ among the emphatic consonants. This point will be further explored in Chapter 5.

Herzallah (1990) also provides the feature representation for laryngeals and pharyngeals, as given here in Figure (2.36).

(2.36) Herzallah's (1990) Feature Representation of Pharyngeals and Laryngeals<sup>67</sup>

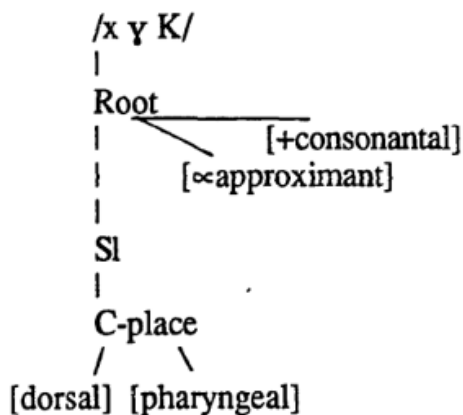


<sup>66</sup> Youssef (2019) explains in detail the rhotic's realization in Arabic dialects. According to him, PA belongs to the Category I Split-R dialect group, in which there are two rhotic phonemes /r/ and /r<sup>ʕ</sup>/. However, his feature representation of the rhotics is different than the one represented by Herzallah (1990).

<sup>67</sup> The symbol /ħ/ used to represent the voiceless pharyngeal fricative in Herzallah's figure is not the one used in standard IPA. Instead, it should be /h/.

The feature representation of pharyngeals and laryngeals given by Herzallah resembles that given by Bin-Muqbil (2006), but with a simpler representation of these two classes, in that Bin-Muqbil has an additional binary  $[\pm RTR]$  feature differentiating the two classes. With regard to the different feature representations of pharyngeals and laryngeals by Zawaydeh and Herzallah, the latter adopts the terminology of McCarthy (1989), treating [pharyngeal] as a feature present in all gutturals, including laryngeals, whereas Zawaydeh differentiates between these two classes using a distinct feature [laryngeal]. Finally, Herzallah provides the feature representation of uvulars (which she calls back velars), as depicted in Figure (2.37):

(2.37) Herzallah's (1990) Feature Representation for Uvulars (Back Velars)



Herzallah's feature representation for /x ɣ q/ is essentially the same as that given by Zawaydeh (1999), with the latter having a slightly more elaborate representation. Both Zawaydeh and Herzallah agree that the primary place of articulation of these consonants is both dorsal and pharyngeal. However, Herzallah insists that these consonants are not true uvulars, but rather back velars.

I can conclude from everything discussed above, that the OCP is an important constraint to consider in constructing the coda cluster in CVCC syllable words in HA. Following Kabrah

(2004), the OCP holds between two nasal consonants and between two sonorant coronals. Therefore, potential coda clusters in words like /ʔamn/ → [ʔa.min] “safety” and /garn/ → [ga.rin] “horn” necessitate vowel insertion in potential coda clusters, to separate two consonants which share similar adjacent features. However, unlike in PA, as represented by Farwaneh (2016), the OCP does not hold between two obstruents with the same manner of articulation in coda clusters in HA as long as they do not share the same place of articulation; for example, /ʕabd/ → [ʕabd] “slave,” /luʔz/ → [luʔz] “puzzle,” and /naħs/ → [naħs] “jinx, curse.” With regard to OCP effects on obstruents based on place of articulation, HA and many Arabic dialects do not allow homorganic obstruents to occur in coda position, even in the underlying form. In addition, the OCP constraint holds between two consonants belonging to the class of gutturals. These two types of co-occurrence restrictions are represented in McCarthy’s “root-consonant co-occurrence restriction” table (see Figure (2.31) above).

With regard to coda clusters which include guttural and emphatic consonants, I propose, following Bin-Muqbil’s (2006) feature representation of gutturals and emphatics, that the OCP does not hold between these two types of consonants because they are asymmetric in their primary featural representation, with a [guttural] feature for gutturals and [coronal] feature for emphatics; for example, /mʔsʕ/ → [mʔsʕ] “stomach ache,”<sup>68</sup> /ruʔsʕ/ → [ruʔsʕ] “cheapness,” and /faħsʕ/ → [faħsʕ] “diagnostic.” Yet another type of OCP effect related to the syllable rhyme is about the status of glide-medial (hollow) roots, as will be presented in Chapter 4.

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<sup>68</sup> A few speakers of HA pronounce this word with [a]-epenthesis in the coda cluster, i.e., [ma.ʔasʕ]. I assume that this pronunciation is mainly due to the influence of Cairene Arabic and that this epenthesis is not due to the similar featural representation of /ʔ/ and /sʕ/, but rather due to the similar manner of articulation of these consonants in that dialect. Another possible interpretation is that the low vowel between gutturals is lexically specified for this word in Cairene Arabic.

Finally, because of the special status of /ʕ/ in HA as an approximant consonant, which has a higher sonority profile than any other sonorant consonant, with the exception of glides, the OCP-[sonorant] constraint (to be explained in Chapter 4) plays a role in coda clusters which include /ʕ/ and other sonorant consonants; for example, /ʕiʕr/ becomes [ʕi.ʕir] “poetry” and /dirʕ/ becomes [di.riʕ] “shield.”

## **2.8. Discussion and Conclusion**

This chapter established a solid theoretical background of sonority in HA and discussed phonological aspects which play a role in regulating coda consonant clusters in nominal and adjectival monomorphemic CVCC syllables. Since the dialect lacks onset clusters, the only available location within the syllable for such a consonant cluster is the coda. One of the definitions of sonority, as mentioned in section 2.1, states that it is a scalar classificatory division of speech sounds based on something like loudness or intensity; therefore, this chapter studies in detail the relative sonority of the consonants of HA based on their respective distinctive features, relating the sonority scale of HA to the most similar sonority scale in the literature proposed by Murray and Vennemann (1983), especially with regard to the class of obstruents. Throughout the literature it is claimed that gutturals in particular have a unique phonological status which differentiates them from other consonants. Phonological studies of these consonants strongly suggest that they form a natural class by themselves based on the zone of articulation of these consonants at the rear area of the vocal tract and other shared phonological alternations of these consonants. For example, one of the phonological alternations triggered by these consonants is the general avoidance of co-occurrence within a root. In Arabic and some other Semitic languages, in addition, they trigger epenthesis when they would otherwise surface in coda

position. Other examples of phonological patterning of gutturals as a natural class are also discussed. It is argued that these consonants form a natural class, though there are a number of phonetic and phonological features differentiating each guttural subclass from the others and each consonant from another. This chapter also studies in detail each consonant in the group of gutturals and places it in its correct position within the sonority scale in HA based on the phonetic and phonological features of these consonants.

The phonetic study of these consonants is divided into acoustical and articulatory phonetics, which supports the idea of placing them on different levels in terms of sonority. Therefore, ‘*ayn* ع /ʕ/ is placed on the highest level among approximants, higher than other gutturals, but under all other non-vocoid consonants, being [-vocoid, +approximant, +sonorant, +continuant, +voice]. The rest of the guttural class was found to have the same sonority level as other obstruents, except for *ghen* غ /ɣ/, which patterns with the class of voiced fricative consonants. Voiced fricatives have higher sonority than other obstruents due to their voicing and continuancy features. The sonority scale for HA is repeated here from Figure (2.23) for clarity.

(2.38) Sonority Hierarchy for Hijazi Arabic (Final)

<i>Natural class</i>	<i>Sonority index</i>
Vowels	7
Glides	6
Voiced pharyngeal /ʕ/	5
Liquids	4
Nasals	3
Voiced fricatives, including /z, zʕ, ʁ, ɦ/	2
Other obstruents, including /ʔ, ʕ, ɣ, dʒ/	1

After finalizing the sonority scale for HA, I discussed the quality of the sonority-driven epenthetic vowel by summarizing what has been said in the literature. In HA, when potential coda clusters exhibit a rising sonority profile, a vowel is epenthesized to break up the cluster.

This vowel is highly dependent upon the quality of the stem vowel. If the stem vowel is high, it spreads its feature to the epenthetic vowel, as in /ism/ → [i.sim] “name,” /ruk<sup>h</sup>n/ → [r<sup>h</sup>u.kun] “corner.” However, when the stem vowel is low, the quality of the epenthetic vowel is affected by the surrounding consonants. For example, this epenthetic vowel would be [a] if preceded by a pharyngeal or laryngeal consonant, as in /ba<sup>h</sup>r/ → [ba.ħar<sup>h</sup>] “sea,” /na<sup>h</sup>r/ → [na.far<sup>h</sup>] “river” as the vowel harmonizes in the feature [pharyngeal] with the neighboring consonant. When the final consonant in the stem is plain coronal (i.e. non-emphatic), the epenthetic vowel will be [i], for example /ʕag<sup>l</sup>/ → [ʕa.gil] “brain” and /daf<sup>n</sup>/ → [da.fin] “to bury.” In other cases, it is the default [i]. A detailed account of the quality of the sonority-driven epenthetic vowel will be presented in Chapter 5.

This chapter also explored the role of sonority in several other Arabic dialects by conducting a short survey of the role of sonority in the coda clusters in these dialects in order to position the status of the HA sonority scale among these dialects. In contrast to HA, other Arabic dialects such as Cairene Arabic allow any two consonants to co-occur in a coda cluster despite a rising sonority profile. Another dialect, PA, prohibits both level and rising sonority in coda clusters. In addition, it may repair falling sonority coda clusters based on several factors, such as place, manner, and markedness of the consonantal sequence. Some dialects, such as Hadhrami Arabic, disallow coda clusters other than geminates due to a syllable structure restriction banning type CVCC. Yet another dialect, LA, has an unusual sonority scale by placing /m/ higher in sonority than /r/ and /n/, but less than /l/.

Finally, I revealed the conspiracy of the SSP, MSD, and OCP to shape coda clusters in HA and several other Arabic dialects as an important theoretical background central to the analysis presented in subsequent chapters. The SSP plays a crucial role in shaping the syllable in

HA by permitting only vocalic segments to surface in the nucleus and preventing any coda cluster from rising in sonority. In addition, minimal sonority distance, which is 0 in HA, plays a role in shaping permissible coda clusters, such that any two obstruents with a different place of articulation are allowed to surface in the coda cluster, for example, /ʕabd/ → [ʕabd] “slave.” However, sonority plateaus still undergo epenthesis if they violate the OCP: when two nasals occur underlyingly, they undergo vowel epenthesis on the surface, for example /ʔamn/ → [ʔa.min] “safety, security,” due to an OCP restriction which takes effect to prohibit adjacent nasal segments. The OCP also plays a role in prohibiting some potential falling sonority coda clusters, /garn/ → [ga.rin] “horn, antler,” due to the restriction on adjacent coronal sonorant segments. In addition, the OCP-[SON], together with the coda condition of ‘*ayn* ɣ /ʕ/ prevent ‘*ayn* ɣ /ʕ/ from surfacing in the potential coda cluster followed by another sonorant consonant; instead, epenthesis is called for to break up such clusters: /ʃiʕr/ → [ʃi.ʕir] “poetry.”

This chapter laid out the most important factors related to the sonority of the coda cluster in HA and other Arabic dialects by way of presenting an extensive background from the literature and explaining some of the most important principles in shaping the HA coda cluster, which will be important for the OT analysis of the coda cluster presented in subsequent chapters.

### Chapter 3: The Sonority of Sound Coda Clusters in HA

This chapter presents the first known Optimality Theoretic (OT) analysis of the coda clusters of Hijazi Arabic (HA) by utilizing the Split-Margin Approach to the syllable (Baertsch, 2002; Baertsch & Davis, 2009), which provides a set of universal markedness constraints, targeting the syllable margin. In addition, faithfulness constraints will be utilized in the analysis of the coda clusters of HA. The OT analysis will be divided into several subsections, each addressing a type of coda cluster in HA of a different sonority profile. All of the data are in monosyllabic adjectival and nominal forms of the shape CVCC.<sup>69</sup> Most of the data in this chapter and in subsequent chapters were collected by the author, who is a native speaker of HA, whereas some of the data were collected from previous treatments of the phonology of HA, such as Abu-Mansour (1987) and Kabrah (2004). Regarding the status of glide, geminate and ‘*ayn*, they will be analyzed in the following chapter, since they exhibit different phonological behavior in the coda of HA.

Section 3.1 lays out the main principles of the Split-Margin Approach to the syllable and its markedness constraints. In addition, it provides the main faithfulness constraints which are used to analyze coda clusters in HA. Section 3.2 presents the data and analysis of the typical case of falling sonority clusters in HA and some sonority clusters which are falling sonority but fail to surface faithfully due to the OCP constraint. Section 3.3 provides the analysis of typical plateau sonority clusters in HA and the OCP constraints which hold between two nasal consonants in the coda clusters of HA. This is followed by an analysis of coda clusters, which surface with epenthesis in order to satisfy the template of the verbal noun *faʕil*, and lexical variation in vowel

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<sup>69</sup> Note that there are verbal forms that end in CVCC syllable shape, which are formed by attaching a pronominal suffix to the verb. For example, /katab-t/ becomes [ka.tabt] “I/you wrote.” However, they always adhere to the sonority rule by forming either a falling or plateau sonority profile, which is tolerated by HA and most other Arabic dialects. Therefore, I do not consider them in great detail here.

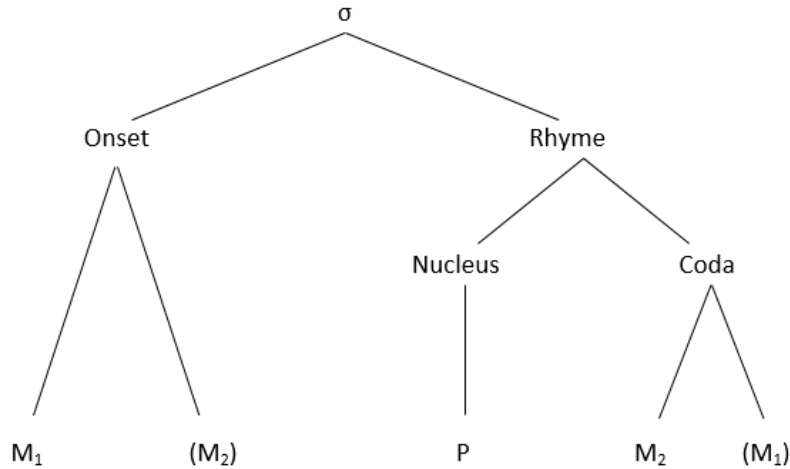
epenthesis. Section 3.4 provides an analysis of the rising sonority coda clusters of HA. Section 3.5 discusses and concludes.

### **3.1. Constraints**

This section lays out the Split-Margin Approach to the syllable with its markedness constraints and provides the necessary faithfulness constraints for the analysis of coda clusters in HA.

#### **3.1.1. The Split-Margin Approach**

Under the Split-Margin Approach, the onset and coda positions in the syllable (i.e., the syllable margins) are each optionally split into two positions,  $M_1$  and  $M_2$ , where  $M_2$  is the position closest to the nucleus of the syllable in each margin, and  $M_1$  is the position furthest from the nucleus. Almost no previous work has examined coda clusters in the Split-Margin approach (however, see Leongue, 2018, for Tibetan languages). The SSP states that sonority is highest at the nucleus and lowest at the edges of a syllable, making  $M_1$  a low-sonority position and  $M_2$  a high-sonority position. Because one version of the SSP (e.g. Clements 1988) states that cross-linguistically, syllables prefer to begin with low-sonority segments and end with high-sonority segments, a singleton onset is  $M_1$ , while a singleton coda is  $M_2$ . The split margin syllable is represented in Figure (3.1).



(3.1) The Syllable under the Split-Margin Approach.

The  $M_1$  position gives preference to low-sonority segments. When an  $*M_1$  constraint is aligned with the sonority hierarchy,<sup>70</sup> constraints avoiding high sonority will be universally ranked high, and constraints avoiding low sonority will be universally ranked low, as shown in Figure (3.2).

(3.2) Split-Margin Constraint Ranking of  $M_1$  in HA

$*M_1/Vowel \gg *M_1/Glide \gg *M_1/'ayn \gg *M_1/Liquid \gg *M_1/Nasal \gg *M_1/VcdFric \gg *M_1/Obs$

This fixed constraint ranking ensures that low-sonority phonemes are preferred in  $M_1$  position—that is, as singleton onsets, the first member of an onset cluster, or the second member of a coda cluster. This is because the low-sonority  $*M_1$  constraints are ranked low.

The  $M_2$  position gives preference to high-sonority segments. When an  $*M_2$  constraint is aligned with the sonority hierarchy, constraints avoiding low sonority are universally high ranked, and constraints avoiding high sonority are universally low ranked, as in Figure (3.3).

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<sup>70</sup> The sonority hierarchy used here is the one arrived at earlier for Hijazi Arabic.

### (3.3) Split-Margin Constraint Ranking of M<sub>2</sub> in HA

\*M<sub>2</sub>/Obs >> \*M<sub>2</sub>/VcdFric >> \*M<sub>2</sub>/Nasal >> \*M<sub>2</sub>/Liquid >> \*M<sub>2</sub>/*ayn* >> \*M<sub>2</sub>/Glide >> \*M<sub>2</sub>/Vowel

This fixed constraint ranking ensures that high-sonority phonemes are preferred in M<sub>2</sub> position—that is, as singleton codas, the first member of a coda cluster, or the second member of an onset cluster. This is because the high-sonority \*M<sub>2</sub> constraints are ranked low.<sup>71</sup>

The constraint rankings for the \*M<sub>1</sub> and \*M<sub>2</sub> hierarchies are exactly reversed from each other. To account for any adjacent M<sub>1</sub> or M<sub>2</sub> segments—for example, in coda clusters—local constraint conjunction of these two constraint hierarchies is used. For coda clusters, this means that \*M<sub>1</sub> and \*M<sub>2</sub> are locally conjoined in the coda. An example conjoined constraint, [\*M<sub>1</sub>/Glide & \*M<sub>2</sub>/Obs]<sub>σ</sub>, representing the universally least ideal coda cluster, is presented in (3.4).

### (3.4) [\*M<sub>1</sub>/Glide & \*M<sub>2</sub>/Obs]<sub>σ</sub>:

“A coda may not contain a glide in M<sub>1</sub> and an obstruent in M<sub>2</sub>. Assign a violation if a glide occurs in M<sub>1</sub> within a coda and an obstruent occurs in M<sub>2</sub> within the same coda.”

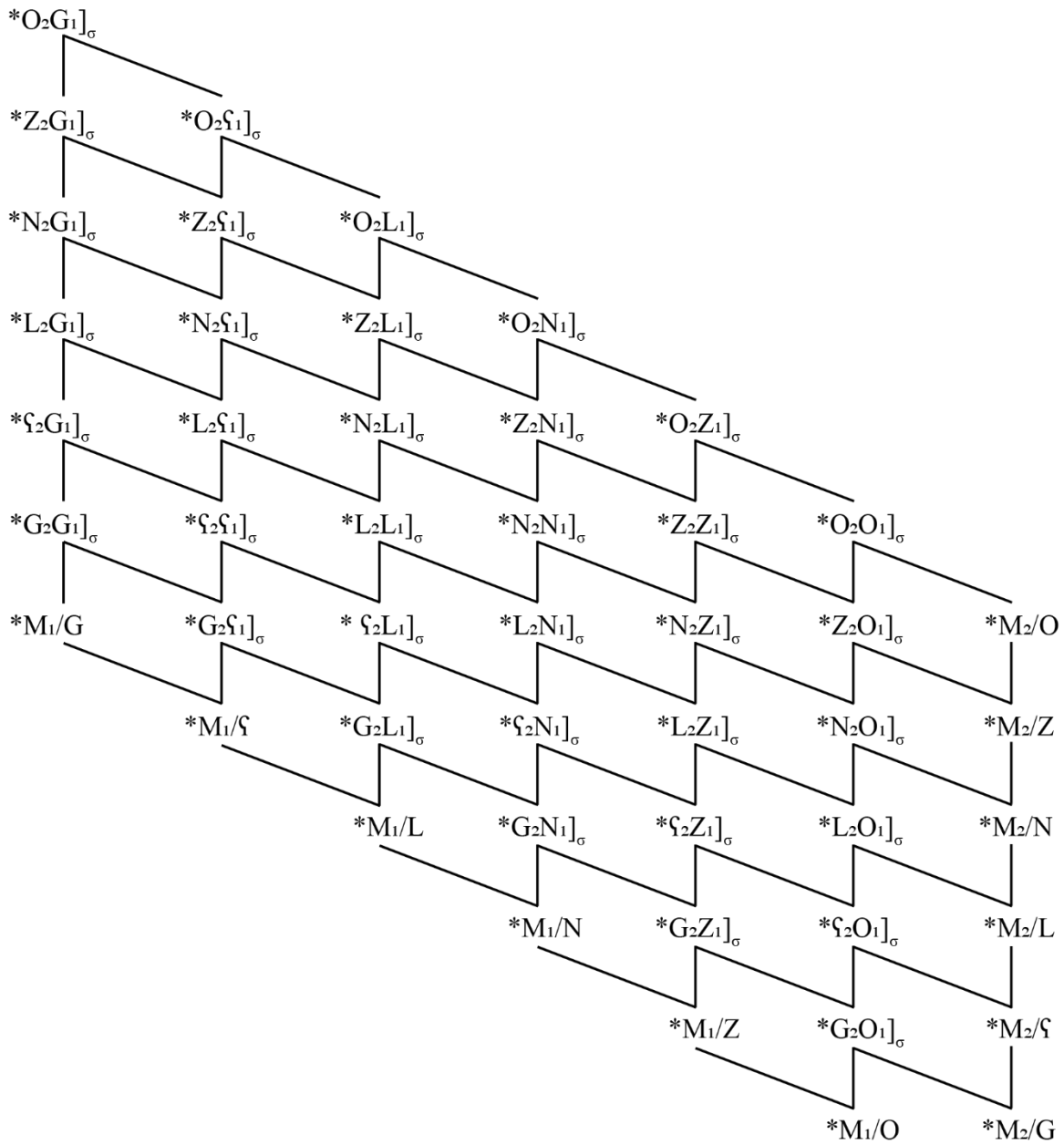
The constraint in (3.4) would be violated by a coda cluster of, for example, [tw]. Since M<sub>1</sub> follows M<sub>2</sub> in the locality of codas, the order of presentation, which is not crucial in conjoined constraints, can be reversed for the sake of clarity. All logically possible conjoined constraints consisting of \*M<sub>1</sub> and \*M<sub>2</sub> exist and are formatted in the same way in this study.

Since each component constraint in a local constraint conjunction must be dominated by the conjoined constraint, the “conjoined constraints are intrinsically ranked with respect to each other (reflecting the ranking of the component M<sub>1</sub> and M<sub>2</sub> hierarchies)” (Baertsch & Davis, 2009, p. 295). The resulting Hasse diagram for conjoined \*M<sub>1</sub> and \*M<sub>2</sub> constraints is shown in Figure

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<sup>71</sup> The low ranked \*M<sub>2</sub>/Vowel constraint is not relevant since vowels will be drawn into the syllable peak i.e. the nucleus.

(3.5). In the figure, the first position refers to the consonant closest to the nucleus, which falls in M<sub>2</sub> position of the coda (see Figure (3.1)). The second position refers to the second consonant—that is, the right edge—which falls in M<sub>1</sub> position of the coda. For example, \*O<sub>2</sub>G<sub>1</sub>]σ represents an obstruent-glide sequence in a coda, such as /badw/ “Bedouin.” Here and elsewhere, O represents obstruents (excluding voiced fricatives), Z represents voiced fricatives, N represents nasals, L represents liquids, ʕ represents the pharyngeal ‘ayn, and G represents glides. Vowels, which are higher in sonority than glides, are omitted from the scale, as they do not fall in coda position.



(3.5) Hasse Diagram of Conjoined  $*M_2$  and  $*M_1$  Hierarchies in Hijazi Arabic.

Figure (3.5) illustrates the predicted possible margins of the syllable with the HA sonority hierarchy (see Figure (2.23)). However, this by itself is not enough to regulate the syllable margin under discussion, the coda cluster in HA. Faithfulness constraints are also necessary to determine the coda clusters which surface in a given language, in this case in HA, to be presented in the next section.

### 3.1.2. Faithfulness constraints

In addition to the markedness constraints provided by the Split-Margin Approach, the following faithfulness constraints will be important in the analysis of HA coda clusters.

#### (3.6) Additional Faithfulness Constraints for the Analysis

a. IDENTITY[sonorant]-IO (ID-[son]):

“Correspondent segments in the input have identical values for the feature [±sonorant] in the output (Kager, 1999, p. 250). Assign a violation any time an output consonant has a different value for [±sonorant] than its corresponding input segment.”

b. DEPENDENCY-IO (DEP):

“Output segments must have input correspondents (Kager, 1999, p. 101). Assign a violation for the epenthesis of a segment.”

c. MAXIMALITY-IO (MAX):

“Every element of the input must have a correspondent in the output (Kager, 1999, p. 205). Assign a violation for the deletion of a segment.”

d. RIGHT-ANCHOR-IO (ANCHOR):

“Any element at the right periphery of the input has a correspondent at the right periphery of the output (Kager, 1999, p. 251). Assign a violation for epenthesis or deletion at the right edge of a form.”

e. CONTIGUITY-IO (CONTIG):

“Elements adjacent in the input must be adjacent in the output (Gouskova, 2001, p. 178). Assign a violation for any epenthesis or deletion between segments (i.e., no medial epenthesis or deletion).”

The interaction of the markedness constraints provided by the Split-Margin Approach and the faithfulness constraints in (3.6) will be shown in the following subsections to account for the range of surface forms seen in HA coda clusters.

### **3.2. Falling sonority clusters**

This section will address two types of falling sonority coda clusters in HA. Section 3.2.1 provides an OT analysis of the typical case of falling sonority clusters in HA, followed by an OT analysis of falling sonority coda clusters containing two coronal sonorants, which are broken up by epenthesis due to an OCP effect, as demonstrated in §3.2.2.

#### **3.2.1. The typical case**

Hijazi Arabic generally allows falling sonority coda clusters with no restriction. The falling sonority coda cluster types of HA are exemplified in Figure (3.7). Note that the underlying form is omitted, as it is assumed to be the same as the surface form, with no epenthesis.

(3.7) Falling Sonority Clusters in HA

a.	' <i>ayn</i> + obstruent	e.	nasal + voiced fricative
	baʃd <sup>ʃ</sup> "some"		kanz "treasure"
	kaʃb "heel"		ramz "symbol"
	ʃaʃb "people"	f.	nasal + obstruent
	daʃs "stepping-over, crashing"		band "section"
	kaʃk "cake"		band <sup>ʒ</sup> "anesthesia"
b.	liquid + nasal		ʔins "mankind"
	χur <sup>ʃ</sup> m "hole"		manħ "granting"
	ʃilm "knowledge"		bint "daughter"
c.	liquid + voiced fricative		ħamd "thanking, praise"
	farz "sorting"		ħimd <sup>ʃ</sup> "acid"
	kur <sup>ʃ</sup> fi "hatred"		nims "mongoose"
	bulħ "idiots"		r <sup>ʃ</sup> umħ "spear"
d.	liquid + obstruent	g.	voiced fricative + obstruent
	dur <sup>ʃ</sup> d <sup>ʒ</sup> "drawer"		kizb "lying, falsehood"
	ward "flower"		mazd <sup>ʒ</sup> "mixing"
	farʃ "furnishing"		nazf "hemorrhage"
	farχ "chick"		mizħ "joking"
	kart "card"		waxd "scoundrel"
	ʃarħ "explanation"		d <sup>ʃ</sup> aʃt <sup>ʃ</sup> "pressure"
	tald <sup>ʒ</sup> "ice, snow"		buʃd <sup>ʃ</sup> "aversion"
	d <sup>ʒ</sup> ild "leather, skin"		naħb "robbing"
	ʃils "small unit of currency"		
	milħ "salt"		
	mulk "monarchy"		

The coda cluster data in Figure (3.7) are organized in gradually descending order, based on the sonority of C<sub>1</sub>, the consonant in M<sub>2</sub> position of the coda cluster. Glides are not present in the C<sub>1</sub> position due to the coalescence process with the preceding vowel, nor are they present in C<sub>2</sub>

position, due to final glide vocalization. This will be analyzed in Chapter 4, §4.1. Also, sequences of /ʃ/ followed by another sonorant consonant are not permitted, despite having falling sonority, due to restrictions on the occurrence of /ʃ/ in the coda with other sonorants; see also Chapter 4 §4.2. With regard to liquid + nasal coda clusters in HA (3.7b), the only available types are the clusters [rm] and [lm], as these two consonants are different in their place features, whereas \*[ln] and \*[rn] are prohibited in HA due to the high-ranking constraint OCP-SONORANT-CORONAL. Tableau 3.1 demonstrates that any  $*M_2/*M_1$  constraint which represents a falling sonority cluster is outranked by the faithfulness constraint DEP, preventing epenthesis from occurring to break up the cluster.

*Tableau 3.1. Falling Sonority Coda without Epenthesis*

/χurm/ “hole”	DEP	$*L_2N_1]_{\sigma}$
☞ a. [χur <sup>h</sup> m]		*
b. [χu.r <sup>h</sup> um]	*!	

If the ranking of these constraints were reversed, for example,  $*L_2N_1]_{\sigma}$  outranked DEP and CONTIG, the losing candidate [χur<sup>h</sup>um] would surface, as in Tableau 3.2.

*Tableau 3.2. Falling Sonority Coda with Ungrammatical Epenthesis*

/χurm/	$*L_2N_1]_{\sigma}$	DEP
☹ a. [χur <sup>h</sup> m]	*!	
☛ b. [χu.r <sup>h</sup> um]		*

These two tableaux prove that falling sonority clusters in HA surface faithfully without epenthesis due to the higher rank of the faithfulness constraint DEP, which outranks any falling

sonority coda cluster markedness constraints. The next section provides the analysis of exceptional falling coda clusters, which surface with epenthesis due to the effect of the OCP.

### 3.2.2. OCP-[sonorant, coronal]

This section analyzes falling coda clusters in HA which include [r] followed by [n]. Coda clusters of /ln/ are absent in HA. This is due to an OCP effect and root consonant co-occurrence restriction, which prevent sequences of sonorant coronals in coda clusters, as discussed in §2.7. Figure (3.8) shows that /rn/ clusters surface with vowel epenthesis due to the OCP sonorant-coronal effect.

#### (3.8) OCP Effect in Codas with Sonorant Coronal Consonants

- |    |        |                       |                         |
|----|--------|-----------------------|-------------------------|
| a. | /garn/ | [garin]               | “century; horn, antler” |
| b. | /furn/ | [fur <sup>s</sup> un] | “furnace”               |

The data above demonstrate a falling coda cluster in HA which does not surface faithfully, due to the OCP effect, which prevents two sonorant coronals from occurring adjacently in the coda cluster. Instead, vowel epenthesis occurs to separate these two consonants with similar features in the output. Tableau 3.3 shows that the markedness constraint OCP-[SONORANT, CORONAL] outranks the faithfulness constraints DEP and CONTIG, forcing vowel epenthesis to occur in the surface form.

#### (3.9) OBLIGATORY CONTOUR PRINCIPLE – [SONORANT, CORONAL] (OCP-[SON, COR]):

“Two segments with the features [+coronal] and [+sonorant] cannot be adjacent in the output of the syllable coda. Assign a violation for any two [+coronal, +sonorant]

consonants which are adjacent in the output of the syllable coda.” (Kabra, 2004, p. 190; see also Davis and Shin, 1999, for a similar constraint in Korean).

*Tableau 3.3. Falling Sonority Clusters with OCP-driven Epenthesis*

/furn/ “oven”	OCP-[SON, COR]	DEP	CONTIGUITY	*L <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub>
a. [fur <sup>s</sup> n]	*!			*
b. [fu.r <sup>s</sup> un]		*	*	

In Tableau 3.3, OCP-[SON, COR] crucially outranks DEP, which outranks \*L<sub>2</sub>N<sub>1</sub>]<sub>σ</sub>. The ranking of OCP-[SON, COR] is independent of the Split-Margin constraint. DEP, which dominates the Split-Margin constraint, militates against epenthesis in the output form; however, because DEP (and CONTIG) are outranked by an OCP constraint which militates against [sonorant, coronal] clusters, candidate (b) wins, because it respects the undominated OCP constraint. If OCP-[SON, COR] were dominated by DEP and CONTIG, the candidate with no epenthesis which exhibits a cluster of [sonorant, coronal] consonants would surface, as shown in Tableau 3.4.

*Tableau 3.4. Ungrammatical Coda Cluster with Sonorant Coronals*

/furn/	DEP	CONTIGUITY	OCP-[SON, COR]	*L <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub>
☹ a. [fur <sup>s</sup> n]			*	*
☺ b. [fu.r <sup>s</sup> un]	*!	*!		

We can conclude from Tableaux 3.3 and 3.4 that the grammar of HA does not tolerate [rn] coda clusters, due to the OCP-[SON, COR] constraint. Hijazi Arabic allows coda clusters of falling sonority, as long as the two consonants are not coronal sonorants. With regard to consonants that share the same place specification, the OCP does not hold as long as both consonants have different values for the feature [±sonorant]; for example, codas consisting of [rt], [rd], [nt], or

[nd] such as [kart] “card,” [bard] “cold,” [bint] “girl,” and [band] “section” are completely tolerable in the grammar of HA.

The next section provides an analysis of plateau sonority clusters in HA, which surface faithfully.

### 3.3. Level sonority clusters

This section provides an OT analysis of the typical case of sonority plateaus in HA, then it analyzes the OCP effect that holds for one of the plateau sonority clusters, in which both consonants are nasal. After that it provides an analysis of the templatic satisfaction of the verbal noun (*masdar*) pattern *faʕil*, which causes epenthesis in coda clusters that would otherwise surface faithfully. Finally, it describes lexical variation of some words which surface with vowel epenthesis but should otherwise surface faithfully as clusters.

#### 3.3.1. The typical case

Hijazi Arabic generally allows coda clusters of level sonority, as shown in Figure (3.10).<sup>72</sup> The data show that HA treats all obstruents, other than voiced fricatives, as being equal in sonority. This includes the only affricate sound in the dialect, which is /dʒ/. I propose that the consonant /dʒ/ is phonetically an affricate and phonologically a strident stop following Kehrein’s (2002) Strident Stop Approach. Therefore, it will be listed among stops in the data sets in this chapter. This is shown in groups (3.10d–h), wherein combinations of voiceless fricatives and voiced and voiceless stops pattern as sonority plateaus.

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<sup>72</sup> In Hijazi Arabic, as well as in most Arabic dialects, including those where level-sonority consonant clusters receive epenthesis, geminates are never broken apart, e.g., [har:] “heat,” [χal:] “vinegar.” This supports the idea that geminates are underlyingly one segment with longer duration of articulation, which occupy two C-slots.

### (3.10) Level Sonority Coda Clusters in Hijazi Arabic

a. voiced fricative + voiced fricative	d. voiceless stop + voiceless stop
luʁz “puzzle”	fatk “destruction”
naʁz “poking”	fiatk “breaching, violating”
b. voiced stop + voiced stop	e. voiceless stop + voiceless fricative
ʕabd “slave”	kitf “shoulder”
nabd <sup>ʕ</sup> “beating”	ʕat <sup>ʕ</sup> s <sup>ʕ</sup> “sneezing”
nagd “cash”	f. voiceless fricative + voiceless stop
madʒd “glory”	ʃaft <sup>ʕ</sup> “suction”
c. voiceless fricative + voiceless fricative	baʁt “luck, chance”
mash “wiping, sweeping, survey”	g. voiceless fricative + voiced stop
naḥs “jinx”	nasdʒ “weaving”
nafs “soul”	nas <sup>ʕ</sup> b “tricking, deceiving”
r <sup>ʕ</sup> uʁs <sup>ʕ</sup> “cheapness”	h. voiced stop + voiceless fricative
nasʁ “copying”	nags <sup>ʕ</sup> “lacking, shortage”
	madh “praise”

As mentioned in §2.1, the sonority scale of HA, in regard to the obstruents, is similar to the one proposed by Murray and Vennemann (1983), with the one difference that HA collapses the two lowest sonority levels of Murray and Vennemann (1983), those being voiced stops and voiceless fricatives on the one hand and voiceless stops on the other, into a single sonority level.

Voiced fricatives, by contrast, occupy a higher sonority level than other obstruents, due to the laryngeal feature [voice] and the manner feature [continuant]. The grammar of HA tolerates two voiced fricatives occurring in coda clusters without epenthesis. Thus, the OCP does not hold between two voiced fricative consonants in coda clusters in HA, nor does it hold between two voiceless fricatives or two stops with a similar laryngeal feature, as long as they are different in

their place specification or do not belong to the same class of gutturals. Neither does it hold for any combination of stops, regardless of voicing.

It may be noted that some types of coda clusters of level sonority do not occur in either HA or MSA. This is because they belong to the same class of sounds, such as the class of gutturals and liquids. For example, liquid + liquid and guttural + guttural are excluded because of the effect of root consonant co-occurrence, as explained by McCarthy (1994), so the sequences /lr/ and /rl/ do not occur. Similarly, the guttural sequences /ħʕ/, /ʕħ/, /ʁħ/, /ħʁ/ etc. do not occur. All sequences above do not occur in HA, nor do they occur in other Arabic dialects. Regarding the coda clusters with two glide consonants, they will be analyzed in detail in chapter 4.

Tableau 3.5 demonstrates that level-sonority coda clusters in HA surface faithfully, with no epenthesis. This is because the faithfulness constraint DEP outranks any level-sonority Split-Margin constraints, preventing epenthesis from occurring.

*Tableau 3.5. Faithful Sonority Plateau Cluster*

/ʕagd/ “contract”	DEP	*O <sub>2</sub> O <sub>1</sub> ] <sub>σ</sub>
☞ a. [ʕagd]		*
b. [ʕa.gid]	*!	

If the markedness constraint \*O<sub>2</sub>O<sub>1</sub>]<sub>σ</sub> outranks the faithfulness constraint DEP, the wrong candidate wins, as illustrated in Tableau 3.6.

*Tableau 3.6. Ungrammatical Epenthesis in Sonority Plateau Clusters*

/ʕagd/	*O <sub>2</sub> O <sub>1</sub> ] <sub>σ</sub>	DEP
☹ a. [ʕagd]	*!	
☛ b. [ʕa.gid]		*

The previous two tableaux show that sonority plateau coda clusters in HA surface faithfully because DEP outranks any level \*M<sub>2</sub>/M<sub>1</sub> Split-Margin constraint, as long as DEP is not outranked by another markedness constraint that necessitates vowel epenthesis, as will be illustrated in the next section.

### 3.3.2. OCP-[nasal]

Some types of coda clusters of level sonority do not occur in HA. These cluster types include nasal + nasal, which is excluded due to an OCP effect. The sequence /nm/ is extremely rare in HA and in most Arabic dialects;<sup>73</sup> however, /mn/ occurs in underlying coda clusters, which surface with vowel epenthesis to separate two adjacent nasals as shown in (3.11).

#### (3.11) OCP Effect in Codas with Nasal + Nasal Cluster

a.	/ʔamn/	[ʔamin]	“safety, security”
b.	/samn/	[samin]	“shortening, fat”
c.	/tumn/	[tumun]	“one-eighth”
d.	/ʁunm/	[ʁunum]	“plundering”

It is clear from the data in (3.11) that the underlying nasal cluster /m + n/ is separated by vowel epenthesis in the surface form due to the effect of OCP-[nasal], defined in (3.12):

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<sup>73</sup> I can list only one example of this sequence from MSA, which is /ʁunm/ “plundering”, which is pronounced as [ʁu.num] in HA. According to Rice (1992, p. 83) coronal consonants have less structure than peripheral consonants such as labials and dorsals; therefore, they govern the segment preceding them. Perhaps because of this, clusters like /mn/ are normal in HA, whereas clusters like /nm/ are extremely rare.

(3.12) OBLIGATORY CONTOUR PRINCIPLE – [NASAL] (OCP-[NAS]):

“Two consonants with the feature [nasal] cannot be adjacent in the output of the syllable coda. Assign a violation for any two [nasal] consonants which are adjacent in the output of the syllable coda.” (Kabrah, 2004, p. 190)

In Tableau 3.7, the constraint OCP-[NAS] outranks both faithfulness constraints DEP and CONTIG, allowing epenthesis to occur to separate two nasal consonants.

Tableau 3.7. OCP Effect on Nasal Coda Clusters

/samn/ “shortening”	OCP-[NAS]	DEP	CONTIGUITY	*N <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub>
a. [samn]	*!			*
b. [sa.min]		*	*	

If the faithfulness constraints DEP and CONTIG outrank the markedness constraint OCP-[NAS], the wrong candidate [samn] wins by preventing epenthesis in the surface form, as shown in Tableau 3.8.

Tableau 3.8. Ungrammatical Nasal + Nasal Coda Clusters

/samn/	DEP	CONTIGUITY	OCP-[NAS]	*N <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub>
☹ a. [samn]			*	*
☺ b. [sa.min]	*!	*!		

It is clear from Tableaux 3.7 and 3.8 that the OCP effect holds only between nasal clusters in sonority plateaus. This OCP constraint is different than the Split Margin \*N<sub>2</sub>N<sub>1</sub>]<sub>σ</sub> constraint, even though they assign violations to the same candidates. OCP-[NAS] is a feature-based, independently ranked constraint that militates against two adjacent segments with the feature

[nasal], whereas the Split Margin  $*N_2N_1]_{\sigma}$  constraint is a sonority-driven constraint, which militates against two nasal consonants in the coda cluster. In Tableau 3.7, OCP-[NAS] is crucially undominated, outranking DEP and CONTIG, which outrank the  $*N_2N_1]_{\sigma}$  constraint. This crucial ranking indicates that sonority plateau clusters including  $*N_2N_1]_{\sigma}$  do surface faithfully, unless they violate an undominated constraint such as OCP-[NAS], which requires epenthesis in the output form.

The following section provides an analysis of some falling and plateau coda clusters in HA, which surface with vowel epenthesis in order to satisfy the template of the verbal noun *masdar faʕil* form.

### 3.3.3. The effect of the verbal noun template (faʕil) on epenthesis

There are some words in HA in the pattern of the *masdar faʕil* (verbal noun) which surface with vowel epenthesis, even though the coda cluster is of falling or level sonority, and hence epenthesis should not be predicted by the sonority rule. This optional epenthetic vowel is triggered in order to satisfy the templatic requirement of the *masdar*.

#### (3.13) Words in the Pattern of faʕil with Optional Epenthesis

##### a. Epenthesis in Falling Clusters

/mizħ/	[mizih]	“joking”
--------	---------	----------

/liʕb/	[liʕib]	“playing”
--------	---------	-----------

##### b. Epenthesis in Level Clusters

/dʕihk/	[dʕihik]	“laughing”
---------	----------	------------

/kidb/	[kidib]	“act of lying, saying falsehood”
--------	---------	----------------------------------

It is clear from the examples in (3.13) that a vowel is epenthesized in a place where it is not expected based on the SSP. The reason for the vowel epenthesis may be the effect of the *masdar* pattern *faʕil*, which requires the underlying CVCC monosyllabic word to match the template CVCVC of the *masdar*. The problem is that the first vowel of the word, which is [i], does not

match the first vowel of the *masdar*. For example, the word [dʰaħik] “laughing” is the *masdar* of the verb [jadʰhak] in MSA. This verbal noun is pronounced in HA as [dʰiħik]. I propose that the output [dʰiħik] is the result of the ranking of the constraints MASDAR-TEMPLATE-SATISFACTION and IDENT-IO-V above DEP and CONTIG, which themselves outrank any level or plateau \*M<sub>2</sub>/\*M<sub>1</sub> Split-Margin constraints. Figure (3.14) provides the definition for the proposed constraints MASDAR-TEMPLATE-SATISFACTION and IDENT-IO-V.

(3.14) MASDAR-TEMPLATE-SATISFACTION and IDENT-IO-V

a. MASDAR-TEMPLATE-SATISFACTION (MTS):

“The output must match the prosodic shape of the *masdar* template, CVCVC. Assign a violation for any *masdar* in the output which is not of the prosodic shape CVCVC.”

b. IDENT-IO-V (IDENT-V):

“A vowel in the output must be identical to its correspondent in the input. Assign a violation for any vowel in the output which differs from its correspondent in the input.”

Tableau 3.9 shows that both MTS and IDENT-V must outrank DEP and CONTIG, causing a vowel to be epenthesized in some level- and falling-sonority clusters.

Tableau 3.9. *Masdar*-Triggered Epenthesis

/dʰiħk/ “laughing”	MTS	IDENT-V	DEP	CONTIG	*O <sub>2</sub> O <sub>1</sub> ] <sub>σ</sub>
a. [dʰiħk]	*!				*
b. [dʰi.ħik]			*	*	
c. [dʰa.ħik]		*!	*	*	
d. [dʰa.ħak]		*!	*	*	

The faithful candidate a. loses because it violates high ranked MTS. Candidate b. is the winner because it satisfies MTS by epenthesizing a vowel in the coda cluster. Candidates c. and d. lose because they violate IDENT-V by having a low vowel in the stem. Tableau 3.9 shows that MASDAR-TEMPLATE-SATISFACTION outranks DEP and CONTIG, causing epenthesis to occur in a level coda cluster, which should not receive an epenthetic vowel in the typical case.

Section 3.3.4 provides an analysis of epenthesis in level and falling clusters due to the effect of lexical variation.

### 3.3.4. Lexical variation of vowel epenthesis in coda clusters

In HA, coda clusters of some words surface unfaithfully with vowel epenthesis even though the cluster is not rising. These words are shown in data set (3.15).

#### (3.15) Lexically Optional Epenthesis in Coda Clusters

- a. Optional Epenthesis in Falling Clusters
  - [ḍʒur<sup>s</sup>ħ] ~ [ḍʒur<sup>s</sup>uh]      “wound”
  - [r<sup>s</sup>uʃb] ~ [r<sup>s</sup>uʃub]      “horror”
  - [film] ~ [filim]      “film”
- b. Optional Epenthesis in Level Clusters
  - [taħt] ~ [taħat]      “downstairs”
  - [subħ] ~ [subuh]      “morning”
  - [muʃt<sup>s</sup>] ~ [muʃut<sup>s</sup>]      “comb”

As illustrated in (3.15), although these words have falling and plateau coda clusters, they surface with an epenthetic vowel to break up these clusters in the surface form. As a solution, I propose, Pater’s (2002, 2007) lexically indexed constraint approach, in which some morphemes or stems are the target of lexically specific constraints (marked with “-L”). The coda clusters in the data in (3.15) surface with epenthesis due to a high-ranking lexically indexed constraint which prevents coda clusters, \*COMPLEX<sup>COD</sup>-L. This constraint outranks both faithfulness constraints DEP and

CONTIG, which themselves outrank both types of general markedness constraints \*COMPLEX<sup>COD</sup> (“codas are simple;” Kager, 1999, p. 97) and any falling or plateau conjoined Split-Margin constraints (represented by \*O<sub>2</sub>O<sub>1</sub>]<sub>σ</sub> here). In Tableau 3.10, lexically exceptional words surface with epenthesis, whereas other words with a similar cluster surface faithfully. This is because lexically indexed \*COMPLEX-L, which necessitates vowel epenthesis in lexically exceptional words (b), is satisfied vacuously by unexceptional words (c–d). The same constraint ranking that holds for sonority plateaus holds for other lexically exceptional words with falling sonority clusters such as /ruʃb/ and /d̪ʒurh̃/ (3.15a), with the change of the Split-Margin constraint from level \*M<sub>2</sub>/\*M<sub>1</sub> to falling \*M<sub>2</sub>/\*M<sub>1</sub>, which makes these words surface with epenthetic vowels in the output form. Candidate (c) represents a typical case of plateau sonority, which would surface faithfully with no vowel epenthesis, as argued in §3.3.1.

Tableau 3.10. Epenthesis in Some Lexical Words

/taht <sub>L</sub> / “downstairs”	*COMPLEX <sup>COD-L</sup>	DEP	CONTIG	*COMPLEX <sup>COD</sup>	*O <sub>2</sub> O <sub>1</sub> ] <sub>σ</sub>
a. [taht]	*!			*	*
b. [ta.hat]		*	*		
/naht/ “carving”	*COMPLEX <sup>COD-L</sup>	DEP	CONTIG	*COMPLEX <sup>COD</sup>	*O <sub>2</sub> O <sub>1</sub> ] <sub>σ</sub>
c. [naht]				*	*
d. [na.hit] <sup>74</sup>		*!	*!		

<sup>74</sup> Note the different epenthetic vowels of candidates (b) and (d). The epenthetic vowel of candidate (b), *tahat*, is a low vowel [a], which is different from the epenthetic vowel in the losing candidate (d), which is a high vowel [i]. I assume that if the candidate (d) receives an epenthetic vowel, then this should be the general sonority-driven epenthetic vowel, [i]. Regarding the epenthetic vowel in candidate (b), Kabrah (2004) proposes that the [+low] feature of the epenthetic vowel is triggered by the preceding pharyngeal consonant, due to consonant-to-vowel harmony.

The grammar of HA eliminates exceptional lexical words with rising sonority clusters by the general strategy of epenthesis. Even if these unattested exceptional forms were to exist hypothetically, the lexically indexed constraint would be vacuously satisfied by the general grammatical rule blocking rising sonority coda clusters.<sup>75</sup> Section 3.4 shows that any potential rising-sonority coda cluster in HA is eliminated by sonority-driven epenthesis.

### 3.4. Rising-sonority clusters

The general strategy in HA for resolving coda clusters of rising sonority is vowel epenthesis.

In HA, the voiceless guttural consonants /ʔ, ħ, χ/ all act as obstruents—that is, they behave as obstruents in terms of sonority (see §2.2.4), whereas the voiced guttural consonants /ʁ, ħ/ pattern with other voiced fricatives, like /z/, by exhibiting a higher sonority profile than other obstruents due to the laryngeal feature [voice] and the manner feature [continuant]. This is different from some other Arabic dialects, such as Lebanese, in which the gutturals pattern with high-sonority segments. The voiced pharyngeal /ʕ/ has its own sonority class, which is distinct from other segments. The data sets (3.16)–(3.19) all include potential rising-sonority clusters. They are divided by the last consonant in the word in each set.

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<sup>75</sup> Abu-Mansour (1987, pp. 201–202) lists some words as exceptional that receive an epenthetic vowel “even though the sonority hierarchy is not violated” (p. 201). She treats these words as exceptional considering only the role of sonority. The sonority hierarchy that I propose in this dissertation is quite different from the one proposed earlier by Abu-Mansour. For example, the present analysis considers *ʕayn* to be a sonorant consonant, whereas it is an obstruent consonant according to Abu-Mansour’s account. Therefore, epenthesis in a word such as /rubʕ/ → [r<sup>s</sup>ubuʕ] “quarter, fourth” is already incorporated under the general rule of sonority-driven epenthesis in the present account, because the coda would exhibit a rising-sonority cluster, whereas it is counted as exceptional in Abu-Mansour’s account, because her sonority scale cannot account for this type of epenthesis.

(3.16) Epenthesis in Potential /ʕ/-Final Rising-Sonority Coda Clusters

	Underlying	Gloss	Surface	Possessed, masc. sg.
a.	/wadʕ/	“position”	[wa.dʕiʕ]	[wadʕ.ʕu]
b.	/nazʕ/	“extraction, taking away”	[na.ziʕ]	[naz.ʕu]
c.	/manʕ/	“prohibition”	[ma.niʕ]	[man.ʕu]
	/ʃamʕ/	“wax”	[ʃa.miʕ]	[ʃam.ʕu]
d.	/dirʕ/	“shield”	[di.riʕ]	[dir.ʕu]
	/χalʕ/	“extracting”	[χa.liʕ]	[χal.ʕu]

Data set (3.16) presents potential [ʕ]-final rising-sonority coda clusters, beginning with the obstruent (a) as the first consonant in such a cluster and ending with liquids (d) as a first member of the potential cluster. It is clear from these examples that whenever /ʕ/ would be the second consonant in a coda cluster and preceded by any consonant other than a glide, epenthesis occurs to avoid the rising-sonority coda cluster. Of course, /ʕ/ cannot occur with another guttural consonant in the coda due to the strong co-occurrence restriction between gutturals, as discussed in §2.2.2. With regard to words that include a medial emphatic consonant + /ʕ/, as shown in (3.16a), they are completely tolerable in the grammar of HA, since both consonants have different feature representations (see §2.7).

Figure (3.17) shows potential liquid-final rising-sonority coda clusters, arranged from obstruent (a) to nasal (c) as the first consonant in such a potential coda cluster.

(3.17) Epenthesis in Potential Liquid-Final Rising-Sonority Coda Clusters

	Underlying	Gloss	Surface	Possessed, masc. sg.
a.	/ħibr/	“ink”	[ħi.bir]	[ħib.r <sup>ʕ</sup> u]
	/nadl/	“scoundrel”	[na.dil]	[nad.lu]
b.	/bizr/	“seed”	[bi.zir]	[biz.r <sup>ʕ</sup> u]
	/baʕl/	“mule”	[ba.ʕil]	[baʕ.lu]
c.	/tamr/	“date (fruit)”	[ta.mir]	[tam.r <sup>ʕ</sup> u]
	/naml/	“ant”	[na.mil]	[nam.lu]

As is clear from the data in (3.17), when liquids are final in potential rising-sonority coda clusters and preceded by any consonant other than a glide and /ʕ/ as a word-medial consonant, this sequence would exhibit a rising-sonority coda cluster, which is not allowed by the grammar of HA. Therefore, vowel epenthesis occurs in the surface form to prevent such a rising-sonority coda cluster from surfacing. Data set (3.17c) includes only words with /mr/ and /ml/ potential coda clusters. With regard to the clusters /nl/ and /nr/, they are lacking due to the strong sonorant coronal co-occurrence restriction in Arabic (see §2.7).

(3.18) Epenthesis in Potential Nasal-Final Rising-Sonority Coda Clusters

	Underlying	Gloss	Surface	Possessed, masc. sg.
a.	/ʔism/	“name”	[ʔi.sim]	[ʔis.mu]
	/dign/	“chin”	[di.gin]	[dig.nu]
b.	/ʕazm/	“determination”	[ʕa.zim]	[ʕaz.mu]
	/ħuzn/	“sadness”	[ħu.zun]	[ħuz.nu]

The data in (3.18) include words with nasal-final potential clusters, in which the nasal is preceded by an obstruent (a) or a voiced fricative (b) in the underlying form. These potential clusters receive an epenthetic vowel in the surface form to avoid coda clusters with rising-sonority.

In HA, when a coda cluster would occur containing two obstruents, in which the second member of the cluster is a voiced fricative and the first member of the cluster is a non-voiced fricative obstruent, epenthesis occurs. Examples of this are shown in (3.19).

(3.19) Epenthesis in Potential Voiced Fricative-Final Rising-Sonority Coda Clusters

Underlying	Gloss	Surface	Possessed Form (3P.MASC.SG)
/χubz/	“bread”	[χu.buz]	[χub.zu]
/ħad̪ʒz/ <sup>76</sup>	“booking, reservation”	[ħa.d̪ʒiz]	[ħad̪ʒ.zu]
/waχz/	“poking”	[wa.χiz]	[waχ.zu]
/tibʁ/	“tobacco”	[ti.biʁ]	[tib.ʁu]
/ladʁ/	“snake bite”	[la.diʁ]	[lad.ʁu]
/wad̪ʒfi/	“face”	[wa.d̪ʒifi]	[wad̪ʒ.fu]

It is clear from the data in (3.19) that the grammar of HA distinguishes between the voiced fricative and other obstruents in terms of sonority by making the voiced fricatives higher in sonority than any other obstruents due to the features [voice] and [continuant] and collapses other obstruents into the lowest level of the sonority scale. When a voiced fricative is word-final and preceded by any other obstruent in the underlying form, vowel epenthesis occurs in the

---

<sup>76</sup> In [ħa.d̪ʒiz] “booking, reservation” one of two phonological alternations is possible. The most common is vowel epenthesis, to break up the rising-sonority cluster. However, as a rare alternative, assimilation may occur, in which /ħad̪ʒz/ becomes [ħaʒz], with the affricate /d̪ʒ/ becoming [ʒ], assimilating in the feature [continuant] with the following consonant. I assume that the assimilation process between consonants in a cluster is sonority-independent, and hence falls outside the scope of this chapter.

surface form to avoid a rising-sonority cluster. However, when a voiced fricative is word-medial and followed by any other obstruent, this qualifies as a falling-sonority cluster in HA, and so vowel epenthesis does not occur (see Figure (3.7g)).

As illustrated in the previous figures with potential rising-sonority coda cluster data, an increase in sonority, even by one level, is not tolerated by the grammar of HA. Tableau 3.11 shows that any rising Split-Margin constraint outranks DEP and CONTIG, causing these cluster types to receive an epenthetic vowel.

*Tableau 3.11. Epenthesis in Rising-Sonority Coda Clusters (the Typical Case)*

/naml/ “ants”	*N <sub>2</sub> L <sub>1</sub> ] <sub>σ</sub>	DEP	CONTIG
a. [naml]	*!		
b. [na.mil]		*	*

As illustrated in Tableau 3.11, the grammar of HA eliminates any rising-sonority coda cluster with vowel epenthesis. This epenthesis happens between the two consonants in the cluster, not at the edge of the stem, due to the high ranking of RIGHT-ANCHOR-IO, shown previously in Figure (3.6), repeated here as (3.20).

(3.20) ANCHOR-IO-RIGHT (ANCHOR):

“Any element at the right periphery of the input has a correspondent at the right periphery of the output (Kager, 1999, p. 251). Assign a violation for epenthesis or deletion at the right edge of a form.”

Tableau 3.12 shows that ANCHOR outranks CONTIG, preventing epenthesis from occurring at the edge of the stem. Instead, vowel epenthesis occurs between C<sub>1</sub> and C<sub>2</sub> in the coda cluster.

Tableau 3.12. No Epenthesis at the Right Edge of the Stem

/naml/ “ants”	ANCHOR	CONTIG
a. [nam.li]	*!	
☞ b. [na.mil]		*

It is clear from Tableau 3.12 that ANCHOR is respected, preventing epenthesis from occurring at the right edge of the stem, at the expense of violating CONTIG, by separating two consonants which are adjacent in the input via epenthesis of a vowel between them in the output form.

As discussed in chapter 2 §2.5, when a coda cluster exhibits rising sonority, several possible strategies to avoid this rising-sonority cluster are expected. One of them is the deletion of the second consonant in the coda cluster; however, the grammar of HA does not allow this strategy to occur. Tableau 3.13 demonstrates that MAX is high ranked, protecting consonants in coda clusters from deletion. For the definition of MAX, see Figure (3.6c).

Tableau 3.13. MAX is respected

/naml/ “ants”	*N <sub>2</sub> L <sub>1</sub> ] <sub>σ</sub>	ANCHOR	MAX	DEP	CONTIG
a. [naml]	*!				
☞ b. [na.mil]				*	*
c. [nam]		*!	*!		
d. [nal]			*!		*

As illustrated in Tableau 3.13, MAX is respected, preventing consonants in coda clusters from being deleted. Candidates (c) and (d) fail because they delete consonants from the coda cluster, incurring fatal violations of MAX, with an additional violation of ANCHOR for candidate (c), as it deletes a consonant from the edge, and of CONTIG for candidate (d). Candidate (a) exhibits a one-

step rise in sonority in the cluster, which fatally violates the Split-Margin constraint, but does not violate any other constraint. Candidate (b) wins, because it does not violate any of the high-ranked constraints, instead violating DEP and CONTIG, allowing epenthesis between the two coda consonants. This means that the critical faithfulness constraint DEP is ranked below Split Margin constraints against rising-sonority codas but above the Split Margin constraints against level- and falling-sonority codas as shown in previous tableaux.

Having demonstrated the failure of the first strategy, resolving the cluster by deletion, in Tableau 3.14 we show that another strategy for resolving rising-sonority coda clusters, which changes the sonority of the second consonant, also fails, due to the high ranking of ID-[son], reproduced here from (3.6).

(3.21) IDENTITY[sonorant]-IO (ID-[son]):

“Correspondent segments in the input have identical values for the feature [ $\pm$ sonorant] in the output (Kager, 1999, p. 250). Assign a violation any time an output consonant has a different value for [ $\pm$ sonorant] than its corresponding input segment.”

*Tableau 3.14. No Change in the Sonority of Coda Clusters*

/naml/ “ants”	*N <sub>2</sub> L <sub>1</sub> ] <sub>σ</sub>	ID-[son]	DEP	CONTIG
a. [naml]	*!			
b. [namd]		*!		
☞ c. [na.mil]			*	*

It is clear from Tableau 3.14 that candidate (c) wins, because it preserves the sonority of the coda, even though it violates DEP and CONTIG. Candidate (b) loses because it violates high ranked ID-[son] by changing [l] to [d], which has a lower sonority than the preceding [m]. Yet

another solution to this rising-sonority coda cluster, which is not considered in the tableau, would be a total assimilation process, which changes /naml/ to [namm] or [nall]. These candidates would violate high-ranked IDENT-[PLACE], and would require epenthesis regardless, so as to respect high-ranked OCP-[nasal] or OCP-[son, cor]. Other repair strategies which could be considered to eliminate the potential rising-sonority coda cluster in a word such as /naml/ are ones with geminate codas, [nam:] and [nal:]. These candidates would be eliminated due to the high ranking of MAX. This is because one of the underlying word-medial or word-final consonants deletes.

Yet another possible solution to the rising-sonority coda cluster could be suggested, that being metathesis of the two consonants in the coda. For example, /naml/ could become [nalm]. However, LINEARITY is an undominated constraint in HA and many Arabic dialects.

After providing the analysis for the typical case of rising-sonority coda clusters in HA, there are still consonants which exhibit different behavior when they are in the syllable coda in HA, such as the status of the glide and *ʿayn*, especially as the first consonant in the coda cluster. The analysis of the glide in the coda cluster will be provided in Chapter 4.

### **3.5. Discussion and Conclusion**

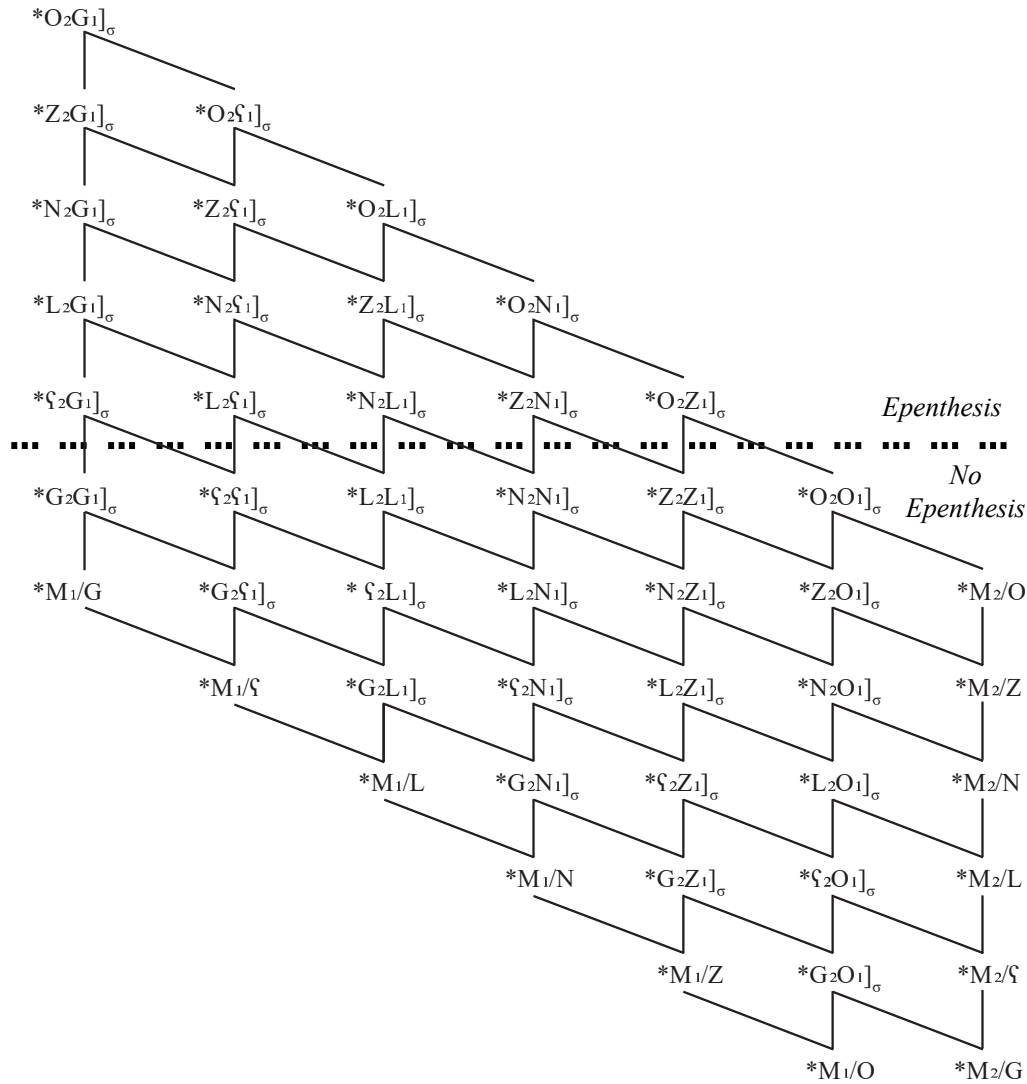
This chapter has provided the OT analysis of coda clusters of the sound-root grammar in HA based on the findings of the previous chapter. In Chapter 2 I have discussed the status of the sonority of consonants in HA including gutturals and provided several phonological and phonetic pieces of evidence, which helped to determine the most appropriate sonority scale for HA. Figure (3.22) repeats the final sonority scale of HA.

(3.22) Final Sonority Hierarchy for Hijazi Arabic

<i>Natural class</i>	<i>Sonority index</i>
Vowels	7
Glides	6
Voiced pharyngeal /ʕ/	5
Liquids	4
Nasals	3
Voiced fricatives, including /z, zʕ, ʁ, ɦ/	2
Other obstruents, including /ʔ, ʕ, ɣ, dʒ/	1

This scale ranks /ʕ/ as the most sonorous segment after glides and ranks the remaining gutturals with other obstruents except for /ʁ/ and /ɦ/, which pattern with voiced fricatives as more sonorous than other obstruents due to voicing and continuancy features. This sonority scale was the baseline to establish the Split-Margin constraints, which regulate the coda cluster in HA.

Figure (3.23) repeats the Hasse diagram of Split-Margin constraints for HA.



(3.23) Hasse diagram of Split-Margin constraints for the sonority hierarchy of HA with the decisive DEP and CONTIG constraints. The diagram is divided by epenthesis and faithful clusters. The dotted line represents the decisive faithfulness constraints DEP and CONTIG. Above the line, epenthesis occurs because of the rising-sonority clusters. Below the line, coda clusters surface faithfully, because they are plateau- and falling-sonority clusters, unless other phonological processes play a role.

In this analysis, besides the Split-Margin Approach to the syllable, several faithfulness constraints preventing epenthesis within coda clusters were ranked between the conjoined Split-Margin constraints, which prevent level- and falling-sonority codas and those that prevent rising-sonority codas. This results in HA allowing falling- and level-sonority clusters, but crucially

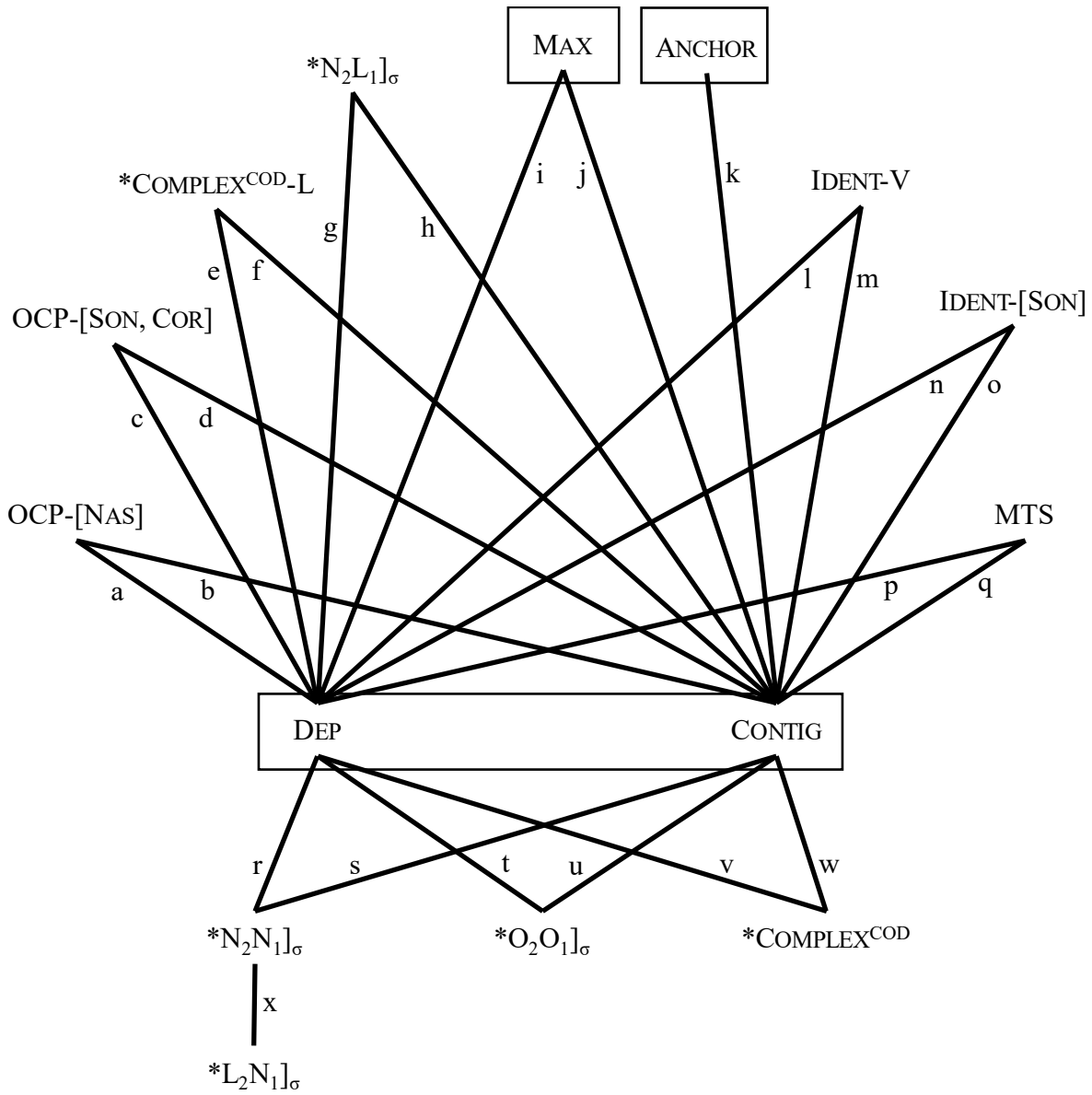
never rising-sonority clusters, as long as these clusters are not prohibited by other undominated constraints that are ranked independently of the Split-Margin constraints. Consider words with falling sonority coda clusters, which surface faithfully, for example, /bard/ → [bard] “cold (noun)” and /bint/ → [bint] “girl, daughter.” In the same way, words with a plateau sonority cluster surface faithfully without epenthesis, for example, /ʕagd/ → [ʕagd] “contract” and /nafʃ/ → [nafʃ] “soul.”

However, some plateau coda clusters do not surface faithfully even though they satisfy the Split-Margin constraints that allow level-sonority coda clusters. This is because they violate other undominated constraints independent of the Split-Margin hierarchy such as OCP-[NAS]. For example, the word /ʔamn/ “safety, security” surfaces with vowel epenthesis as [ʔa.min] and /kunm/ “plundering” as [ku.num]. In the same way, some falling-sonority coda clusters do not surface even though they are allowed by the general rules of HA grammar. This is because they exhibit an OCP violation by having two adjacent coronal sonorant segments within the potential coda cluster. For example, the word /furn/ ‘furnace’ surfaces with vowel epenthesis as [fu.r<sup>h</sup>un] and /garn/ “century” as [ga.rin]. Besides OCP-[NAS] and OCP-[SON, COR], which are ranked independently of the Split-Margin constraints and which prevent some falling- and level-coda clusters from surfacing faithfully, there are still other constraints that force epenthesis in the output form such as MTS. This constraint requires the output form of some level- and falling-sonority coda clusters, which would otherwise surface faithfully, to surface with an epenthetic vowel. For example, the word /liʕb/ “playing”, which would exhibit a falling-sonority coda cluster, surfaces as [li.ʕib] and the word /d<sup>h</sup>iħk/ “laughing”, which would exhibit a plateau sonority coda cluster, surfaces as [d<sup>h</sup>i.ħik]. These words surface with an epenthetic vowel that separates the consonants in the coda cluster, imitating the Masdar template *faʕil*, which exhibits a

high vowel in the second syllable. Yet, some level- and falling-sonority coda clusters surface with epenthesis even though similar coda clusters in other words surface faithfully. This is because the lexical effect on these certain words forces these words to surface with an epenthetic vowel. Consider, for example, the word /taħt/ “downstairs”, which surfaces with an epenthetic vowel as [ta.ħat] in order to satisfy the high-ranked \*COMPLEX<sup>COD</sup>-L. On the other hand, /naħt/ “carving”, which has the same consonants in the coda cluster, surfaces faithfully without an epenthetic vowel. This is because this word is governed by the general rule of sonority-driven epenthesis and not restricted by the lexical constraint, \*COMPLEX<sup>COD</sup>-L. In summary, falling- and level-sonority coda clusters surface without vowel epenthesis, unless these coda clusters violate other high-ranked constraints independent of the Split-Margin constraints such as OCP-[NAS], OCP-[SON, COR], MTS, and \*COMPLEX<sup>COD</sup>-L.

After we provided the analysis in which some falling- and level-sonority coda cluster sequences do not surface faithfully because of several high-ranked constraints such as OCP-[NAS], etc., we provided the analysis of rising-sonority coda clusters, which surface with an epenthetic vowel to break up such a prohibited cluster. Vowel epenthesis occurs in these forms because the rising-sonority Split-Margin conjoined constraints outrank DEP and CONTIG. In addition, RIGHT-ANCHOR-IO (ANCHOR) is an undominated constraint, which prevents epenthesis from occurring at the right periphery of the word i.e. after the second consonant of the coda cluster. Consider, for example, the word /naml/ “ant”, which surfaces with vowel epenthesis after the /m/ as [na.mil] and not \*[nam.li]. In addition, MAX and ID-[SON] are undominated constraints, which ensure that /naml/ surfaces as [na.mil], and not \*[nam] or \*[namd]. From all of this, we can conclude that the only strategy for avoiding rising-sonority coda clusters in HA is via vowel epenthesis, not by deletion of one of the coda consonants or desonorization of the

sonorant consonant. Figure (3.24) presents the Hasse diagram for the Sound Root grammar of HA.



(3.24) Hasse Diagram of the Sound Root Grammar of HA.

Table 3.1 provides an index for the constraint ranking in the Hasse diagram in Figure (3.24).

Table 3.1

*Index of Constraint Rankings for Sound Root Grammar*

	Ranking	Tableaux	Section	Example Word
a.	OCP-[NAS] >> DEP	3.7, 3.8	3.3.2	[sa.min]
b.	OCP-[NAS] >> CONTIG	3.7, 3.8	3.3.2	[sa.min]
c.	OCP-[SON, COR] >> DEP	3.3, 3.4	3.2.2	[fu.r <sup>h</sup> un]
d.	OCP-[SON, COR] >> CONTIG	3.3, 3.4	3.2.2	[fu.r <sup>h</sup> un]
e.	*COMPLEX <sup>COD</sup> -L >> DEP	3.10	3.3.4	[ta.ħat], [naħt]
f.	*COMPLEX <sup>COD</sup> -L >> CONTIG	3.10	3.3.4	[ta.ħat], [naħt]
g.	*N <sub>2</sub> L <sub>1</sub> ] <sub>σ</sub> >> DEP	3.11	3.4	[na.mil]
h.	*N <sub>2</sub> L <sub>1</sub> ] <sub>σ</sub> >> CONTIG	3.11	3.4	[na.mil]
i.	MAX >> DEP	3.13	3.4	[na.mil]
j.	MAX >> CONTIG	3.13	3.4	[na.mil]
k.	ANCHOR >> CONTIG	3.12	3.4	[na.mil]
l.	IDENT-V >> DEP	3.9	3.3.3	[d <sup>h</sup> i.ħik]
m.	IDENT-V >> CONTIG	3.9	3.3.3	[d <sup>h</sup> i.ħik]
n.	IDENT-[SON] >> DEP	3.14	3.4	[na.mil]
o.	IDENT-[SON] >> CONTIG	3.14	3.4	[na.mil]
p.	MTS >> DEP	3.9	3.3.3	[d <sup>h</sup> i.ħik]
q.	MTS >> CONTIG	3.9	3.3.3	[d <sup>h</sup> i.ħik]
r.	DEP >> *N <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub>	3.7, 3.8	3.3.2	[sa.min]
s.	CONTIG >> *N <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub>	3.7, 3.8	3.3.2	[sa.min]
t.	DEP >> *O <sub>2</sub> O <sub>1</sub> ] <sub>σ</sub>	3.5, 3.6	3.3.1	[ʃagd]
u.	CONTIG >> *O <sub>2</sub> O <sub>1</sub> ] <sub>σ</sub>	3.9	3.3.3	[d <sup>h</sup> i.ħik]
v.	DEP >> *COMPLEX <sup>COD</sup>	3.10	3.3.4	[naħt]
w.	CONTIG >> *COMPLEX <sup>COD</sup>	3.10	3.3.4	[naħt]
x.	*N <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub> >> *L <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub>	Split Margin	3.1.1	

*Note.* Letters in the left column refer to labels in Figure (3.24).

This chapter has provided the analysis for sound trilateral roots with CVCC syllable shape in which neither of the consonants in the coda is a glide, a geminate or ‘*ayn*’ followed by another

sonorant. The interaction between Split-Margin constraints and other Markedness and Faithfulness constraints will continue to be illustrated in several separate grammatical components. This is because it is highly complicated and almost impossible to present the final Hasse diagram which includes all Split-Margin constraints and other Markedness and Faithfulness constraints used in this chapter and subsequent chapters, because of the excessive number of constraints and the complicated relationships between them. Therefore, I will zoom into each component of the HA coda cluster grammar and demonstrate how they interact with the Split-Margin constraints in separate Hasse diagrams, which interconnect to demonstrate coda cluster types in HA. Chapter 4 will provide the analysis of the status of glides, geminates and ‘*ayn* in the HA syllable coda.

## **Chapter 4: The Role of Glides, ‘Ayn and Geminates in Constructing the Coda Cluster of HA**

This chapter elaborates on the role of glides, ‘*ayn* and geminates in constructing the coda cluster in HA. Since the phonological process is different when these consonants occur in the coda of HA than the sound-root, this chapter provides an OT analysis of these consonants in which the grammar of these consonants interacts with the Split-Margin approach to the syllable yielding the final output form of HA codas containing these consonants.

Section 4.1 provides the analysis of coda clusters that would include a glide. Section 4.2 analyzes the coda clusters of HA that would include /ʕ/ with another sonorant. Section 4.3 analyzes the status of geminate codas in HA. Finally, Section 4.4 discusses and concludes.

### **4.1. The special status of glides**

This section elaborates on the role of the glide in constructing the coda cluster of HA. Since most Arabic words display triconsonantal roots, this chapter, as well as the other chapters in the dissertation, mainly deals with CVCC nominal and adjectival monosyllabic words. When the glide occurs as the second root consonant in a trilateral word, this is traditionally termed by the Arabic grammarians as a *hollow root*, whereas, when it ends with a glide, it is called a *weak root* (or *lame root*). This section starts by analyzing trilateral words of the weak type (§4.1.1) then provides an analysis of hollow roots, in which the glide and the preceding low vowel coalesce, in what some modern phonologists have described as monophthongization of a diphthong (Youssef, 2013; Kabrah, 2004); I analyze it rather as vocoid feature sharing and spreading (see §4.1.2). Section 4.1.3 summarizes glides in coda clusters.

### 4.1.1. Weak roots

When a glide would occur as the second member of a coda cluster in HA, it vocalizes in the surface form due to the general process of final glide vocalization in Arabic. This occurs even if the glide is preceded by another glide, forming a sonority plateau coda cluster. Words of this type are traditionally termed *weak roots* by the Arab grammarians. For example, the words /ʃawj, ʕawj/ surfaces as [ʃawi, ʕawi] “grilling,” “howl.” Figure (4.1) shows potential glide-final clusters, arranged in descending order from glide (a) to obstruent (e) according to the sonority of the first consonant in the coda cluster.

#### (4.1) Final Glide Vocalization in Consonant + Glide Clusters

	Underlying Form	Gloss	Surface Form	Possessed Form (3P.MASC)
a.	/ʃawj/	“grilling”	[ʃa.wi]	[ʃaw.ju]
	/ʕawj/	“howl”	[ʕa.wi]	[ʕaw.ju]
b.	/waʕj/	“awareness”	[wa.ʕi]	[waʕ.ju]
	/farw/	“fur”	[fa.r <sup>ʕ</sup> u]	[far <sup>ʕ</sup> .wu]
c.	/galj/	“frying”	[ga.li]	[gal.ju]
	/ʔazw/	“conquest”	[ʔa.zu]	[ʔaz.wu]
e.	/rabw/	“asthma”	[ra.bu]	[rab.wu]

As shown in the data in Figure (4.1), a final glide vocalizes, even if it is preceded by another glide, forming a level-sonority coda cluster in the underlying form (a).<sup>77</sup> Kabrah (2004, pp. 195–

<sup>77</sup> Recall from the introduction of §4.1 that glide-medial roots are called hollow and glide-final roots are called weak: the data in (4.1a) are both. The underlying sequence of the glides in (a) is /wj/ as the second and third consonants in the root, however the sequence /jw/ does not occur in HA. The data in (a) provide the right environment for final-glide vocalization and medial vowel-glide coalescence; however, final glide vocalization takes precedence, giving the impression that coalescence underapplies. The relationship between these rules in rule

200), in her analysis of sonority reversals in weak roots, proposes that glide-final coda clusters in rising-sonority weak roots are eliminated in the surface form by glide vocalization, because the vocoids cannot be a nucleus for the preceding consonant. Therefore, according to her, the SSP constraint outranks ID-[vocoid], allowing the final glide to vocalize. However, I take issue with some details of her analysis. The feature [+vocoid] includes both vowels and glides. Therefore, the constraint ID-[vocoid] should still not be violated, even when changing a glide into a vowel, as analyzed by Kabrah. Instead, I propose that the relevant constraint is NOWEAKCODACLUSTER, for reasons discussed below, and that this constraint outranks ID-[FEAT]-[VOCALIC], changing the glide ([-vocalic]) to a vowel ([+vocalic]) (Chomsky & Halle, 1968, p. 176). Regarding words in which both the second and third consonants in the underlying form are glides, as shown in Figure (4.1a), the medial glide does not vocalize due to the constraint against diphthongs, which eliminates sequences of vowels in Arabic nuclei. Figure (4.2) introduces the definitions of additional constraints used in analyzing final glide vocalization in HA.

#### (4.2) OT Constraints for Final Glide Vocalization

- a. NODIPH (Rosenthal, 1994, p. 21; 2006, p. 410; Trask, 1996, p. 114; McCarthy, 2008, p. 229):

“No diphthongs. Assign a violation for any two vowels of nonidentical quality which occur in a single syllabic nucleus in the output.”<sup>78</sup>

- b. IDENTITY-[FEAT]-[VOCALIC] (ID-[F]-[VOC]) (Kager, 1999):

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ordering would be bleeding: vocalization bleeds coalescence. Words that have medial and final glides in the root are accounted for in Tableau 4.1a.

<sup>78</sup> In Tableau 4.1a, NODIPH is ranked above ID-[F]-[VOC] so candidate (c) is eliminated because it violates NODIPH and candidate (d) is even worse because it violates NODIPH twice in the same nucleus, or it violates both NOHIATUS and ONSET if the final vowel [i] is parsed in a separate syllable.

“Assign a violation for any segment in the output which has a different value for [±vocalic] from its correspondent in the input.”<sup>79</sup>

Tableau 4.1a. Final Glide Vocalization in G<sub>2</sub>G<sub>1</sub> Clusters.

/fawj/ “grilling”	MAX	DEP	CONTIG	NODIPH	*G <sub>2</sub> G <sub>1</sub> ] <sub>σ</sub>	ID-[F]-[VOC]
a. [fawj]					*!	
☞ b. [fa.wi]						*
c. [fauj]				*!		*
d. [fauɪ]				*!*		**
e. [faw]	*!					
f. [faj]	*!		*			
g. [fa.waj]		*!	*!			

It is clear from Tableau 4.1a that the faithful candidate (a) loses because it preserves the final glide of the weak coda cluster, violating the Split-Margin constraint \*G<sub>2</sub>G<sub>1</sub>]<sub>σ</sub>. Candidate (b) is the winner because it only violates the lowest ranked constraint ID-[F]-[VOC], therefore, /j/ becomes [i], changing the feature of this segment from [-vocalic] to [+vocalic]. Candidate (c) loses because it vocalizes the first glide of the coda cluster and preserves the glide at the end of the stem, violating NODIPH. Candidate (d) is even worse than (c), because it violates the constraint NODIPH twice by vocalizing both glides; therefore, we end up with three different

<sup>79</sup> When ID-[F]-[VOC] is violated by glide vocalization changing the feature from [-vocalic] to [+vocalic], this entails changing the feature [consonantal] from [+cons] to [-cons]. Therefore, the constraint ID-[F]-[VOC] is sufficient for the ranking in this analysis. I assume that glides (like true consonants) are [-vocalic] while vowels are [+vocalic]. This is equivalent to the feature [syllabic] in the SPE (p. 354), where vowels are considered [+syllabic], and obstruents and sonorant consonants are normally considered [-syllabic]. My reasoning that glides are [-vocalic] in Arabic rests on the fact that glides behave like consonants in the lexical and morphological analysis of trilateral roots. In addition, ID-[F]-[VOC] only affects glides and not other consonants, which suggests a high-ranked ID-CONSONANTAL constraint that is not presented in the tableaux below for the sake of brevity.

vowels in a row; in addition, it violates ID-[F]-[VOC] twice. Candidates (e) and (f) are eliminated because they violate the undominated constraint MAX by deleting one of the segments of the coda cluster. Candidate (g) loses because it epenthesizes a vowel between the two glides in the cluster, fatally violating DEP and CONTIG.

The argument in Tableau 4.1a illustrates the most challenging case of final glide vocalization—namely, when it is preceded by another glide. However, when a glide is preceded by a nonglide consonant in the coda position, for example /farw/ → [fa.r<sup>h</sup>u] “fur,” the same ranking argument holds.

Tableau 4.1b. Final Glide Vocalization in L<sub>2</sub>G<sub>1</sub> Clusters

/farw/ “fur”	*L <sub>2</sub> G <sub>1</sub> ] <sub>σ</sub>	MAX	DEP	CONTIG	NODIPH	ID-[F]-[VOC]
a. [farw]	*!					
<sup>100</sup> b. [fa.r <sup>h</sup> u]						*
c. [fa.raw]			*!	*!		
d. [far]		*!				
e. [faw]		*!		*		

In Tableau 4.1b, NODIPH is vacuously satisfied by all candidates because the first consonant of the coda is not a glide and there is no reason to vocalize it. The faithful candidate (a) loses because it violates the \*L<sub>2</sub>G<sub>1</sub>]<sub>σ</sub> constraint, as it exhibits a rising-sonority coda cluster.<sup>80</sup>

Candidate (b) is the winner as it violates only the lowest ranked constraint, ID-[F]-[VOC], changing the value of the glide from [-vocalic] to [+vocalic]. Candidate (c) loses by violating the

<sup>80</sup> The [r] in candidate (a) in Tableau 4.1b should be emphatic [r<sup>h</sup>] since it is next to the glide /w/; however, it is presented as the plain [r] here because the main argument of this tableau is to illustrate final glide vocalization. The status of the emphatic [r<sup>h</sup>] will be analyzed in Chapter 5.

constraints DEP and CONTIG, which crucially outrank ID-[F]-[VOC]. Both candidates (d) and (e) are eliminated because they violate the undominated MAX constraint with an additional violation of CONTIG for candidate (e).

As mentioned in Chapter 3, the general strategy for HA to eliminate a rising-sonority coda cluster is vowel epenthesis. However, when the second consonant in the cluster is a glide, the strategy changes from vowel epenthesis to final glide vocalization, a less costly resolution, as ID-[F]-[VOC] is ranked lower than DEP and CONTIG. The words [ʃa.wi] and [fa.r<sup>h</sup>u] exhibit plateau and rising sonority coda clusters, respectively, if vocalization were not to take place; however, the final glide does vocalize due to the crucial ranking of  $*G_2G_1]_\sigma$  and  $*L_2G_1]_\sigma$  over ID-[F]-[VOC]. This ranking militates against having a glide at the end of the coda cluster.

Recall that  $*G_2G_1]_\sigma$ , a conjoined Split Margin constraint, penalizes the best possible  $M_2G_1]_\sigma$  coda cluster. Therefore, we can represent all Split Margin  $*M_2G_1]_\sigma$  constraints by the cover constraint in (4.3).

(4.3) NOWEAKCLUSTER ( $*M_2G_1]_\sigma$ ):

“No glides in the  $M_1$  position of a coda cluster. Assign a violation mark for any glide which occurs in  $M_1$  position in the coda cluster.”<sup>81</sup>

The constraint NOWEAKCLUSTER encompasses all Split-Margin constraints in which the glide is at the right edge of the syllable in a coda cluster. This cover constraint explains in a precise and elegant way why the glide vocalizes when it falls as the second consonant in the coda cluster and

---

<sup>81</sup> Word-final glides that are not part of clusters do not vocalize. For example, the word [ʃa:j] “tea”, which ends with a singleton glide in the coda, and the word [ʃaj:] “thing”, which ends with a geminate glide in the coda, both retain their final glides. Final glides also do not vocalize in function words. For example, the word [ʔaw] “or” and the word [ʔaj] “which” do not become  $*[ʔau]$  or  $*[ʔai]$ . This falls out from the predictions made by Tableaux 4.1a and 4.1b, because these words vacuously satisfy any level or rising Split-Margin conjoined constraint ending in a glide, by having a simple glide coda. Furthermore, if these glides were to vocalize, they would violate several high-ranked constraints, among them NODIPH and NOHIATUS.

why it is preserved in a simple coda. By labelling all glide-final Split-Margin constraints in this way, we capture the generalization that glide-final (weak) clusters are not allowed by the grammar of HA and many Arabic dialects. This does not contradict the inherent ranking of coda cluster constraints in the Split-Margin Approach to the syllable, because it preserves the hierarchy of constraints of that theory. In the relevant tableaux of this chapter, this cover constraint is presented at the same level as DEP and CONTIG, with no crucial ranking; however, the crucial ranking of this cover constraint with regard to other markedness and faithfulness constraints is depicted in the final Hasse diagram (§4.4), in which DEP and CONTIG crucially intervene between rising and level or falling Split-Margin constraints. This constraint is an innovation in the Split-Margin Approach to the syllable, which is motivated by the grammar of HA and most Arabic dialects.

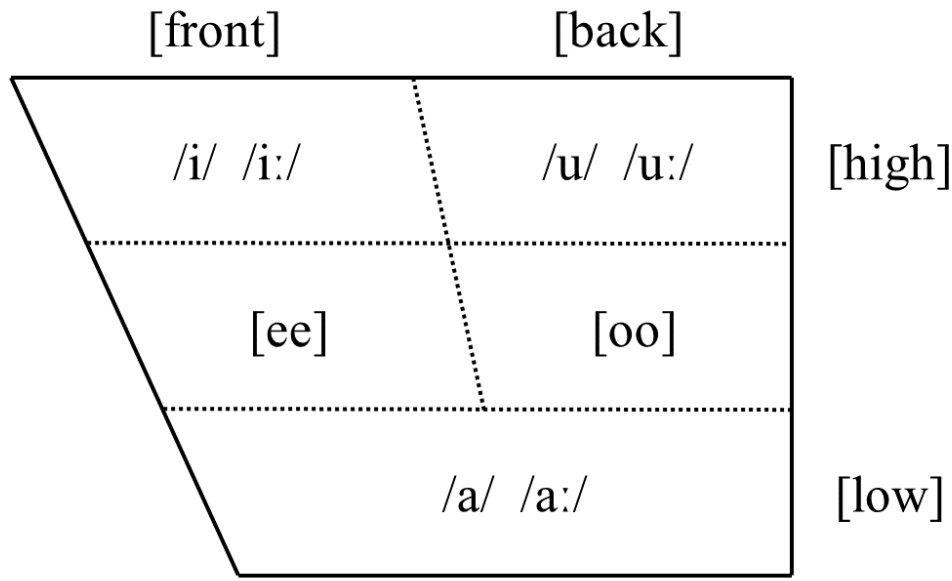
#### **4.1.2. Hollow roots**

A second phenomenon related to glides in the coda position of HA is vowel-glide coalescence in nouns and adjectives from trilateral roots, in which the second radical is a glide. This process happens only with the monosyllabic trilateral hollow roots. Regarding forms derived from this stem, the glide does not coalesce with the preceding vowel, because it is represented as either a simple coda or a geminate coda. In such words (shown in Figure (4.4)), when the glide is first in the coda cluster and is preceded by the low vowel /a/—that is, in the sequences /ajC/ and /awC/, where C represents any nonglide consonant, the glide vocalizes and coalesces with the preceding vowel.

#### (4.4) Vowel-Glide Coalescence in Hollow Noun and Adjective Roots

	Underlying Form	Gloss	Surface Form	Possessed Form (3P.MASC)	Related Form
a.	/bajʕ/	“sale”	[be:ʕ]	[be:.ʕu]	[baj.ja:ʕ] “salesperson”
b.	/nawʕ/	“type, kind”	[no:ʕ]	[no:.ʕu]	[ʔan.wa:ʕ] “kinds”
c.	/χajr/	“blessing”	[χe:r]	[χe:.rʕu]	[aχ.ja:r] “blessed people”
d.	/χajl/	“horse, PL.”	[χe:l]	[χe:.lu]	[χaj.ja:l] “jockey”
e.	/lawn/	“color”	[lo:n]	[lo:.nu]	[ʔal.wa:n] “color, PL.”
f.	/ʕajm/	“cloud”	[ʕe:m]	[ʕe:.mu]	[ʕu.ju:m] “cloud, PL.”
g.	/mawd̥ʒ/	“wave”	[mo:d̥ʒ]	[mo:.d̥ʒu]	[ʔam.wa:d̥ʒ] “wave, PL.”
h.	/bajt/	“house”	[be:t]	[be:.tu]	[bu.ju:t] “house, PL.”
i.	/ħawdʕ/	“basin”	[ħo:dʕ]	[ħo:.dʕu]	[ʔaħ.wa:dʕ] “basin, PL.”
j.	/lawħ/	“board”	[lo:ħ]	[lo:.ħu]	[ʔal.wa:ħ] “board, PL.”

This underlying glide in the first position of the coda cluster vocalizes and receives the [low] feature from the preceding vowel, thereby lowering to a mid vowel. It also spreads its [high] and [front] or [back] feature specification to the stem vowel, which is underlyingly only [low]. As backness is not contrastive in Arabic low vowels, I argue that the low central vowel is specified only for height and is not specified underlyingly as either [front] or [back]. For this reason, I represent [front] and [back] as privative features in Arabic, rather than as a binary [±back] feature. See also Al-Ani (1970, p. 25). Figure (4.5) depicts the phonemic vowel space for Arabic, including the two long mid derived vowels [ee] and [oo].



(4.5) Arabic Vowel Space.

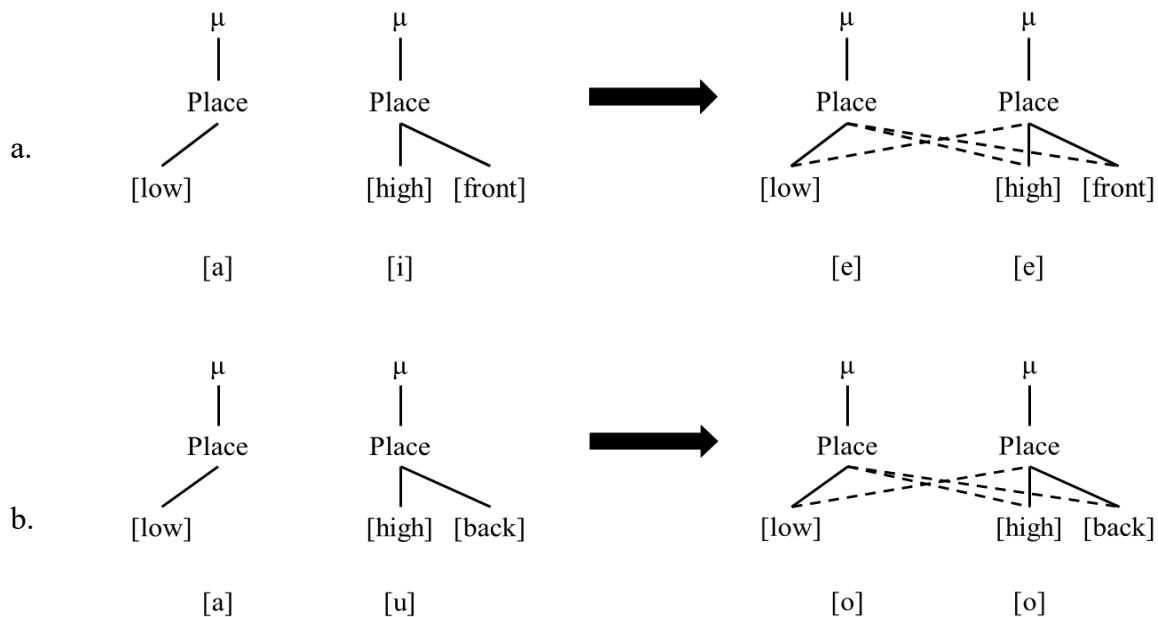
As depicted in Figure (4.5), Arabic has three phonemic short vowels /a i u/ and their long counterparts /a: i: u:/.<sup>82</sup> The features associated with the phonemic vowels are privative. With regard to the derived mid vowels, they are the result of the coalescence process between the stem low vowel and the following high glide. For this reason, they are represented in the vowel space by [ee] and [oo], which indicates that their underlying Place nodes are preserved.<sup>83</sup>

I analyze the vocalized glide as determining the feature specification for the preceding stem vowel in terms of frontness and backness. In addition, the sequences of /aw/ and /aj/ become [oo] and [ee], respectively, having both [high] and [low] features, which results in a surface mid vowel. This is consistent with Kostakis (2015, pp. 24–25, 147, 174–175; 2016, pp.

<sup>82</sup> According to McCarthy (2008, p. 220) languages tend to have triangular vowel systems, /i a u/ or /i e a o u/. In addition, according to Gordon (2016, pp. 58-60) /i a u/ is the most common system among languages with three vowels like HA. Therefore, the HA vowel system may be attributed to Quantal Theory, which is defined in Gordon (2016, pp. 63-64).

<sup>83</sup> This is a little bit different than the usual coalescence process in which two underlying segments coalesce yielding one segment on the surface carrying features from both underlying segments. The reason behind that is that preserving the underlying root place for the glide which conveys a lexical meaning in Arabic takes priority over the coalesced glide which fuses with the preceding vowel, yielding one segment on the surface.

1–3), who argues that mid vowels can be derived from the combination of the features [high] and [low]. These two changes of stem vowel and glide sequences are depicted in Figure (4.6). Note that the figure represents the coalescence between the stem vowel /a/ and the following [high] vowel, which is itself the result of glide vocalization changing the feature of the glide from [-vocalic] to [+vocalic].



(4.6) Feature Geometry of Vowel-Glide Coalescence in Hollow Roots.

The features, [high], [low], [back], and [front] are each represented on separate tiers; therefore, their lines of association do not cross. The coalescence process between a vowel and an adjacent glide does not violate OCP-[feature], because underlyingly there is only one instance of each feature spread between segments.<sup>84</sup> We cannot consider this coalescence process compensatory lengthening, as analyzed in Kabrah (2004). This is because both segments, the vowel and the glide, affect each other in terms of feature spreading. This is also not the typical case of

<sup>84</sup> In addition, according to Padgett (2011, p. 2), “Effects...of glides on vowels, affecting either vowel color (backness and/or roundness) or height...seem common in languages.”

compensatory lengthening as proposed by some linguists, in which the segment deletes with all its features, leaving a mora behind to be associated with the preceding vowel, causing lengthening yielding [o:] and [e:]. This is because they propose long mid vowels, where many Arabic dialects including HA do not have the short vowel equivalents, i.e. they are proposing a complex form, where the language does not have the simplex, which contradicts the predictions of markedness theory. The common form of compensatory lengthening attested in Arabic occurs with a deleted glottal stop. Examples of this are given in Figure (4.7).

(4.7) Compensatory Lengthening with Glottal Stop

- |    |        |        |         |
|----|--------|--------|---------|
| a. | /raʔs/ | [ra:s] | “head”  |
| b. | /faʔr/ | [fa:r] | “mouse” |

Kabrah (2004, pp. 194–197) analyzes the underlying sequence of vowel-glide in CVCC syllables as a diphthong, which undergoes a monophthongization process in the surface form. However, according to the definition of *diphthong* provided by Trask (1996, p. 114, emphasis is his), “a single syllabic **nucleus** which begins with one vowel quality and changes more or less smoothly to a second quality,” the sequence of vowel-glide labeled by Kabrah as a diphthong does not qualify. This is because there is only one vowel underlyingly, which is the low vowel, followed by a glide consonant, which is a root consonant and not part of the nucleus. Therefore, based on this definition, what Kabrah claims to be a monophthongization process on the surface, in which the underlying diphthong /aj/ or /aw/ becomes [e:] or [o:], does not hold, because according to Trask (1996, p. 226, emphasis is his), *monophthongization* is “any phonological process in which a **diphthong** is converted into a **monophthong**.” There is no underlying diphthong in the HA examples. In English, the word *bite* has a diphthongal nucleus, which starts with a full vowel and ends with an offglide (i.e., a *decrecendo*). The diphthongal nucleus does not change through

derivation in the present; for example, *bite* [bait̃] ~ *bites* ~ *biting*, whereas the Arabic word *bayt* /bajt/ “house” becomes [beet] in the singular, *buyuut* [bu.'ju:t] in the plural, and *bayyat* ['baj.jat] “cause so. to stay, PAST.” As illustrated by the examples, the diphthong nucleus in the English word *bite* is preserved throughout the present tense paradigm, whereas the sequence of the vowel and glide of the Arabic example coalesces in the underived surface form and is preserved in the plural and causative past tense by resyllabifying the glide (see also Herzallah, 1990, p. 146).

Youssef (2013, p. 187) argues against historical monophthongization, in which the sequences /aj/ and /aw/ become [ee] and [oo] in the underived environment; instead, it is synchronic. His evidence includes the fact that there are no short counterparts of these long mid vowels, several synchronic derivations in which the glides /w/ or /j/ surface based on the syllabic and morphophonological environment, and the contrast between long vowels and diphthongs in Cairene Arabic. His study investigates the sequence of a low vowel and a high vowel (/ai/ and /au/) and how the process of *monophthongization*, in his terminology, interacts with syllabification and morpheme structure.

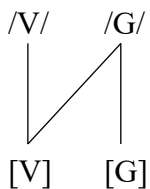
As part of his analysis, he analyzes the glides [j] and [w] as high vowels underlyingly, realized as glides based on position in the syllable; however, I take issue with this analysis of the glides. Glides as root consonants help to convey lexical meaning, like other root consonants in Arabic, and they are preserved in most morphophonological environments. Although the proposed underlying unity of glides and high vowels is valid for many languages (see Rosenthal, 1994, for a typology), the proposal which derives glides from underlying vowels in Arabic (a) contradicts the theory of the consonant root-based morphology of Arabic; (b) neglects the majority of cases of derived environments, in which the glide surfaces rather than a high vowel, which never surfaces in hollow nouns and adjectives without coalescing; and (c)

contradicts the definition of a diphthong in the same way as Kabrah (2004) by considering a sequence of the vowel and a glide to constitute a diphthong.

In addition, a consonantal glide cannot be derived from a high vowel in Arabic, in which vowels convey morphosyntactic rather than lexical information. The evidence that Youssef provides for the synchronicity of what he calls monophthongization is valid (see Youssef, 2013; Chapter 5); however, the proposal of this section treats a glide as a consonant which undergoes special phonological repair to avoid its occurrence within a coda cluster in HA. A glide undergoes vocalization cluster-finally (see §4.1.1), whereas cluster-initial glides in triliteral noun and adjective roots coalesce with the preceding stem vowel in the surface form.

Levi (2011) provides a thorough typological study on the realization of glides and vowels in a number of unrelated languages. Based on her study, she provides 8 common classifications of the realization of glides and vowels. Among them are the Type III languages with alternating underlying vowels, e.g. Sanskrit, Type V languages with non-alternating underlying vowels and non-alternating underlying glides, e.g. Turkish, and Type VII languages with non-alternating underlying vowels and alternating underlying glides, which is unattested according to her. Figure (4.8) illustrates the realization of vowels and glides in Type VII languages, which also corresponds to her figure (35b).

(4.8) Type VII Languages in Realization of Vowels and Glides (Levi, 2011, p. 359)



However, I argue that Hijazi Arabic, as well as many Arabic dialects, falls into Type VII of Levi's (2011) classification in which underlying vowels do not alternate with glides, but underlying consonantal root glides could alternate with vowels, which again corresponds to her interpretation in (35b). The analysis of glides provided by Youssef (2013) discussed above would correspond to Levi's (2011) Type III classification, in which an underlying vowel is realized as a glide in non-syllabic position, i.e. in the syllable onset or as a singleton coda. However, I believe that Cairene Arabic like Hijazi Arabic is better understood as a Type VII language. Consider the words in Figure (4.9) from the verbal and nominal paradigms in both Hijazi and Cairene Arabic.

(4.9) Verbal/Nominal Paradigm and the Realization of Underlying Medial Glides in HA and CA

a. Verbal Paradigm

Past 3P.MASC	Present 3P.MASC	Masdar	Gloss
[ba:ʕ]	[ji.bi:ʕ]	[be:ʕ]	“to sell”
[na:m]	[ji.na:m]	[no:m]	“to sleep”

b. Nominal Paradigm

Underlying Form	Gloss	Surface Form	Related Form
/bajʕ/	“sale”	[be:ʕ]	[baj.ja:ʕ] “salesperson”
/nawm/	“sleep (n)”	[no:m]	[naw.wa:m] “person who sleeps a lot”

In the examples in Figure (4.9), the underlying medial glide /j/ in the word /bajʕ/ and /w/ in /nawm/ in the nominal form surface as [be:ʕ] and [no:m] in which the medial glides coalesce

with the preceding stem vowel. These underlying glides surface in the nominal related forms [baj.ja:ʕ] and [naw.wa:m]. In the verbal paradigm, the underlying medial /j/ and /w/ vocalize in the present and the Masdar form. All of these examples demonstrate that the glides /j/ and /w/ in Hijazi and many other Arabic dialects, such as Cairene Arabic, fall in the Type VII category given by Levi (2011), in which underlying root consonantal glides are realized faithfully on the surface as a glide or unfaithfully as a high vowel, which, according to my analysis, undergoes the further phonological process of coalescing with the preceding stem vowel. With regard to final glides in both the verb and noun paradigm, consider Figure (4.10).

(4.10) Verbal/Nominal Paradigm and the Realization of Underlying Final Glides in HA and CA

a. Verbal Paradigm

Past 3P.MASC	Present 3P.MASC	Masdar	Gloss
[sa.ʕa]	[jis.ʕa]	[sa.ʕi]	“to endeavor”
[ʁa.za]	[jiʁ.zu]	[ʁa.zu]	“to conquer”

b. Nominal Paradigm

Underlying Form	Gloss	Surface Form	Related Form
/saʕj/	“endeavor (noun)”	[sa.ʕi]	[saʕ.ju] “his endeavor”
/ʁazw/	“conquering (noun)”	[ʁa.zu]	[ʁaz.wu] “his conquering”

The final glides /j/ and /w/ in the underlying words /saʕj/ and /kʌzw/ vocalize to [i] and [u] in the present and Masdar forms in the verb paradigm and the surface form in the noun paradigm. However, in the morphophonological environment in the process of suffixation with the 3<sup>rd</sup> person singular possessive, both the glide /j/ and /w/ surface faithfully in the words [saʕ.ju] and [kʌz.wu]. In addition, Levi (2011, pp. 359-360) suggested that the analysis of a language as a Type VII language “would require identification of a phonological phenomenon that treated ‘derived vowels’ (i.e. glides surfacing as vowels) as different from underlying vowels.” In Hijazi Arabic, a high vowel gets syncopated in double-sided open syllables, e.g. /kibir+u/ “they grow up” → [kib.r<sup>h</sup>u], \*[ki.bi.ru]. Compare this with /fawj/ “grilling”, which surfaces as [fa.wi], and /fawj+fa/ “her grilling”, which becomes [faw.ja.fɑ], \*[faw.fɑ]. In this example, there is no syncope of the underlying glide and instead there is vowel epenthesis and resurfacing of the underlying glide as an onset for the epenthetic vowel. This example demonstrates that the phonological process of syncope takes effect with an underlying high vowel in [kib.ru], whereas it does not take effect with the word [faw.ja.fɑ]. We can conclude from the examples given in Figure (4.9) and (4.10) that glides are strongly participating in the lexical meaning of the trilateral root like any other consonant, whereas the stem vowel conveys the syntactic information, such as the verb tense. Therefore, although the analysis of the surface glide which generates from the underlying vowel based on syllable position has strong support in many languages, I nevertheless believe that the trilateral consonantal root base of the glide strongly demonstrates that the glide is underlyingly a consonant in Arabic and is realized sometimes as a high vowel, based on the phonological alternation.<sup>85</sup>

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<sup>85</sup> There are some varieties of Arabic such as MSA and Lebanese Arabic that preserve the glide in the noun paradigm. For example, underlying /lawn/ “color” surfaces as [lawn] in both MSA and Lebanese Arabic. The glide is also preserved in the related forms such as [ʔal.wa:n] “colors.” Both varieties still can be considered as Type VII languages, even though they have fewer glide/vowel alternations than Cairene and Hijazi.

Figure (4.11) provides definitions for the additional constraints used in the analysis of glide-medial roots (i.e., hollow clusters).

(4.11) OT Constraints for Medial Glide Coalescence

a. MAX-VOCOID-[PLACE-FEATURE] (MAX-V-[F]):

“The place features associated with vocoids in the input must have correspondents in the output. Do not delete a place feature from a vowel or glide. Assign a violation mark for any vowel or glide place feature which is deleted.”

b. AGREE-VOWEL-PLACE (AGREE-V-PLACE):

“Adjacent tautosyllabic vowels agree in Place. Assign a violation for any place feature in the output which is not shared between adjacent vowels in a syllable.”<sup>86</sup>

c. \*MIDVOWEL:

“A word stem does not surface with a mid vowel. Assign one violation for any mid vowel occurring in a word stem.”

Tableau 4.2a provides an analysis of the coalescence process in the underlying hollow cluster.

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<sup>86</sup> A violation to this constraint is assigned by counting features that are not shared between two adjacent vowels.

Tableau 4.2a. [a]-[j] Coalescence in Underlyingly CVCC Words

/bajʃ/ “sale”	MAX	DEP	CONTIG	MAX-V-[F]	AGREE-V-PLACE	NODIPH	*G <sub>2</sub> σ <sub>1</sub> σ	ID-[F]-[VOC]	*MIDV
a. [bajʃ]							*!		
b. [beeʃ]								*	**
c. [biiʃ]				*!				*	
d. [baaʃ]				*!*				*	
e. [baiʃ]					*!***	*		*	
f. [beiʃ]					*!	*		*	*
g. [baeʃ]					*!*	*		*	*
h. [bajaʃ]		*!	*!						
i. [baʃ]	*!		*	**					
j. [baj]	*!								

The faithful candidate (a) loses even though it exhibits a falling sonority cluster, because it violates the Split Margin constraint. Candidate (b) is the winner, because it does not violate any constraint other than the lowest ranked ID-[F]-[VOC] and \*MIDV. The candidates (c) and (d) lose, despite respecting AGREE-V-[PLACE], like the winner, as they violate MAX-V-[F], which is ranked above ID-[F]-[VOC] and \*MIDV. Candidates (e), (f), and (g) all lose because they surface with a true diphthong, violating NODIPH and AGREE-V-[PLACE]. Candidate (e) fatally violates AGREE-[V]-[PLACE] by having two adjacent vowels in the stem with different features, in addition to violating NODIPH. In candidate (f), the high vowel only disagrees with the preceding vowel by not receiving the feature [low]. For (g), the first vowel in the stem does not receive the features [high] and [front] from the following vowel. Candidate (h) loses because it violates DEP

and CONTIG by epenthesizing a vowel between the glide [j] and [ʃ]. Candidates (i) and (j) both lose by violating the undominated MAX constraint.<sup>87</sup>

Since the hollow root word does not surface faithfully, as it exhibits a violation of the Split-Margin constraint, even though the coda cluster would exhibit a falling-sonority profile, we can propose another cover constraint, parallel to the one proposed in Figure (4.3), which encompasses all glide-initial Split-Margin constraints. This new cover constraint is defined in Figure (4.12).

(4.12) NOHOLLOWCLUSTER (\*G<sub>2</sub>M<sub>1</sub>]<sub>σ</sub>):

“No hollow coda clusters. Assign a violation for any glide which occurs in M<sub>2</sub> position in a coda cluster.”<sup>88</sup>

This cover constraint, NOHOLLOWCLUSTER, intersects with the previous cover constraint, NOWEAKCLUSTER, in words which contain two underlying glides as the second and third radicals. Tableau 4.2b analyzes a sequence of the low stem vowel [a] and the glide [w] in a trilateral hollow root.

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<sup>87</sup> Both NODIPH and AGREE-V-PLACE militate against candidates that surface with a true diphthong such as [ai], [au] etc. However, AGREE-V-PLACE has an additional function that motivates the featural agreement between the low stem vowel and the following glide. In addition, any violation of AGREE-V-PLACE is also a violation of NODIPH. Therefore, only AGREE-V-PLACE will be used in the following tableaux. NODIPH will be eliminated for the sake of brevity, but will be presented nonetheless in the Hasse Diagram in §4.4.

<sup>88</sup> The constraint NOHOLLOWCLUSTER does not include hollow clusters ending in a glide. Hollow clusters ending in a glide can be understood as hollow and weak clusters, which are addressed in the tableaux as \*G<sub>2</sub>G<sub>1</sub>]<sub>σ</sub>.

Tableau 4.2b. [a]-[w] Coalescence in Underlyingly CVCC Words

/nawʕ/ “type, kind”	MAX	DEP	CONTIG	MAX- V-[F]	AGREE- V- PLACE	*G <sub>2</sub> M <sub>1</sub> ] <sub>σ</sub>	ID-[F]- [VOC]	*MIDV
a. [nawʕ]						*!		
b. [nooʕ]							*	**
c. [nuuʕ]				*!			*	
d. [naaʕ]				*!*			*	
e. [nauʕ]					*!***		*	
f. [nouʕ]					*!		*	*
g. [naoʕ]					*!*		*	*
h. [na.waʕ]		*!	*!					
i. [naʕ]	*!		*	**				
j. [naw]	*!							

The faithful candidate (a) loses even though it exhibits a falling-sonority cluster, because it violates the Split-Margin constraint. Candidate (b) is the winner, because it does not violate any constraint other than the lowest ranked constraints ID-[F]-[VOC] and \*MIDV. MAX-V-[F] is not violated by coalesced segments, because all original features are preserved. Also, [round] is an inherent feature of back vowels in Arabic. The candidates (c) and (d) lose, despite respecting AGREE-V-[PLACE], like the winner, as they violate MAX-V-[F]. Candidates (e), (f), and (g) all lose because they violate AGREE-V-[PLACE] by surfacing with a true diphthong. The constraint NODIPH is eliminated from this tableau for the sake of brevity. Candidate (h) loses because it violates DEP and CONTIG by epenthesizing a vowel between the glide [w] and [ʕ]. Candidates (i)

and (j) both lose by violating the undominated MAX constraint. In addition, candidate (i) also violates MAX-V-[F] and CONTIG.

Having presented the analyses in which glide-final weak roots vocalize in §4.1.1 and in which glide-medial hollow roots coalesce in Tableaux 4.2a and 4.2b of this section, now Tableau 4.3 reanalyzes the trilateral root examined in Tableau 4.1a, /ʃawj/, in which the second and third radicals are glides (a hollow and weak root), using the same constraint ranking of Tableaux 4.2a and 4.2b.

With regard to the Split-Margin constraint,  $*G_2G_1]_{\sigma}$  is retained in Tableau 4.3, instead of the two cover constraints,  $NOWEAKCLUSTER (*M_2G_1]_{\sigma})$ , as presented in 4.1b, and  $NOHOLLOWCLUSTER (*G_2M_1]_{\sigma})$ , as presented in 4.2a-b, for the sake of explicitness, as  $*G_2G_1]_{\sigma}$  fulfills the function of both cover constraints in this instance. Tableau 4.3 presents the analysis for the weak and hollow root, in which the final glide vocalizes instead of the first glide coalescing.

Tableau 4.3. No Vowel-Glide Coalescence in Hollow and Weak Roots

/fawj/ “grilling”	MAX	DEP	CONTIG	MAX- V-[F]	AGREE- V- PLACE	*G <sub>2</sub> G <sub>1</sub> σ	ID-[F]- [VOC]	*MIDV
a. [fawj]						*!		
b. [fa.wi]							*	
c. [fooj]							*	*!*
d. [fooi]					*!***		**	**
e. [fauj]					*!***		*	
f. [fauj]					*!****		**	
g. [fa.waj]		*!	*!					
h. [faw]	*!			**				
i. [faj]	*!		*	**				

Candidate (a) loses because it violates the Split-Margin constraint. Candidate (b) is the winning candidate, because it does not violate any constraint but the lowest constraint ID-[F]-[VOC]. The final glide vocalizes to [i]. Therefore, the preceding [w] will form the onset of the newly created syllable with [i] forming the nucleus of this syllable. Candidate (c) loses, because it violates \*MIDV twice by having two mid vowels in the output; in addition, it violates ID-[F]-[VOC]. This tableau shows that both processes of final glide vocalization and vowel-glide coalescence compete until we reach the lowest constraint \*MIDV, where the winner performs better by not violating this constraint, whereas (c) violates this constraint twice.<sup>89</sup> For candidate (b), the

<sup>89</sup> Another potential constraint can be suggested to select the expected winner in (b) over its close competitor in (c), even if \*MIDV is not present. This constraint is OCP-[HIGH], in which there is a restriction against two segments occurring with the feature [high] in the syllable rhyme, as in the following:

OCP-[HIGH]: No two adjacent [high] features in a syllable rhyme. Assign a violation any time two adjacent [high] features occur in a syllable rhyme.

Recall from Figure 4.6b that, while the second [o] does receive the [low] feature from the preceding stem vowel, it also preserves [high] from /w/ as a result of word-medial glide vocalization. This [high] feature precedes the [high]

winner, the process of final glide vocalization applies; for candidate (c), which loses, the process of vowel-glide coalescence applies. Candidate (d) is least harmonic because it exhibits both final glide vocalization and vowel-glide coalescence; therefore, it violates each of the low ranked constraints twice in addition to violating AGREE-V-PLACE three times. This is because the [i] is not receiving the [low] and [back] features from the preceding [o] and the [o] is not receiving the [front] feature from the [i]. Candidate (e) loses because it violates AGREE-V-PLACE three times; in addition, it violates ID-[F]-[VOC]. Candidate (f) is even worse than (e) because it violates AGREE-V-PLACE four times; in addition, it has two violations of ID-[F]-[VOC]. Candidate (g) loses because it violates the high-ranked DEP and CONTIG by epenthesizing a vowel between the glides. Both candidates (h) and (i) violate MAX and MAX-V-[F] by deleting one of the two glides with an additional violation of CONTIG for (i).<sup>90</sup>

#### 4.1.3. Summary of glides in coda clusters

We can conclude from the previous tableaux that the grammar of HA and many Arabic dialects does not tolerate glides appearing in M<sub>1</sub> position in the coda cluster in a weak root, even if the coda cluster exhibits the best possible glide-final coda, as in /ʃawj/ “grilling.” The strategy of HA, as with many Arabic dialects, of avoiding this cluster is final glide vocalization, which forces both glides to form a new light syllable in the process of resyllabification in the output form. In the same way, the grammar also does not allow a glide to appear in M<sub>2</sub> position in the

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of the glide /j/, which falls in the coda in candidate (c) (i.e., [ʃooj]). OCP-[HIGH] is borne out by Arabic grammar, which exhibits no sequence of nongeminate iw]<sub>σ</sub>, uw]<sub>σ</sub>, ij]<sub>σ</sub>, or uj]<sub>σ</sub> (e.g., MSA *mašwīj* [maf.ˈwiːj] “grilled;” cf. HA *mašwi* [ˈmaf.wi]). See also Rosenthal (2006, p. 411) for \*ADJACENTHIGHVOCIDS, a similar constraint which prevents high vocoids from occurring adjacent to each other. In Arabic, the [high] feature is associated with vocoids. Other analyses consider the feature [high] for nonglide consonants (e.g., Middle High German; see Hall, 2008, p. 220). The feature [high] is also useful in characterizing segments that block rightward pharyngealization spread (emphasis spreading) in some dialects; see Davis (1995). However, this constraint is not fully necessary in the analysis here, because the low-ranked constraint \*MIDV prevents candidate (c) from winning, as it has two mid vowels in the stem.

<sup>90</sup> I assume that any violation of MAX that occurs by the deletion of one of the glides is also a violation of MAX-V-[F], since the features of the glides do not surface in the output form for these candidates.

coda cluster of the hollow root. Even though the glide is followed by a consonant which is lower in sonority, the strategy of the grammar of HA to avoid such a cluster is to vocalize the glide and have it coalesce with the preceding vowel. In other words, glides do not cluster. Therefore, two new cover constraints are proposed in the analysis to prevent glides from appearing in the coda cluster. These are  $\text{NOWEAKCLUSTER} (*M_2G_1]_\sigma)$ , which prevents glides from appearing as the second consonant of a coda cluster, and  $\text{NOHOLLOWCLUSTER} (*G_2M_1]_\sigma)$ , which prevents glides from appearing as the first consonant of a coda cluster. In a word like /fawj/, in which both cover constraints intersect, by having a weak and hollow cluster, final glide vocalization takes precedence by violating  $\text{ID-[F]-[VOC]}$ , changing the glide from [-vocalic] to [+vocalic]. These two cover constraints are well-motivated by the grammar of Arabic as observed by the Arab grammarians and given formal definition by the mechanism of the Split Margin approach to the syllable. In the ranking argument, the cover constraint is presented to encompass all relevant conjoined Split Margin constraints as a shorthand. However, these conjoined Split Margin constraints will be presented intact in the final Hasse diagram together with other Split Margin and faithfulness constraints. These two cover constraints could be unified into a single constraint, such as  $\text{NOGLIDE/CODACLUSTER}$ , which penalizes any glide in a coda cluster. However, I prefer to use the two Split Margin cover constraints  $*M_2G_1]_\sigma$  and  $*G_2M_1]_\sigma$  instead of using this broader cover constraint  $\text{NOGLIDE/CODACLUSTER}$ , since the phonological process is different when the word contains a final glide than when the word contains a medial glide.

#### **4.2. Coda Condition and OCP-[son] with ‘ayn in HA**

This section provides an analysis for /ʕ/ when it would fall in a coda cluster. As illustrated in Figure (2.23), reproduced here as (4.13), /ʕ/ falls in a high position in the sonority

scale, after only the glides, and is a [+sonorant] consonant.

(4.13) Sonority Hierarchy for Hijazi Arabic (Final)

<i>Natural class</i>	<i>Sonority index</i>
Vowels	7
Glides	6
Voiced pharyngeal /ʕ/	5
Liquids	4
Nasals	3
Voiced fricatives, including /ʁ, ɦ/	2
Other obstruents, including /ʔ, ʕ, χ, d̥ʒ/	1

Therefore, when /ʕ/ is word-final and preceded by any nonglide consonant, epenthesis occurs in the output form to eliminate this potential rising-sonority cluster. This is illustrated in Figure (4.14) below.

(4.14) Potential ‘*ʕyn*-Final Rising-Sonority Coda Clusters

	Underlying	Gloss	Surface Form	Possessed Form (3P.MASC)
a.	/dirʕ/	“shield”	[di.riʕ]	[dir.ʕu]
	/farʕ/	“branch”	[fa.riʕ]	[far.ʕu]
b.	/balʕ/	“swallowing”	[ba.liʕ]	[bal.ʕu]
	/χalʕ/	“extracting”	[χa.liʕ]	[χal.ʕu]
c.	/manʕ/	“forbidding, prohibiting”	[ma.niʕ]	[man.ʕu]
d.	/ʃamʕ/	“wax”	[ʃa.miʕ]	[ʃam.ʕu]
	/samʕ/	“hearing”	[sa.miʕ]	[sam.ʕu]
e.	/nazʕ/	“extraction, taking away”	[na.ziʕ]	[naz.ʕu]
f.	/wadʕiʕ/	“position”	[wa.dʕiʕ]	[wadʕi.ʕu]
	/rafʕ/	“raising”	[ra.fiʕ]	[raf.ʕu]

As shown in Figure (4.14), a word-final /ʕ/ preceded by any consonant other than glides receives an epenthetic vowel in the output form, with no exceptions. This occurs even if the /ʕ/ is preceded by a liquid, as shown in (a) and (b), demonstrating that /ʕ/ has higher sonority than liquid consonants. However, in any potential coda cluster, in which /ʕ/ occurs first and is followed by any nonglide sonorant consonant, epenthesis still occurs in the output form, as shown below in Figure (4.15a–d). With regard to coda clusters in which /ʕ/ is followed by an obstruent consonant, including a voiced fricative, epenthesis does not occur in the output form, as shown in (4.15e–f).

(4.15) Underlying Coda Clusters with Medial [ʕ] in Hijazi Arabic

	Underlying	Gloss	Surface Form	Possessed Form (3P.MASC)
a.	/siʕr/	“price”	[si.ʕir]	[siʕ.r <sup>ʕ</sup> u]
	/ʃiʕr/	“poetry”	[ʃi.ʕir]	[ʃiʕ.r <sup>ʕ</sup> u]
b.	/fiʕl/	“action, verb”	[fi.ʕil]	[fiʕ.lu]
	/naʕl/	“shoe”	[na.ʕil]	[naʕ.lu]
c.	/taʕn/	“stabbing”	[ta.ʕin]	[taʕ.nu]
	/laʕn/	“cursing”	[la.ʕin]	[laʕ.nu]
d.	/daʕm/	“support”	[da.ʕim]	[daʕ.mu]
	/t <sup>ʕ</sup> aʕm/	“taste”	[t <sup>ʕ</sup> a.ʕim]	[t <sup>ʕ</sup> aʕ.mu]
e.	/waʕz <sup>ʕ</sup> /	“sermon”	[waʕz <sup>ʕ</sup> ]	[waʕ.z <sup>ʕ</sup> u]
f.	/kaʕk/	“cake”	[kaʕk]	[kaʕ.ku]
	/baʕd <sup>ʕ</sup> /	“some”	[baʕd <sup>ʕ</sup> ]	[baʕ.d <sup>ʕ</sup> u]
	/kaʕb/	“heel”	[kaʕb]	[kaʕ.bu]

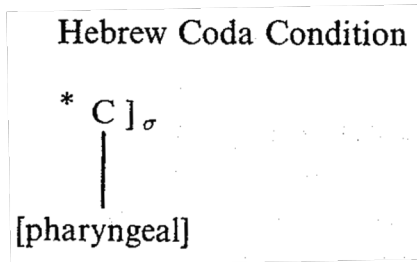
/ʃaʕb/	“people”	[ʃaʕb]	[ʃaʕ.bu]
/daʕs/	“stepping-over, crashing”	[daʕs]	[daʕ.su]

From Figure (4.15), it can be said that potential coda clusters in which /ʕ/ is followed by a sonorant behave differently from coda clusters in which /ʕ/ is followed by an obstruent consonant. The former type requires vowel epenthesis in the output form, whereas the latter type surfaces faithfully without vowel epenthesis. This provides evidence that there is a type of restriction preventing /ʕ/ from falling in a coda cluster with another sonorant.

As we proposed in §2.2, supported by several types of phonetic and phonological evidence, gutturals constitute a natural class in Semitic languages. These guttural consonants share a broad region of articulation in the back part of the vocal tract and exhibit similar behavior with regard to certain phonological processes. However, there are still some differences between different subclasses of gutturals and between individual segments within these subclasses, as argued in chapter 2. Therefore, we concluded that /ʕ/ in HA occupies the highest sonority level among gutturals, based on the differences observed between this segment and the other gutturals.

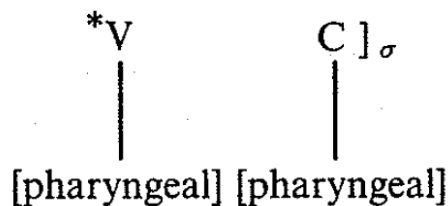
Yet another difference between /ʕ/ and other gutturals in HA can be observed in terms of its behavior in coda clusters. /ʕ/ exhibits resistance to syllabification as the first consonant in a coda cluster when it is followed by another sonorant consonant, even if this potential cluster has a falling sonority profile. I analyze this resistance as a subtype of the general guttural coda condition described by McCarthy (1994) in Semitic languages in general. It is unremarkable that only /ʕ/ exhibits this condition, distinct from other gutturals, since it has a much higher sonority profile than other gutturals, which are all classified with obstruents and voiced fricatives in terms of sonority. McCarthy (1994, p. 216) proposes the following constraint for Hebrew, given in Figure (4.16).

(4.16) Hebrew Coda Condition (McCarthy, 1994)



This constraint restricts the occurrence of any guttural in a syllable coda in Hebrew, except in stem-final or word-final position. Note that McCarthy analyzes all gutturals, including uvulars and laryngeals, as having the feature [pharyngeal]. Similar to the constraint proposed for Hebrew, he also proposes another constraint for Arabic, specifically Bedouin varieties such as Bedouin Hijazi Arabic, which prevents gutturals from occurring in a syllable rhyme when preceded by a low vowel (p. 215). His constraint is given in Figure (4.17).

(4.17) No Gutturals in Syllable Coda in BHA (McCarthy, 1994)



He analyzes this as a type of OCP constraint, which militates against the occurrence of two adjacent [pharyngeal] segments (pp. 213–216). Similar to the Hebrew constraint, this constraint does not restrict stem- or word-final gutturals. Consider the examples in Figure (4.18), extracted from McCarthy (1994).

(4.18) Examples of Coda Condition in Bedouin Hijazi Arabic (McCarthy, 1994)

- a. /jaχdim/ → jaχadim → [jχa.dim] “serve, 1P.MASC.SG”  
91
- b. /tiħtirim/ → tiħtirim → [tiħ.ti.rim] “respect, 1P.FEM.SG”

Epenthesis does not occur in (4.18b) because the guttural consonant is preceded by a high vowel, and hence there is no motivation for epenthesis to occur. Compare these examples with the ones for Urban Hijazi Arabic, given in Figure (4.19).

(4.19) Nonapplication of Coda Condition with non-[ħ] Gutturals in HA

- a. /gafiwa/ → [gafi.wa] \*[għa.wa] “coffee” (cf. BHA [għa.wa])
- b. /faħra/ → [faħ.ra] \*[fħa.ra] “strand of hair” (cf. BHA [fħa.ra])

From Figure (4.18), we can note that: (a) the Coda Condition with regard to all guttural consonants is active in BHA, prohibiting gutturals from falling in a coda position by epenthesizing a vowel, which forces the guttural into onset position during resyllabification; (b) Urban HA does not exhibit a Coda Condition effect when a guttural other than /ħ/ falls in coda position; and (c) even when /ħ/ falls in a coda, it is only targeted by the Coda Condition if the coda is complex, and when it is followed by another sonorant. Therefore, in order to provide an analysis of vowel epenthesis in  $\zeta + C_{\text{sonorant}}$  consonant clusters in HA, there is a need to posit a modified coda condition constraint for HA.

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<sup>91</sup> Note that the first vowel in the intermediate stage deletes, creating an onset cluster in the output form, as a result of low vowel deletion, when it is followed by two open syllables.

(4.20) CODACONDITION (\*ʕ]<sub>Co</sub>):

“No [ʕ] in a syllable coda. Assign a constraint violation for every segment [ʕ] which occurs in a syllable coda in the output (reformulated from McCarthy, 1994). This constraint does not target stem or word-final [ʕ].”

This constraint is ranked below DEP and CONTIG, which themselves are outranked by the undominated MAX constraint, making sure that single [ʕ] in a coda does not receive an epenthetic vowel or delete. In order to eliminate syllabifications with complex onsets, an additional constraint is required.

(4.21) \*COMPLEX<sup>ONS</sup> (\*<sub>o</sub>[CC):

“Onsets are simple (Kager, 1999, p. 97).”

This constraint is undominated in HA as well as some Arabic dialects which do not allow onset clusters. Consider Tableau 4.4, in which single [ʕ] surfaces faithfully in the coda.

Tableau 4.4. Single [ʕ] in a Coda is Protected

/ʃaʕra/ “strand of hair”	MAX	* <sub>o</sub> [CC	DEP	CONTIG	*ʕ] <sub>Co</sub>	*M <sub>2</sub> /ʕ
a. [ʃaʕ.ra]					*	*
b. [ʃa.ʕa.ra]			*!	*!		
c. [ʃa.ra]	*!			*		
d. [ʃa.ʕa]	*!			*		
e. [ʃa.ʕra]		*!				
f. [ʃʕa.ra] <sup>92</sup>	*!	*!	*	*		*

<sup>92</sup> Some analyses consider metathesis in this candidate (see Al-Mozainy 1981). However, I assume that this candidate arises from deletion and epenthesis. If we would consider the metathesized candidate to win, as some argue to be the case in BHA, an additional constraint such as LINEARITY, which is not necessary in HA because it is inviolable, would be crucial for the grammar of BHA. This constraint would be ranked low along with \*<sub>o</sub>[CC in order to motivate candidate (f) to win.

The faithful candidate (a) is the winner, even though it violates CODA CONDITION and \*M<sub>2</sub>/ʕ, which are ranked low.<sup>93</sup> Candidate (b) epenthesizes a vowel after [ʕ] to satisfy CODA CONDITION at the expense of violating higher-ranked DEP and CONTIG, which cause this candidate to lose. Candidates (c) and (d) lose because they violate the undominated MAX constraint by deleting one consonant in the output. Candidate (e) loses because it violates undominated \*COMPLEX<sup>ONS</sup>. Candidate (f), which represents the most harmonic candidate in Bedouin Hijazi Arabic, is the worst with regard to Urban Hijazi Arabic, because it violates both MAX, by deleting the first vowel, and \*COMPLEX<sup>ONS</sup>; in addition, it violates DEP and CONTIG, by inserting a vowel between two adjacent consonants, and \*M<sub>2</sub>/ʕ, by syllabifying [ʕ] in M<sub>2</sub> position of the onset. In Tableau 4.5a, [ʕ] gets an epenthetic vowel when it is followed by another sonorant, obeying CODA CONDITION.

Tableau 4.5a. Spurious Underapplication of Epenthesis in ʕ<sub>2</sub>L<sub>1</sub>]<sub>σ</sub> Clusters with \*ʕ]<sub>C<sub>0</sub></sub>

/ʕiʕr/ “poetry”	MAX	ANCHOR	DEP	CONTIG	*ʕ] <sub>C<sub>0</sub></sub>	*ʕ <sub>2</sub> L <sub>1</sub> ] <sub>σ</sub>
● <sup>*</sup> a. [ʕiʕr]					*	*
☹ b. [ʕi.ʕir]			*!	*!		
c. [ʕir]	*!			*		
d. [ʕiʕ]	*!	*!				

In Tableau 4.5a, the faithful candidate (a) unexpectedly wins because it does not violate any constraint other than the Split Margin constraint. Candidate (b), which is the expected winner, loses because it violates DEP and CONTIG, even though it respects CODA CONDITION by

<sup>93</sup> One might argue that the [ʕ] in candidate (a) could be parsed in the M<sub>1</sub> position of the coda, which would make it transparent to \*M<sub>2</sub>/ʕ. However, the solution comes from the FILL family of constraints, which militate against syllable positions not filled with segmental content (Prince & Smolensky, 1993; Tesar & Smolensky, 1998). Therefore, we can say here that Fill<sup>M<sub>2</sub></sup>]<sub>σ</sub> outranks Fill<sup>M<sub>1</sub></sup>]<sub>σ</sub>, making sure that the M<sub>2</sub> position, which is the coda position closest to the nucleus, is filled with segmental content.

syllabifying the [ʃ] into the onset of the syllable containing the epenthetic vowel. Candidates (c) and (d) lose by violating the undominated MAX, with (c) additionally violating CONTIG and (d) violating undominated ANCHOR by deleting a segment from the edge. This constraint will not be presented in the following tableaux for the sake of brevity.

From this tableau, we can note that CODACONDITION alone is not enough for the ranking argument to select the real winner, as the potential coda cluster contains two sonorant consonants. Therefore, there is need for an additional constraint in the ranking. This constraint is OCP-[son], presented in Figure (4.22).

(4.22) OBLIGATORY CONTOUR PRINCIPLE-[sonorant] (OCP-[son]):

“Two consonants with the feature [+sonorant] cannot be adjacent in the syllable rhyme of the output. Assign a violation for any two [+sonorant] consonants which are adjacent in the syllable rhyme in the output (adapted from Kabrah, 2004, p. 190).”

Similar to the CODACONDITION constraint, this constraint is outranked by DEP and CONTIG; otherwise, it would prevent any sonorant coda cluster from surfacing, even if it exhibits a falling sonority profile (e.g., /ʃilm/ → [ʃilm] “knowledge”). Tableau 4.5b shows OCP-[son] and CODACONDITION ranked low together.

Tableau 4.5b. Spurious Underapplication of Epenthesis in  $\zeta_2L_1]_\sigma$  Clusters with OCP-[son]

/ʃiʃr/ “poetry”	MAX	DEP	CONTIG	OCP-[son]	* $\zeta_{Co}$	* $\zeta_2L_1]_\sigma$
● a. [ʃiʃr]				*	*	*
⊕ b. [ʃi.ʃir]		*!	*!			
c. [ʃir]	*!		*			
d. [ʃiʃ]	*!					

Tableau 4.5b has identical violations to 4.5a, even though OCP-[son] is added. Therefore, a constraint conjunction of CODACONDITION and OCP-[son] that outranks DEP and CONTIG is the solution for the ranking argument in order for EVAL to select the real winner with epenthesis. This constraint conjunction is high-ranked with MAX, to prevent any deletion in the output form.

(4.23) \*ʃ]<sub>Co</sub> & OCP-[son]:

“No [ʃ] followed by a sonorant consonant in a coda cluster. Assign a violation any time [ʃ] is followed by a sonorant consonant in a coda cluster.”

Tableau 4.6. Correct Vowel Epenthesis in ʃ<sub>2</sub>L<sub>1</sub>]<sub>σ</sub> Clusters with \*ʃ]<sub>Co</sub> & OCP-[son]

/ʃiʃr/ “poetry”	MAX	*ʃ] <sub>Co</sub> & OCP-[son]	DEP	CONTIG	OCP-[son]	*ʃ] <sub>Co</sub>	*ʃ <sub>2</sub> L <sub>1</sub> ] <sub>σ</sub>
a. [ʃiʃr]		*!			*	*	*
b. [ʃi.ʃir]			*	*			
c. [ʃir]	*!			*			
d. [ʃiʃ]	*!						

The faithful candidate (a) loses because it violates the high-ranked \*ʃ]<sub>Co</sub> & OCP-[son]; in addition, it violates each of its components and the low-ranked Split Margin Constraint.

Candidate (b), which was the loser in the previous tableaux, is now the winner even though it violates DEP and CONTIG, because it respects the constraint conjunction \*ʃ]<sub>Co</sub> & OCP-[son] by syllabifying the [ʃ] in the onset position of the new syllable. In addition, it respects the undominated MAX constraint. Candidates (c) and (d) both lose because they violate the undominated MAX constraint, with an additional violation of CONTIG for (c). In Tableau 4.7, the same ranking argument holds with a different input, in which [ʃ] is followed by an obstruent consonant.

Tableau 4.7. Correct Prediction for  $\zeta_2O_1]_\sigma$  Clusters with  $*\zeta]_{Co}$  & OCP-[son]

/[faʃb/ “folk”	MAX	$*\zeta]_{Co}$ & OCP-[son]	DEP	CONTIG	OCP- [son]	$*\zeta]_{Co}$	$*\zeta_2O_1]_\sigma$
a. [faʃb]						*	*
b. [fa.ʃib]			*!	*!			
c. [fab]	*!			*			
d. [faʃ]	*!						

The faithful candidate (a) is the winner in this tableau because it respects all high-ranked constraints with one violation of CODACONDITION and the Split Margin constraint, which is ranked low. Candidate (b) loses because it violates high-ranked DEP and CONTIG. Candidates (c) and (d) both lose because they violate undominated MAX. All candidates in this tableau are transparent to the constraint conjunction, because the syllable does not contain two sonorant consonants, even though the winning candidate (a) violates CODACONDITION by syllabifying [ʃ] in coda position. An input such as /waʃz/ “sermon” would surface faithfully in the same way as candidate (a) in this tableau according to the same ranking, because the faithful candidate would not violate the conjoined markedness constraint. This is because voiced fricatives are not [+sonorant] consonants despite their higher sonority than other obstruents. Both the winners [ʃi.ʃir] in Tableau 4.6 and [faʃb] in Tableau 4.7 respect the conjunction  $*\zeta]_{Co}$  & OCP-[son]. The case of [ʃi.ʃir] demonstrates correct application of epenthesis; the case of [faʃb] demonstrates that epenthesis does not overapply when [ʃ] is followed by an obstruent. Having provided an analysis in which [ʃ] receives an epenthetic vowel in the output form when it is followed by a sonorant consonant, and [ʃ] + obstruent surfaces faithfully, Tableau 4.8 demonstrates that falling sonority coda clusters which include two sonorant consonants other than [ʃ] surface faithfully.

Tableau 4.8. Correct Prediction for  $L_2N_1]_\sigma$  Clusters with  $*\zeta]_{Co}$  & OCP-[son]

/ʒilm/ “knowledge”	MAX	$*\zeta]_{Co}$ & OCP-[son]	DEP	CONTIG	OCP- [son]	$*\zeta]_{Co}$	$*L_2N_1]_\sigma$
a. [ʒilm]					*		*
b. [ʒi.lim]			*!	*!			
c. [ʒim]	*!			*			
d. [ʒil]	*!						

The faithful candidate (a) is the winner because it respects all constraints except the low-ranked OCP-[son] and  $*L_2N_1]_\sigma$ . Candidate (b) loses because it violates high-ranked DEP and CONTIG by epenthesizing a vowel in a falling-sonority coda cluster, which surfaces without epenthesis.

Candidate (c) loses because it violates MAX and CONTIG by deleting the [l]; candidate (d) loses because it violates MAX by deleting the [m]. This tableau shows that the conjoined constraint and its components do not prevent falling-sonority clusters with sonorant consonants from surfacing faithfully, as long as they do not include [ʒ] in  $M_2$  position of the coda cluster.

Recall from Figure (4.7), when [ʒ] would fall in the  $M_1$  position of a coda cluster, a vowel epenthesizes before [ʒ] in the output form to prevent a rising-sonority coda cluster from surfacing. The analysis of such a potential rising-sonority coda cluster including [ʒ] in  $M_1$  position is the same as a typical potential rising-sonority cluster. Tableau 4.9 revisits the analysis of would-be rising-sonority coda clusters with [ʒ] in  $M_1$  position i.e. the second consonant in such a cluster, using the current ranking for the sake of completeness. The Split Margin constraint  $*L_2\zeta_1]_\sigma$  is undominated and crucially ranked above DEP and CONTIG, and so it appears next to MAX.

Tableau 4.9. Correct Prediction for  $L_2[\zeta]_{\sigma}$  Clusters with  $*[\zeta]_{Co}$  & OCP-[son]

/dir $\zeta$ / “shield”	MAX	$*L_2[\zeta]_{\sigma}$	$*[\zeta]_{Co}$ & OCP-[son]	DEP	CONTIG	OCP-[son]	$*[\zeta]_{Co}$
a. [dir $\zeta$ ]		*!				*	
b. [di.ri $\zeta$ ]				*	*		
c. [dir]	*!						
d. [di $\zeta$ ]	*!				*		

The faithful candidate (a) loses because it violates the Split Margin constraint by exhibiting a rising-sonority coda cluster in the output. Candidate (b) is the winner because it satisfies the Split Margin constraint at the expense of violating DEP and CONTIG. Candidate (c) loses because it violates the undominated MAX constraint. Candidate (d) loses because it also violates the undominated MAX constraint; in addition, it also violates CONTIG. Candidates (a), (b), and (d) all preserve  $[\zeta]$  in the coda, which is not a violation of CODACONDITION, because word- or stem-final  $[\zeta]$  is exempt from penalty by this constraint.

This section has analyzed the status of  $[\zeta]$  in HA syllable coda. There is an asymmetry between the treatment of  $[\zeta]$  when it would fall in  $M_1$  position to form a rising-sonority coda cluster and when it would fall in  $M_2$  position followed by another sonorant consonant to form a falling-sonority coda cluster. Although the correct surface form receives epenthesis in both types of potential clusters, epenthesis is motivated differently. When  $[\zeta]$  is final, epenthesis is motivated by the undominated rising-sonority Split Margin constraints. When  $[\zeta]$  is medial followed by another sonorant consonant excluding glides, epenthesis is motivated by the conjunction  $*[\zeta]_{Co}$  & OCP-[son], which outranks DEP and CONTIG, which themselves outrank any falling-sonority coda cluster Split Margin constraint. This ranking results in epenthesis in the output form i.e. epenthesis is motivated by the conjoined  $*[\zeta]_{Co}$  & OCP-[son] not by a Split

Margin constraint. With regard to coda clusters in which [ʕ] is followed by an obstruent, they pass through the threshold of the conjoined constraint \*ʕ]<sub>Co</sub> & OCP-[son]. This is because [ʕ], as the first consonant in the coda cluster, is followed by an obstruent consonant. Therefore, epenthesis is not motivated by \*ʕ]<sub>Co</sub> & OCP-[son], and it is prevented by the crucial ranking of DEP and CONTIG above level- or falling-sonority Split Margin constraints. [ʕ] + obstruent clusters surface faithfully like any other falling-sonority coda cluster, even though they violate low-ranked CODACONDITION.

This section provided the analysis for /ʕ/ when it would fall in a coda cluster. Section 4.3 will provide the analysis when geminate consonants form the coda cluster of HA.

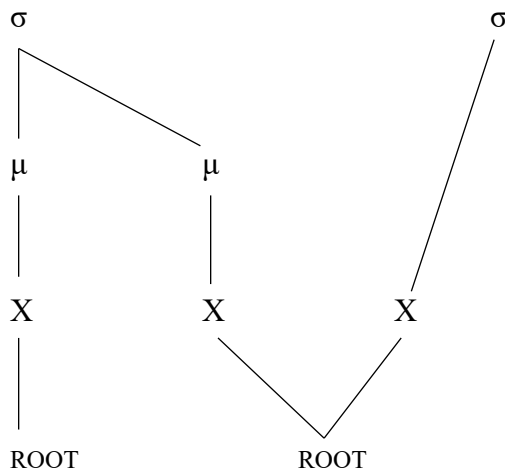
### **4.3. Geminate status of Coda Clusters in HA**

Regarding the geminate consonants in the coda, there is some controversy in the literature whether geminates should be represented using the moraic weight approach, in which a geminate is underlyingly moraic, or the length approach, in which a geminate surfaces occupying two timing slots. However, Davis (2011b, p. 22) suggests that the composite view of geminate representation, in which a geminate is underlyingly moraic and surfaces with two timing slots, might be the best approach to analyze geminates in some Arabic dialects such as PA. For example, consider the PA words [bit.na] “our house” as opposed to [sitt.na] “our grandmother” (see Abu-Salim 1980 for the original data). If only considering moraic weight for geminates, the surface representations of [bit.na] and [sitt.na] are indistinguishable, although [sitt.na] is pronounced with a longer occlusion. In addition, according to Davis (2011b), one cannot distinguish if the coda in the second example gets a mora inherently or by Weight-By-Position. Furthermore, Dmitrieva (2012, p. 13) states that:

Tranel (1991) concludes that geminate codas tend to behave with respect to weight the same way other consonants do in a language and proposes a principle of equal weight for codas. These observations suggest that the question of geminate representation may require a more complex treatment involving features of both moraic and skeletal models.

Consider Figure (4.24), in which a geminate has both underlying moraic weight and occupies two timeslots on the surface.

(4.24) Hume et al.'s Composite Representation of Gemimates (1997, p. 397)



In Figure (4.24) the first ROOT presents the vowel, although it is indistinguishable from the second ROOT, since both branch to X-slots that do not distinguish consonants and vowels. The second ROOT, which presents the geminate consonant, branches to two X-slots, the first of which branches to a mora, which forms the coda of the first syllable and the second of which forms the onset of the following syllable. This is of course used to represent intervocalic gemination in which the first part of the geminate forms the coda of the first syllable and the second part forms the onset of the second syllable. In case this geminate is final, the second part of the geminate, by

some theories, forms a degenerate second syllable.<sup>94</sup> Therefore, I extend Davis's (2011b) composite representation of geminate consonants from PA to HA. HA allows coda clusters as long as they adhere to the SSP. In the same way, the dialect also allows geminates to surface in the coda. Consider the examples ['kalb] "dog" vs. ['χall] "vinegar." When a coda cluster is followed by a consonant-initial suffix, such a cluster of three consonants is broken up by epenthesis after the second consonant. The same thing happens with geminates in which epenthesis occurs after the geminate consonant, which provides strong evidence that a geminate is one root consonant underlyingly and occupies two timing slots i.e. two C-slots on the surface. Consider the examples /kalb+na/ "our dog" → ['kal.ba.na] and /χall+na/ "our vinegar" → ['χal.la.na]. Furthermore, both examples have identical stress placement, epenthesis location, and surface resyllabification, which strongly suggests that geminate consonants occupy two C-slots on the surface and have underlying moraic weight. This is different from Hadhrami Arabic in which the dialect does not allow any coda cluster even if the cluster adheres to the SSP. Consider, for example, /gird/ "monkey", which surfaces with an epenthetic vowel as [gi.rid]. The dialect allows geminates to appear in coda position, which leads to the assumption that a geminate in Hadhrami Arabic is a single consonant that occupies a single C-slot and carries underlying moraic weight (see Bamakhramah 2009). Furthermore, geminates always surface faithfully in HA. In other words, degemination does not occur in a free-standing word under any circumstance nor does epenthesis occur to separate the two C-slots violating GEMINATEINTEGRITY. According to Dmitrieva (2012, p.11): "Integrity refers to the resistance of geminate consonants to phonological processes that violate the unity of the segment, for

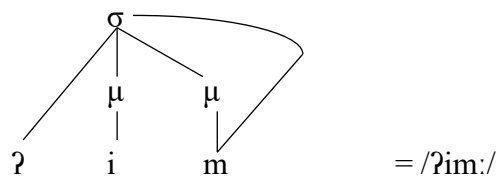
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<sup>94</sup> I avoid the degenerate syllable analysis for final geminates in HA.

instance, epenthesis, supporting the view of geminates as single units on the segmental tier.”  
 Therefore, constraints like GEMINATEINTEGRITY are high-ranked in HA.

Keer (1999), who provides a comprehensive typological study of geminates, proposes three possibilities of underlying geminate representation for PA. One proposal, which I find convincing, is presented in Figure (4.25), adapted from Keer (1999, p. 192).

(4.25) Underlying Representation of Geminates in PA (adapted from Keer 1999, p. 192)



In this figure, the geminate consonant /m:/ is connected to the syllable in two ways, the first is via the moraic node, and the second is a direct connection to the syllable. I assume that the underlying representation of HA is similar to the underlying representation of geminates in PA. This underlying geminate occupies what is equivalent to two C-slots in the rhyme in the surface form, but it is underlyingly one long, moraic segment. Consider the Figure (4.26).

(4.26) Surface Form of the Geminate in HA

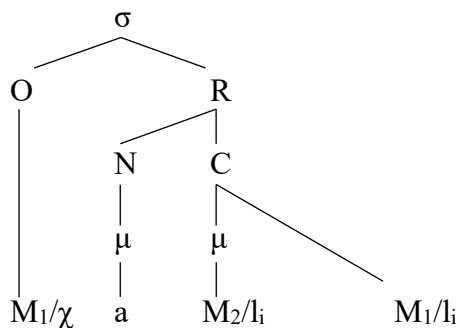


Figure (4.26) is based on binary branching for the syllable in which the syllable branches to an onset and a rhyme. The rhyme branches into a moraic nucleus and a coda, and the single long,

moraic underlying geminate coda occupies what is equivalent to two C-slots on the surface in which the left part, which is closest to the nucleus, is moraic, and the right part, which is furthest from the nucleus, is non-moraic. The figure also employs the Split-Margin approach to the syllable in which the onset is  $M_1$  and the two C-slots of the geminate consist of the  $M_2$  and  $M_1$  margins. The subscript notation  $_i$  indicates that the same underlying segment /l:/ occupies both margins  $M_2$  and  $M_1$  on the surface. This indicates that the Split-Margin approach to the syllable does not discriminate between the surface segments in the coda, whether they are geminates or two independent similar segments. What discriminates between the geminate consonant and the two similar adjacent consonants are other constraints such as OCP and GEMINATE-INTEGRITY.

Consider the data in Figure (4.27).

## (4.27) Geminate Coda in HA

	Underlying	Surface	Gloss	1st Plural possessed
a.	/ħajː/	[ħajji]	“neighborhood, alive”	[ħaj.ja.na]
	/d͡ʒawː/	[d͡ʒawwi]	“weather, atmosphere”	[d͡ʒaw.wa.na]
b.	/ʃarː/	[ʃarri]	“evil (noun)”	[ʃar.ra.na]
	/χalː/	[χalili]	“vinegar”	[χal.la.na]
c.	/fanː/	[fanini]	“art”	[fan.na.na]
	/ʃamː/	[ʃamimi]	“uncle”	[ʃam.ma.na]
d.	/ħazː/	[ħazzi]	“fortune”	[ħaz.zʰa.na]
	/ruzː/	[ruzzi]	“rice”	[ruz.za.na]
e.	/χadː/	[χadidi]	“cheek”	[χad.da.na]
	/rabː/	[rabibi]	“God”	[rab.ba.na]
	/ʃakː/	[ʃakiki]	“doubt”	[ʃak.ka.na]
	/kafː/	[kafifi]	“palm (of one’s hand)”	[kaf.fa.na]
	/faχː/	[faχchi]	“trap”	[faχ.χa.na]

The data in (4.27) have a geminate consonant in the coda cluster and this geminate consonant gets an epenthetic vowel when the possessive suffix is added. The same behavior occurs when the possessive suffix is added to a root ending in a coda cluster, providing strong evidence that the geminate consonant is a single moraic long root occupying two C-slots on the surface.<sup>95</sup>

<sup>95</sup> The data in (4.27) are lacking /ʔ/, /ħ/, /ʕ/, and /ʁ/ as a geminate consonant in coda position of a monosyllabic CVCC nominal word, which may add to the evidence that they act as a natural class in resisting to fall in a syllable coda. Regarding /ħ/, there are very few examples when it appears as a geminate in the coda in HA, such as /sʰħ:/ ‘correct’.

Several new constraints are needed for the OT analysis of the geminate consonants in the coda in HA. Figure (4.28) provides the definitions for these constraints.

(4.28) Additional OT Constraints for the Analysis of Geminate Codas

a. GEMINATE-INTEGRITY (GEM-INTEG):

“A geminate consonant cannot be split. Assign a violation for any geminate that is split via an epenthetic vowel (modified from Noamane 2018, p. 146).”

b. \*DEGEMINATION (\*DEGEM):

“An underlying geminate consonant cannot be degeminated in the surface form occupying only one timing slot. Assign a violation when an underlying geminate is degeminated in the surface form, occupying only one C-slot.”

c. MAX- $\mu$ -GEMINATE (MAX- $\mu$ -GEM):

“An underlying mora associated with a geminate consonant in the input must have a correspondent in the output. Do not delete a mora from a geminate consonant in the output. Assign a violation mark for a mora which is deleted from a geminate consonant in the output.”<sup>96</sup>

Tableau 4.10 provides the analysis when an underlying geminate surfaces faithfully with no degemination or epenthesis.

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<sup>96</sup> This constraint is similar to the constraint GEM $\mu$  proposed by Muller (2001), which can be identified as a constraint that “targets single root nodes that are multiply-linked to two X-slots” (Muller 2001, p. 88). However, I prefer to use MAX- $\mu$ -GEM in the analysis of geminates in HA.

Tableau 4.10. Geminate Surfaces Faithfully

/sum <sup>u</sup> :/ “poison”	GEM-INTEG	*DEGEM	ANCHOR	MAX-μ-GEM	DEP	CONTIG	*N <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub>
a. [sum <sup>u</sup> ] <sup>97</sup>		*!					
b. [sum <sup>u</sup> m]							*
c. [su.mum] <sup>98</sup>	*!			*	*	*	
d. [sum <sup>u</sup> .mu]			*!		*		
e. [summ] <sup>99</sup>				*!			*
f. [sum]		*!		*			

Candidate (a) loses because the underlying geminate consonant is not realized as occupying two C-slots on the surface. Candidate (b) is the winner because it only violates the lowest Split-Margin constraint. This is because the underlying geminate consonant occupies the two margins M<sub>2</sub> and M<sub>1</sub> on the surface. Candidate (c) loses because the epenthetic vowel separates out the two components of the geminate consonant on the surface. Therefore, it violates the undominated GEMINATEINTEGRITY<sup>100</sup> and the relatively high-ranked MAX-μ-GEM because of the

<sup>97</sup> This candidate also violates an undominated constraint that is not presented in this tableau for the sake of brevity. This constraint is EXTRAMETRICALITY, which militates against having a word-final moraic consonant.

<sup>98</sup> This losing candidate exhibits an epenthetic [u]. This is due to the high vowel spreading in HA, which will be analyzed in detail in Chapter 5.

<sup>99</sup> Both candidates e and f would also violate an undominated constraint that is not presented in this tableau for the sake of brevity. This constraint is MINIMUMWORD, which requires a lexical word to be at least bimoraic. This constraint will be presented in subsequent tableaux.

<sup>100</sup> One may argue that geminate integrity should not be a constraint because it is a general principle and is never violated in any language. However, GEM-INTEG is violable in Arabic. For example, consider the positive/base forms of adjectives with geminates in the comparative/superlative. Consider the examples from Egyptian Arabic (see Davis, 2019, p. 41), which also correspond to HA:

/alaz:/ “delicious (comparative)”                      /lazi:z/ “delicious (positive)”  
 /afad:/ “strong, strict (comparative)”                      /fidi:d/ “strong, strict (positive)”

Even within the comparative/superlative some words show variation between geminate and geminate integrity. Consider the word from Egyptian Arabic, which also corresponds to HA (with a different realization of the affricate):

Egyptian:                      /gidi:d/ “recent,new (positive)”                      /agad:/ or /agdad/ “recent, new (comparative)”  
 HA:                              /d̥ʒadi:d/ “recent,new (positive)”                      /ad̥ʒad:/ or /ad̥ʒdad/ “recent, new (comparative)”

resyllabification caused by the epenthetic vowel, which forces the /m:/ to split into two non-moraic positions: onset and word-final consonant. In addition, it violates high-ranked DEP and CONTIG. Candidate (d) also loses because it violates the high-ranked ANCHOR and DEP by epenthesizing a vowel at the right edge of the word. Candidate (e) resembles the winner, but loses because it violates MAX- $\mu$ -GEM where the winner does not. Candidate (f) loses because it violates high-ranked \*DEGEM.

The Split-Margin Theory does not distinguish between the two surface consonants, whether they are as a result of the underlying geminate consonant or have two independent underlying roots. What discriminates between these surface consonants in the coda is the general OCP constraint or another OCP constraint, which bans two adjacent consonants from the same sonority level. Figure (4.29) provides the definition for the general OCP constraint. In addition, it repeats the definition of OCP-NASAL, which was presented in Chapter 3.

#### (4.29) OCP and OCP-[NAS]

##### a. OBLIGATORY CONTOUR PRINCIPLE (OCP):

“Adjacent identical elements are prohibited. Assign a violation for any two identical consonants which are adjacent in the output.” (Leben 1973, Myers and Carleton 1996, p. 48)

##### b. OBLIGATORY CONTOUR PRINCIPLE – [NASAL] (OCP-[NAS]):

“Two consonants with the feature [nasal] cannot be adjacent in the output of the syllable coda. Assign a violation for any two [nasal] consonants which are

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In addition, Abu-Mansour (1987, p. 150) listed a special type of verb, which would also violate geminate integrity in MA/HA in the imperfect tense. For example:

/jiʃa:ri:/ “he fights always”

*Masdar*/base: /ʃV:r:/

/ʔaħa:dʒidʒ/ “I argue”

*Masdar*/base: /ħV:dʒ:/

Thus, geminate integrity is violable in HA in verbal and comparative/superlative adjectival forms, but is not violable in nominal and positive adjectival forms as is listed in Figure (4.27) and Figure (4.30).

adjacent in the output of the syllable coda. (Kabrah, 2004, p. 190).”

Tableau 4.11. Underlying Geminate Coda passes OCP Threshold

/ruz <sup>h</sup> <sub>i</sub> :/ “rice”	GEM- INTEG	*DEGEM	OCP	OCP- [NAS]	MAX	DEP	CONTIG	*N <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub>	*Z <sub>2</sub> Z <sub>1</sub> ] <sub>σ</sub>
☞ a. [r <sup>s</sup> uz <sup>h</sup> <sub>i</sub> z <sub>i</sub> ]									*
b. [r <sup>s</sup> u.z <sub>i</sub> uz <sub>i</sub> ]	*!					*	*		
c. [r <sup>s</sup> uz <sup>h</sup> <sub>i</sub> ]		*!							
/ruz <sub>i</sub> z <sub>j</sub> /	GEM- INTEG	*DEGEM	OCP	OCP- [NAS]	MAX	DEP	CONTIG	*N <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub>	*Z <sub>2</sub> Z <sub>1</sub> ] <sub>σ</sub>
d. [r <sup>s</sup> uz <sup>h</sup> <sub>i</sub> z <sub>j</sub> ]			*!						*
☞ e. [r <sup>s</sup> u.z <sub>i</sub> uz <sub>j</sub> ]						*	*		
f. [r <sup>s</sup> uz <sub>i</sub> ]					*!				
/tum <sup>h</sup> n/ “eighth”	GEM- INTEG	*DEGEM	OCP	OCP- [NAS]	MAX	DEP	CONTIG	*N <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub>	*Z <sub>2</sub> Z <sub>1</sub> ] <sub>σ</sub>
g. [tum <sup>h</sup> n]				*!				*	
☞ h. [tu.mun]						*	*		
i. [tum]					*!				

Candidate (a) wins because it does not violate any constraint other than the lowest ranked Split-Margin constraint. Candidate (b) loses by violating the undominated GEMINATE-INTEGRITY constraint. Candidate (c) loses because the underlying geminate surfaces with only one consonant, violating the undominated \*DEGEM. The hypothetical candidate (d) loses by violating the high-ranked constraint OCP. This is because the two distinct underlying consonants surface adjacent to one another in the coda. Candidate (e) is the winner of its group by obeying the OCP constraint at the expense of violating DEP and CONTIG, which results in separating between two

independent identical roots on the surface. Candidate (f) loses by exhibiting a deletion in the underlying root on the surface, violating the high-ranked MAX. Candidate (g) loses because the two nasal consonants [m] and [n] in the coda surface faithfully adjacent to each other, violating the high-ranked OCP-[NAS]. Candidate (h) is the winner of its group. This is because it respects the high-ranked OCP-[NAS] constraint at the expense of violating DEP and CONTIG. Candidate (i) loses by violating high-ranked MAX. This is because the underlying root consonant [n] does not surface. The same MAX violation would be assigned if the deleted consonant were [m]. In addition, it would violate CONTIG.

As we can notice from this triple tableau, underlying geminate consonants surface occupying two C-slots, passing the threshold of the OCP constraint, whereas the underlying hypothetical /ruz<sub>i</sub>z<sub>j</sub>/ and /tumn/ “eighth” surface with an epenthetic vowel separating between the second and the third root consonant. This is because roots with hypothetical identical consonants such as /ruz<sub>i</sub>z<sub>j</sub>/ and roots with similar consonants such as /tumn/ do not pass the OCP threshold. Conjoined Split-Margin constraints such as \*N<sub>2</sub>N<sub>1</sub>]<sub>σ</sub> and \*Z<sub>2</sub>Z<sub>1</sub>]<sub>σ</sub> do not distinguish whether the root consonants are similar i.e. from the same level of sonority, identical or underlyingly geminate consonants. What discriminates between these consonants in a certain position of the syllable such as the coda are other high-ranked, sonority-independent constraints such as OCP and GEMINATE INTEGRITY. These constraints allow the underlying geminate to occupy two adjacent C-slots on the surface, obeying GEMINATE INTEGRITY, and disallow identical or similar consonants to be adjacent to each other, obeying OCP. Having provided the analysis in which OCP and constraints relating to geminates such as GEMINATE INTEGRITY play a significant role in determining whether consonants surface faithfully or separated by an epenthetic vowel, the

next tableau will show the interaction between the geminate constraints such as GEMINATE INTEGRITY and \*DEGEM and constraints related to the glide grammar.

Tableau 4.12. No Vocalization or Medial Coalescence in a Monosyllabic Geminate Glide-Final Word

$\bar{d}\bar{z}aw^{\mu}!$ "weather"	GEM- INTEG	*DEGEM	ANCHOR	MAX- $\mu$ -GEM	DEP	CONTIG	MAX- V-[F]	AGREE- V-PLACE	*G <sub>2</sub> G <sub>1</sub> <sup>σ</sup>	ID-[F]- [Voc]	*MIDV
a. [ $\bar{d}\bar{z}aw^{\mu}$ ]		*!									
<sup>100</sup> b. [ $\bar{d}\bar{z}aw^{\mu}w$ ]									*		
c. [ $\bar{d}\bar{z}a.waw$ ]	*!			*	*	*					
d. [ $\bar{d}\bar{z}aw^{\mu}.wa$ ] <sub>101</sub>			*!		*						
e. [ $\bar{d}\bar{z}aww$ ]				*!					*		
f. [ $\bar{d}\bar{z}aw$ ]		*!		*							
g. [ $\bar{d}\bar{z}oow$ ]		*!		*						*	**
h. [ $\bar{d}\bar{z}a.wu$ ]		*!		*						*	

<sup>101</sup> There is no crucial argument for ANCHOR to be demoted in this tableau. However, the crucial argument will be obvious in the coming tableaux.

Candidate (a), [d̥ʒaw<sup>h</sup>], loses because it exhibits degemination on the surface. Candidate (b), the winner [d̥ʒaw<sup>h</sup>w], does not violate any constraints other than the low-ranked Split-Margin \*G<sub>2</sub>G<sub>1</sub>σ. Candidate (c), [d̥ʒa.waw], loses because it violates the undominated GEM-INTEG by epenthesizing a vowel between the two parts of the geminate. It also violates MAX-μ-GEM, DEP and CONTIG. This is because the underlying geminate /w<sup>h</sup>:/, which is associated with a mora, is resyllabified on the surface in non-moraic positions, the onset and the word-final consonant. Candidate (d), [d̥ʒaw<sup>h</sup>.wa], loses due to its violation of the high-ranked ANCHOR by epenthesizing a vowel at the right edge of the word. In addition, it violates the high-ranked DEP constraint. Candidate (e), [d̥ʒaww], resembles the winner, but it loses because it violates the relatively high-ranked MAX-μ-GEM, whereas the winner in (b) respects that constraint, by preserving the mora for the geminate. Candidates (f), [d̥ʒaw], (g), [d̥ʒoow], and (h), [d̥ʒa.wu], all lose because of their violations of undominated \*DEGEM. In addition, they all violate MAX-μ-GEM because the underlying /w<sup>h</sup>:/ surfaces with no mora. Furthermore, both candidates (g) and (h) violate ID-[F]-[VOC], with (g) also violating \*MIDV twice.

This tableau demonstrates that a word-final geminate glide fails to undergo glide-medial coalescence or glide-final vocalization in monosyllabic CVG words, in which G means underlying geminate consonant. The geminate grammar in HA insists that underlying geminates must be realized occupying two timing slots on the surface. Any other process, which separates between the two parts of a geminate or deletes one part, making the geminate surface with a single C-slot, fails to produce the winning output form. In addition, phonological processes which force the first part of the geminate to undergo coalescence in the case of glides, or force the word-final glide to vocalize, leaving one timing slot to be realized on the surface for the geminate, are prohibited and not allowed by the grammar of HA. From Tableau 4.12, we can

observe that the word-final geminate in monosyllabic CVG words must surface faithfully occupying two timing slots on the surface. The geminate grammar in HA does not discriminate whether the geminate consonant is an obstruent or a sonorant such as a glide, if the geminate falls at the end of a monosyllabic word. Geminate integrity in the surface form applies for any consonant regardless of its sonority.

However, the story will be different when a geminate glide falls at the end of a polysyllabic word in HA. In underlying polysyllabic words, the geminate glide is deleted in the surface form. Consider for example the words /ʕadu<sup>w</sup>:/ → [ʕadu] “enemy,” /nabij<sup>w</sup>:/ → [nabi] “prophet.” This geminate glide surfaces faithfully in MSA with no deletion. Compare the surface forms in HA with the surface forms in MSA of word-final geminate glides in polysyllabic words.

(4.30) Polysyllabic Word-Final Geminate in HA and MSA

	Underlying	Gloss	HA Surface Form	MSA Surface Form	HA Possessive Form (1st Plural)	MSA Possessive Form (1st Plural)
a.	/ʕadu <sup>w</sup> :/	“enemy”	[ʕa.du]	[ʕa.'duw <sup>w</sup> ]	[ʕa.'duw <sup>w</sup> .wa.na]	[ʕa.'duw <sup>w</sup> .wu.na]
	/nabij <sup>w</sup> :/	“prophet”	[na.bi]	[na.'bij <sup>w</sup> ]	[na.'bij <sup>w</sup> .ja.na]	[na.'bij <sup>w</sup> .ju.na]
	/ʕabij <sup>w</sup> :/	“stupid”	[ʕa.bi]	[ʕa.'bij <sup>w</sup> ]	[ʕa.'bij <sup>w</sup> .ja.na]	[ʕa.'bij <sup>w</sup> .ju.na]
	/ðaki <sup>w</sup> :/	“smart”	[ða.ki]	[ða.'ki <sup>w</sup> ]	[ða.'ki <sup>w</sup> .ja.na]	[ða.'ki <sup>w</sup> .ju.na]
b.	/maʕad <sup>w</sup> :/	“bandage”	[ma.'ʕad <sup>w</sup> d]	[ma.'ʕad <sup>w</sup> d]	[ma.'ʕad <sup>w</sup> .da.na]	[ma.'ʕad <sup>w</sup> .du.na]
	/marad <sup>w</sup> :/	“destiny”	[ma.'rad <sup>w</sup> d]	[ma.'rad <sup>w</sup> d]	[ma.'rad <sup>w</sup> .da.na]	[ma.'rad <sup>w</sup> .du.na]
	/maħal <sup>w</sup> :/	“place”	[ma.'ħal <sup>w</sup> l]	[ma.'ħal <sup>w</sup> l]	[ma.'ħal <sup>w</sup> .la.na]	[ma.'ħal <sup>w</sup> .lu.na]
	/maqar <sup>w</sup> :/	“location”	[ma.'qar <sup>w</sup> r]	[ma.'qar <sup>w</sup> r]	[ma.'qar <sup>w</sup> .ra.na]	[ma.'qar <sup>w</sup> .r <sup>u</sup> .na]
	/masan <sup>w</sup> :/	“knife-sharpener”	[ma.'san <sup>w</sup> n]	[ma.'san <sup>w</sup> n]	[ma.'san <sup>w</sup> .na.na]	[ma.'san <sup>w</sup> .nu.na]
	/ʔas <sup>ʕ</sup> am <sup>w</sup> :/	“deaf, deafer”	[ʔa.'s <sup>ʕ</sup> am <sup>w</sup> m]	[ʔa.'s <sup>ʕ</sup> am <sup>w</sup> m]	[ʔa.'s <sup>ʕ</sup> am <sup>w</sup> .ma.na]	[ʔa.'s <sup>ʕ</sup> am <sup>w</sup> .mu.na]

The examples in Figure (4.30b) demonstrate that HA and MSA polysyllabic word-final nonglide geminate consonants surface faithfully with no final geminate consonant deletion. However, the final geminate glide in polysyllabic words deletes in the surface form in HA, as demonstrated in Figure (4.30a).<sup>102</sup> I propose that deletion of the final geminate glide in HA in these words is due to the high-ranked \*WORDFINALGEMINATEGLIDE. This constraint is active in the grammar of HA, unless the word is a monosyllabic word that ends with a geminate consonant. In this case, MINWORD outranks \*WORDFINALGEMINATEGLIDE, making sure that a word is minimally bimoraic. This will be illustrated in Tableau 4.13. Figure (4.31) provides the necessary constraints for the analysis of final geminate glides in polysyllabic words.

(4.31) Additional OT Constraints for the Analysis of Final Geminate Glides in Polysyllabic Words

a. \*WORDFINALGEMINATEGLIDE (\*FGEMG):

“Word-final geminate glides are not allowed to surface. Assign a violation any time that a geminate glide surfaces word-finally.”

b. \*GEM-SPLIT:

“Root-final geminate does not split. Assign a violation any time a root-final geminate splits into two syllables in the surface form.”

Tableau 4.13 analyzes the status of a word-final geminate glide in a polysyllabic word.

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<sup>102</sup> The case ending vowel [u] after the geminate consonant and before the possessive suffix [-na] in MSA indicates the nominative case. With regard to the vowel [a] between the geminate consonant and the possessive suffix in HA, it is an epenthetic vowel to prevent a word-internal CVCC syllable from surfacing. HA, as well as many other Arabic dialects, does not have case endings.

Tableau 4.13. Final Geminate Glide does not surface in a Polysyllabic Word in Isolation

/ʕadu <sup>h</sup> :/ "enemy"	GEM- INTEG	*DEGEM	*GEM- SPLIT	*FGEMG	ANCHOR	MAX	MAX-μ- GEM	DEP	CONTIG	*G <sub>2</sub> G <sub>1</sub> ] <sub>σ</sub>
a. [ʕa.du <sup>h</sup> w]				*!						*
b. [ʕa.du]					*	*	*			
c. [ʕa.du <sup>h</sup> ]		*!								
d. [ʕa.duww]				*!			*			*
e. [ʕa.du.waw]	*!						*	*	*	
f. [ʕa.du <sup>h</sup> .wa]			*!		*			*		

Candidate (a), [ʃa.duw<sup>h</sup>w], loses because it violates high-ranked \*FGEMG. In addition, it violates the low-ranked Split-Margin constraint. Candidate (b), [ʃa.du], is the winner, even though it violates the relatively high-ranked ANCHOR, MAX and MAX- $\mu$ -GEM. Candidate (c), [ʃa.duw<sup>h</sup>], loses because it violates the undominated \*DEGEM by degeminating the underlying geminate glide on the surface. Candidate (d), [ʃa.duww], loses by violating \*FGEMG. In addition, it violates the relatively high-ranked MAX- $\mu$ -GEM and the low-ranked \*G<sub>2</sub>G<sub>1</sub>] <sub>$\sigma$</sub> . Candidate (e), [ʃa.du.waw], loses by violating GEM-INTEG. In addition, it violates MAX- $\mu$ -GEM. Furthermore, this candidate violates the relatively high-ranked DEP and CONTIG by epenthesizing a vowel between the two geminate entities. Candidate (f), [ʃa.duw<sup>h</sup>.wa], also loses because it violates \*GEM-SPLIT by epenthesizing at the right edge of the word. In addition, it violates ANCHOR and DEP.

The Tableau 4.13 demonstrates that a final geminate glide is deleted on the surface in a polysyllabic word. However, if the final geminate consonant is anything other than a glide such as an obstruent or sonorant, it does not delete on the surface. Tableau 4.14 illustrates that a non-glide final geminate consonant in a polysyllabic word resists deletion.

Tableau 4.14. Polysyllabic Non-Glide Geminate Final Consonant does not delete<sup>103</sup>

/maħal <sup>h</sup> :/ “place”	GEM- INTEG	*DEGEM	*GEM- SPLIT	ANCHOR	MAX	MAX- μ- GEM	DEP	CONTIG	*G <sub>2</sub> G <sub>1</sub> ] <sub>σ</sub>
a. [ma.ħal <sup>h</sup> ]		*!							
☞ b. [ma.ħal <sup>h</sup> l]									*
c. [ma.ħa.lal]	*!					*	*	*	
d. [ma.ħal <sup>h</sup> .la]			*!	*			*		
e. [ma.ħall]						*!			*
f. [ma.ħal]		*!				*			
g. [ma.ħa]				*!	*!	*!			

Candidate (a) loses because it violates the undominated \*DEGEM. Candidate (b) wins because it does not violate any constraint other than the lowest ranked \*G<sub>2</sub>G<sub>1</sub>]<sub>σ</sub>. Candidate (c) loses for several reasons, among them the violation of GEM-INTEG, MAX-μ-GEM, DEP and CONTIG.

Candidate (d) loses because it violates \*GEM-SPLIT and ANCHOR, by epenthesizing at the right-edge of the word, causing the root geminate to split into two syllables on the surface. In addition, it violates DEP. Candidate (e) resembles the winner, however it loses because it violates relatively high-ranked MAX-μ-GEM, whereas the winner does not. Candidate (f) loses because it violates undominated \*DEGEM. In addition, it violates MAX-μ-GEM by having the /l<sup>h</sup>/ surface with no mora. Candidate (g) loses because it violates ANCHOR, MAX and MAX-μ-GEM. This is because the underlying geminate at the right edge of the word does not surface. In addition, since the geminate consonant is deleted on the surface, its mora also deletes violating MAX-μ-GEM.

<sup>103</sup> The constraint ranking is slightly shortened by removing the constraint \*FGEMG and the level that it occupies. This is because this constraint does not relate to Tableau 4.14, since it does not have a final glide.

After analyzing the polysyllabic glide geminate-final words in which the geminate does not surface in an unaffixed word and the polysyllabic non-glide geminate final words when the geminate does surface in isolation, the coming Tableau 4.15 revisits the OT analysis for the monosyllabic CVG glide geminate-final words according to the ranking in Tableau 4.13, with MINIMUMWORD added among the undominated constraints. Figure (4.32) provides the definition for the MINIMUMWORD constraint that will be used in Tableau 4.15.

(4.32) MINIMUMWORD (MINWORD):

“The minimum word is bimoraic. Assign a violation any time when a word surfaces with fewer than two moras (adapted from Borowsky and Harvey 1997).”



Candidate (a), [d̥ʒaw<sup>h</sup>w], wins even though it violates \*FGEMG and the Split-Margin \*G<sub>2</sub>G<sub>1</sub>]<sub>σ</sub> constraints. Candidate (b), [d̥ʒaw<sup>h</sup>], loses because it violates the undominated \*DEGEM constraint. Candidate (c), [d̥ʒaw], loses because it violates both undominated \*DEGEM and MINWORD. This is because the underlying geminate glide surfaces as a single consonant with no mora. Candidate (d), [d̥ʒa], loses for several violations, among them the undominated MINWORD, high-ranked ANCHOR, MAX and MAX-μ-GEM. Candidate (e), [d̥ʒaww], loses because it violates the undominated MINWORD. In addition, it violates high-ranked \*FGEMG and MAX-μ-GEM as well as the low-ranked Split-Margin \*G<sub>2</sub>G<sub>1</sub>]<sub>σ</sub>. Candidate (f), [d̥ʒa.waw], loses for several violations, among them undominated GEM-INTEG. Furthermore, it violates relatively high-ranked MAX-μ-GEM, DEP and CONTIG. Candidate (g), [d̥ʒaw<sup>h</sup>.wa], loses because it violates high-ranked \*GEM-SPLIT. In addition, it violates ANCHOR and DEP.

As we can notice from Tableaux 4.13 and 4.15, when a geminate glide falls at the end of a polysyllabic word, it deletes on the surface obeying \*FGEMG, whereas a word-final geminate glide in a monosyllabic CVG word does not delete, obeying the MINWORD constraint.<sup>104</sup> The following tableau demonstrates that a final geminate glide does not delete in the suffixed form of a polysyllabic root. Instead, it resyllabifies on the surface as a coda for the preceding vowel and an onset for the vowel-initial suffix. Figure (4.33) provides the definition for the new constraint used in Tableau 4.16.

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<sup>104</sup> The constraint MINWORD is violable in some function words such as /min/ “from”, /fij/ “in”, /ʔaw/ “or” etc. However, it is inviolable in content words as is the case with /d̥ʒaw<sup>h</sup>:/ “weather”, /ħaj<sup>h</sup>:/ “neighborhood, alive” etc.

## (4.33) ONSET:

“Syllables must have onsets. Assign a violation any time a syllable surfaces with no onset  
(Prince and Smolensky 1993).”

Tableau 4.16. Final Geminate Glide does surface in a Suffixed Polysyllabic Root<sup>105</sup>

/ʕadu <sup>h</sup> :-u/ “his enemy”	ONSET	GEM- INTEG	*DEGEM	*GEM- SPLIT	MAX	MAX- μ-GEM	DEP	CONTIG	*G <sub>2</sub> G <sub>1</sub> ] <sub>σ</sub>
a. [ʕa.du <sup>h</sup> .wu]				*					
b. [ʕa.du.u]	*!				*	*		*	
c. [ʕa.du <sup>h</sup> .u]	*!		*!						
d. [ʕa.du.wu]			*!			*			
e. [ʕa.du.wu]				*		*!			

Candidate (a) is the winner, even though it violates \*GEM-SPLIT by resyllabifying the root geminate as a coda for the previous vowel and an onset for the vowel initial suffix on the surface.

Candidate (b) loses because it violates ONSET, MAX, MAX-μ-GEM and CONTIG. Candidate (c) loses because it violates two undominated constraints ONSET and \*DEGEM. Candidate (d) also loses by violating \*DEGEM and the relatively high-ranked MAX-μ-GEM. Candidate (e) ties with the winner on the second level of constraints by violating \*GEM-SPLIT, however it loses by violating MAX-μ-GEM.

Finally, for the sake of completeness, Tableau 4.17 illustrates that the final geminate glide in a CVG monosyllabic root surfaces faithfully in a suffixed form.

<sup>105</sup> The constraints \*FGEMG and ANCHOR are omitted from this tableau for the sake of brevity.

Tableau 4.17. Final Geminate Glide does surface in a Suffixed Monosyllabic Root

/hāj <sup>h</sup> :-u/ “his neighborhood	ONSET	GEM- INTEG	*DEGEM	*GEM- SPLIT	MAX	MAX- μ-GEM	DEP	CONTIG	*G <sub>2</sub> G <sub>1</sub> ] <sub>σ</sub>
a. [h̥a.ju]			*!			*			
b. [hāj <sup>h</sup> .ju]				*					
c. [h̥aj.ju]				*		*!			
d. [h̥a.ja.ju]		*!		*		*	*	*	
e. [h̥a.u]	*!				*	*		*	

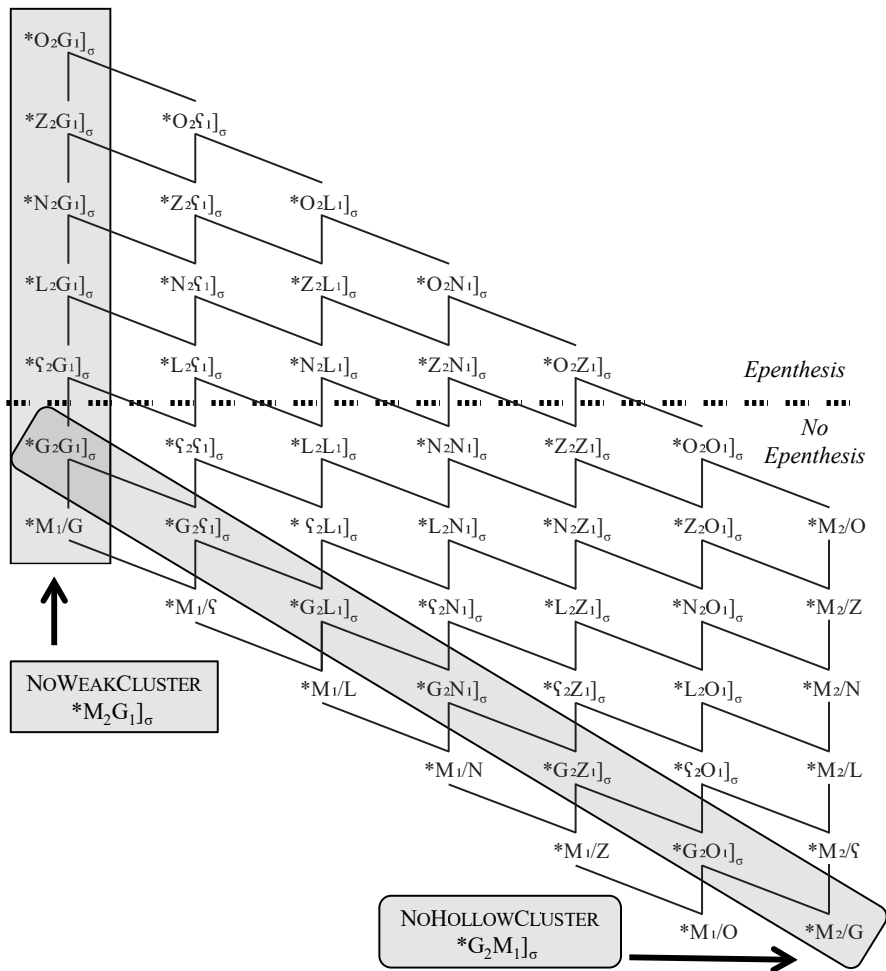
Candidate (a) loses because it violates both \*DEGEM and MAX-μ-GEM. This is because it degeminates the geminate glide on the surface, which becomes an onset for the vowel-initial suffix. Therefore, the glide surfaces in a non-moraic position in the syllable. Candidate (b) wins even though it violates high-ranked \*GEM-SPLIT, by splitting the geminate glide into the coda of the preceding vowel and the onset of the vowel-initial suffix. Candidate (c) loses even though it resembles the winner. This is because it violates relatively high-ranked MAX-μ-GEM, a constraint that the winner does not violate. Candidate (d) loses because it violates undominated GEM-INTEG by epenthesizing a vowel between the two parts of the root geminate glide. In addition, it violates \*GEM-SPLIT, MAX-μ-GEM, DEP and CONTIG. Candidate (e) loses because it violates undominated ONSET. In addition, it violates MAX, MAX-μ-GEM and CONTIG.<sup>106</sup>

Having provided the analysis for the status of the final geminate consonants in HA, the next section discusses and concludes the chapter.

<sup>106</sup> This candidate also loses for the violation of other constraints not presented in this tableau, among them NODIPH and NOHIATUS.

#### 4.4. Discussion and Conclusion

The analysis of the sonority of the HA coda cluster necessitates the study of the role of the subgrammar of glides in shaping the HA syllable coda. Glides do not surface in coda clusters in HA under any circumstances. Glide-final roots are known in the Arabic grammatical tradition as weak roots, and glide-medial roots are known as hollow roots. Figure (4.34) reintroduces the Hasse diagram for the Split-Margin constraints with the two cover constraints NOWEAKCLUSTER and NOHOLLOWCLUSTER.

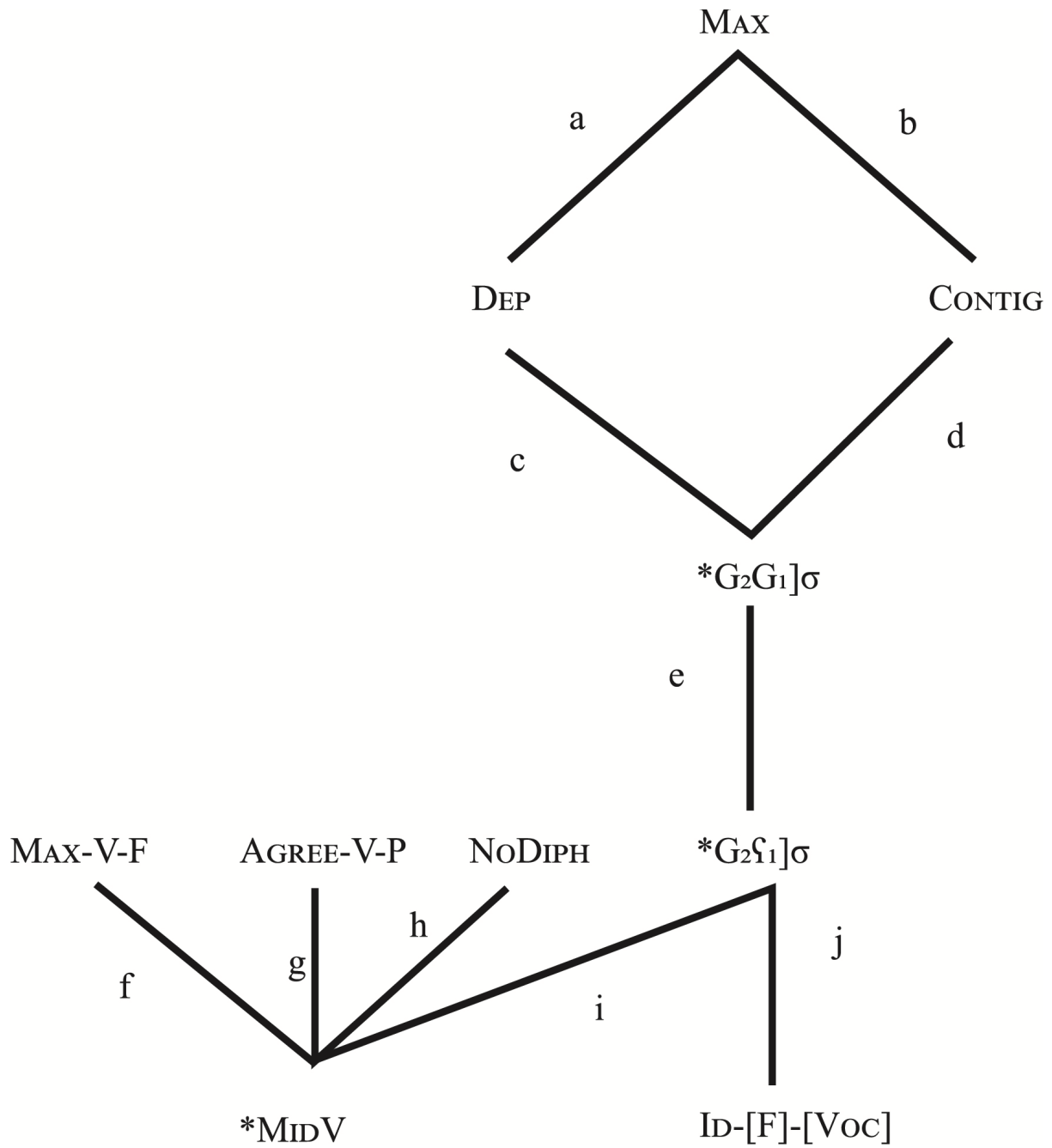


(4.34) Hasse Diagram of Split-Margin Constraints with Cover Constraints NOWEAKCLUSTER and NOHOLLOWCLUSTER.

When a glide is final in a potential coda cluster (i.e. in weak roots), it vocalizes in the output form, forcing the preceding consonant to surface as an onset for a new syllable. For example, the word /ʃawj/ “grilling” becomes [ʃa.wi] cf. [ʃaw.ju] “grilling (Possessed Form 3P.MASC.SG)” and the word /farw/ “fur” becomes [fa.r<sup>s</sup>u] cf. [far<sup>s</sup>.wu] “fur (Possessed Form 3P.MASC.SG).”

However, when a glide falls as the first consonant of a potential coda cluster, i.e. word-medially, the glide coalesces with the adjacent low vowel of the stem, such that the two form a sequence of two identical mid vowels, in a process that has been known in the literature as monophthongization of a diphthong. The chapter derives several pieces of evidence that the glide coalescing with the stem low vowel is not a monophthongization of a diphthong, but rather it is a coalescence of the glide with the preceding low vowel in such a way that each vocoid exchanges features with the other, resulting in two identical mid vowels, [ee] in the case of /aj/ and [oo] in the case of /aw/. The glide spreads the features [high] and [front] or [back] to the preceding vowel and the low vowel spreads the feature [low] to the following glide. Both the low vowel and the glide preserve their original features in addition to the new features that they receive from the adjacent vocoid via spreading. Among the evidence that this process is a coalescence and not a monophthongization is the fact that glides are considered consonants, which play a role in determining the lexical root in Arabic, as any other consonant would. In addition, these glides surface faithfully in related, derived forms of the root, especially when they fall in syllable-onset position. For example, compare the words /mawd̤ʒ/ “wave” and /bajt/ “house”, which surface as [mood̤ʒ] and [beet] cf. [ʔam.wa:d̤ʒ] “waves” and [bi.ju:t] “houses.” The glide surfaces faithfully in the onset position in both related plural forms. Both final glide vocalization and glide-vowel coalescence occur regardless of whether the sonority profile of the coda cluster is falling, level, or rising. The only situation in which the rules of final glide vocalization and glide-vowel

coalescence compete is when the word includes two glides as the second and third root consonants in the underlying form. Consider, for example, the word /ʃawj/. In this word, final glide vocalization takes precedence over glide-vowel coalescence, resulting in [ʃa.wi], not \*[ʃooj]. Several constraints play a role in yielding the correct output form. Among them is ID-[F]-[VOC], which is a low ranked constraint. Although this constraint is low ranked, it does play a crucial role in vocalizing the final and medial glide, in the process of final glide vocalization and glide-vowel coalescence. In addition, AGREE-V-PLACE plays a role in the coalescence process between the medial glide and the preceding stem vowel, yielding [oo] or [ee]. Furthermore, NODIPH is ranked high, preventing the medial glide from vocalizing independent of the stem vowel, which would result in [au] or [aj]. Moreover, DEP and CONTIG are ranked relatively high, preventing epenthesis from occurring between consonants in the coda. The interaction of constraints in the glide subgrammar of HA is summarized in the Hasse diagram in Figure (4.35).



(4.35) Hasse Diagram of the Subgrammar of Glides in HA (Hollow Roots and Weak Roots).

Table 4.1 provides an index for the constraint ranking in the Hasse diagram in Figure (4.35).

Table 4.1

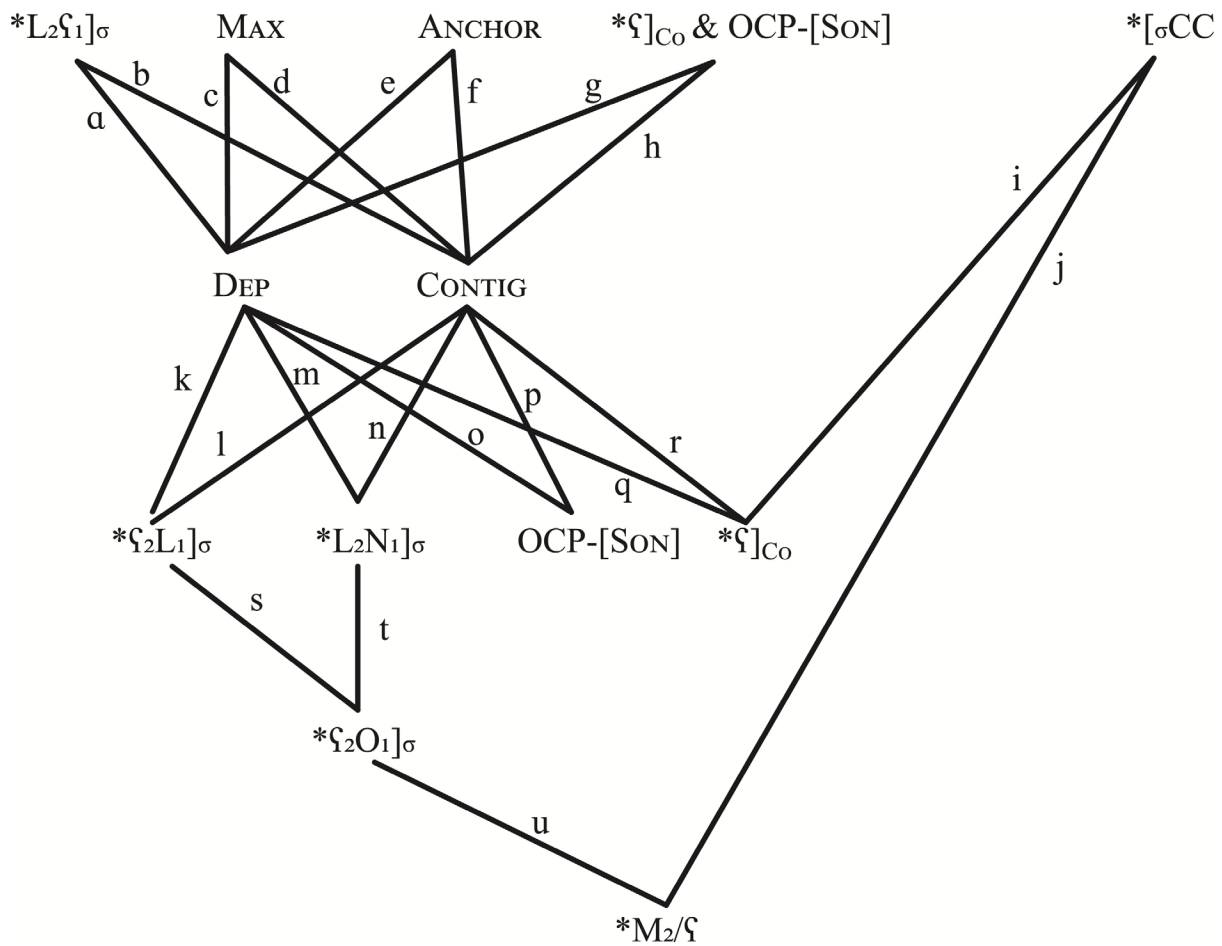
*Index of Constraint Rankings for Glide Subgrammar*

	Ranking	Tableaux	Section	Example Word(s)
a.	MAX >> DEP	3.13	3.4	[na.mil]
b.	MAX >>> CONTIG	3.13	3.4	[na.mil]
c.	DEP >> *G <sub>2</sub> G <sub>1</sub> ] <sub>σ</sub>	Split-Margin	3.5	
d.	CONTIG >> *G <sub>2</sub> G <sub>1</sub> ] <sub>σ</sub>	Split-Margin	3.5	
e.	*G <sub>2</sub> G <sub>1</sub> ] <sub>σ</sub> >>> *G <sub>2</sub> ʕ <sub>1</sub> ] <sub>σ</sub>	Split-Margin	3.1	
f.	MAX-V-F >> *MIDV	4.2ab	4.1.2	[beeʕ], [nooʕ]
g.	AGREE-V-P >> *MIDV	4.2ab	4.1.2	[beeʕ], [nooʕ]
h.	NO-DIPH >> *MIDV	Footnote 87	4.1.2	
i.	*G <sub>2</sub> ʕ <sub>1</sub> ] <sub>σ</sub> >> *MIDV	4.2ab	4.1.2	[beeʕ], [nooʕ]
j.	*G <sub>2</sub> ʕ <sub>1</sub> ] <sub>σ</sub> >>> ID-[F]-[VOC]	4.2ab	4.1.2	[beeʕ], [nooʕ]

*Note.* Letters in the left column refer to labels in Figure (4.35).

This chapter also elaborated on the status of /ʕ/ in coda clusters in HA based on what has been found in Chapter 2. /ʕ/ is the most sonorous consonant among gutturals and it occupies a high position on the sonority scale, even higher than liquids and nasals. This is of course due to several phonological and phonetic pieces of evidence, which confirm that it is the most sonorous consonant after glides. Therefore, when /ʕ/ is word-final and preceded by any consonant, excluding glides, vowel epenthesis occurs in the output form to prevent such rising-sonority coda clusters from surfacing. For example, /dirʕ/ “shield” becomes [dirɪʕ], not \*[dirʕ]. However, when /ʕ/ is word-medial and followed by any other non-vocoid sonorant consonant, epenthesis also occurs but for a different reason. Epenthesis occurs in this type of sequence to avoid a violation of the undominated conjoined constraint, \*ʕ]<sub>C<sub>0</sub></sub> & OCP-[SON], which militates against having /ʕ/ as a first consonant in the coda cluster, followed by another sonorant consonant. For example,

the word /ʃiʀ/ “poetry” surfaces as [ʃiʀ], not \*[ʃiʀ]. The constraints  $*\zeta]_{Co}$  and OCP-[SON] alone cannot prevent /ʃ/ from surfacing followed by another sonorant consonant in a coda cluster. They must be conjoined into one undominated constraint to militate against such clusters. When /ʃ/ is followed by any other obstruent consonant, even voiced fricatives, it still surfaces faithfully in coda clusters. This is because  $*\zeta]_{Co}$  is weak and dominated by DEP and CONTIG, which militate against epenthesis in such a cluster. For example, /ʃaʃb/ “folk” and /waʃzʃ/ “sermon” surface faithfully as [ʃaʃb] and [waʃzʃ], not \*[ʃaʃib] and \*[waʃizʃ]. The Hasse diagram in Figure (4.36) summarizes the constraint ranking of the subgrammar of /ʃ/ in coda clusters in HA.



(4.36) Hasse Diagram of the Subgrammar of [ʃ] in Coda Clusters.

Table 4.2 provides an index for the constraint ranking in the Hasse diagram in Figure (4.36).

Table 4.2

*Index of Constraint Rankings for [ʃ] in Coda Clusters*

	Ranking	Tableaux	Section	Example Word(s)
a.	*L <sub>2</sub> ʃ <sub>1</sub> ] <sub>σ</sub> >> DEP	4.9	4.2	[di.riʃ]
b.	*L <sub>2</sub> ʃ <sub>1</sub> ] <sub>σ</sub> >> CONTIG	4.9	4.2	[di.riʃ]
c.	MAX >> DEP	4.6	4.2	[ʃi.ʃir]
d.	MAX >> CONTIG	4.6	4.2	[ʃi.ʃir]
e.	ANCHOR <sup>107</sup> >> DEP	3.13	3.4	[na.mil]
f.	ANCHOR >> CONTIG	3.13	3.4	[na.mil]
g.	*ʃ] <sub>c<sub>o</sub></sub> & OCP-[SON] >> DEP	4.6	4.2	[ʃi.ʃir]
h.	*ʃ] <sub>c<sub>o</sub></sub> & OCP-[SON] >> CONTIG	4.6	4.2	[ʃi.ʃir]
i.	* <sub>σ</sub> [CC >> *ʃ] <sub>c<sub>o</sub></sub>	4.4	4.2	[ʃaʃ.ra]
j.	* <sub>σ</sub> [CC >> *M <sub>2</sub> /ʃ	4.4	4.2	[ʃaʃ.ra]
k.	DEP >> *ʃ <sub>2</sub> L <sub>1</sub> ] <sub>σ</sub>	Inherited Ranking	3.5	See Figure 3.23
l.	CONTIG >> *ʃ <sub>2</sub> L <sub>1</sub> ] <sub>σ</sub>	Inherited Ranking	3.5	See Figure 3.23
m.	DEP >> *L <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub>	4.8	4.2	[ʃilm]
n.	CONTIG >> *L <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub>	4.8	4.2	[ʃilm]
o.	DEP >> OCP-[SON]	4.8	4.2	[ʃilm]
p.	CONTIG >> OCP-[SON]	4.8	4.2	[ʃilm]
q.	DEP >> *ʃ] <sub>c<sub>o</sub></sub>	4.4, 4.7	4.2	[ʃaʃ.ra], [ʃaʃb]
r.	CONTIG >> *ʃ] <sub>c<sub>o</sub></sub>	4.4, 4.7	4.2	[ʃaʃ.ra], [ʃaʃb]
s.	*ʃ <sub>2</sub> L <sub>1</sub> ] <sub>σ</sub> >> *ʃ <sub>2</sub> O <sub>1</sub> ] <sub>σ</sub>	Split Margin	3.1.1	
t.	*L <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub> >> *ʃ <sub>2</sub> O <sub>1</sub> ] <sub>σ</sub>	Split Margin	3.1.1	
u.	*ʃ <sub>2</sub> O <sub>1</sub> ] <sub>σ</sub> >> *M <sub>2</sub> /ʃ	Split Margin	3.1.1	

*Note.* Letters in the left column refer to labels in Figure (4.36).

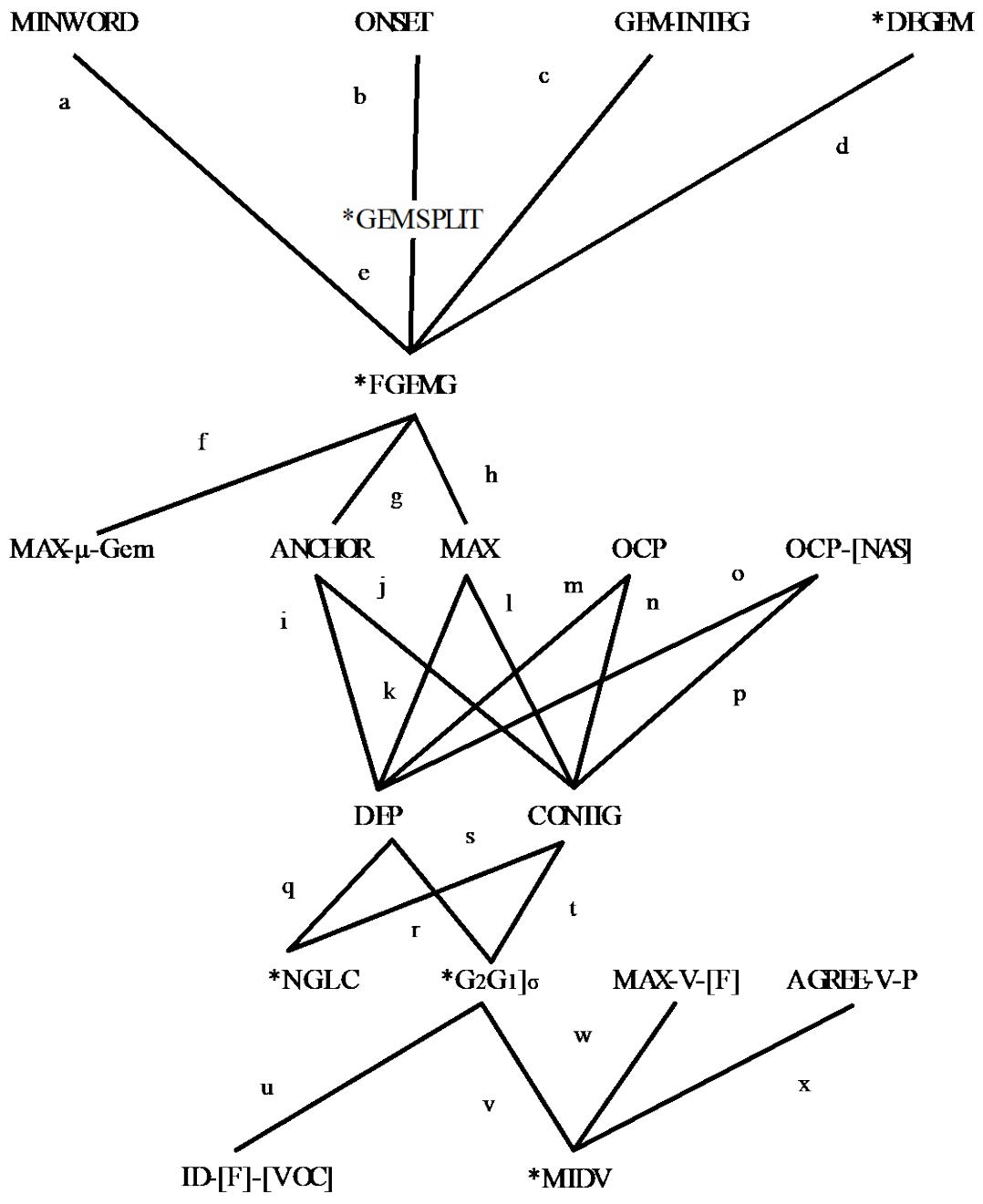
<sup>107</sup> ANCHOR is a high-ranked constraint in the sonority grammar of HA and it is respected in all tableaux in section 4.2, even though it is not explicitly presented in the ranking argument.

Finally, the chapter elaborated in a detailed manner on the status of final geminates in HA. In HA, a geminate is a single root consonant with moraic weight and it occupies double timing slots on the surface. Consider the example /χal:<sup>μ</sup>/ “vinegar” → [χal<sup>μ</sup>il<sub>i</sub>]. Since it occupies double timing slots on the surface, it is considered by the Split-Margin approach as being a level coda cluster, which is allowed to surface by the grammar of HA if there is no higher constraint preventing this level cluster from surfacing. OCP constraints such as general OCP or OCP-[NAS] discriminate between the two similar consonants on the surface, whether they belong to one underlying root such as /sum:<sup>μ</sup>/ “poison” or two independent underlying roots /sum<sub>i</sub>m<sub>j</sub>/. In the latter case, OCP constraints take effect, at the expense of violating DEP and CONTIG, which results in epenthesis on the surface between two independent similar consonants. Otherwise, constraints preserving the shape of the geminate such as \*GEMINTEG and \*DEGEM are strongly active and undominated, preventing epenthesis between the two timing slots of the geminate on the surface or the deletion of one of these timing slots.

As a rule of thumb, a final non-glide geminate consonant does surface intact, regardless of whether the word is a monosyllabic root or a polysyllabic root. Consider the examples /χad:<sup>μ</sup>/ “cheek” → [χad<sup>μ</sup>idi] and /χal:<sup>μ</sup>/ “vinegar” → [χal<sup>μ</sup>il<sub>i</sub>]. However, an underlying geminate glide in a polysyllabic root does not surface due to the high-ranked \*FGEMG constraint. Consider the words /ʕaduw:<sup>μ</sup>/ “enemy” → [ʕadu] and /nabij:<sup>μ</sup>/ “prophet” → [nabi]. The constraint \*FGEMG does not take effect in underlying monosyllabic final geminate glide roots. Consider the words /ḍʒaw:<sup>μ</sup>/ “weather, atmosphere” → [ḍʒaw<sup>μ</sup>w<sub>i</sub>] and /ħaj:<sup>μ</sup>/ “neighborhood, alive” → [ħaj<sup>μ</sup>ij<sub>i</sub>]. This is because the undominated MINWORD constraint militates against the deletion of the final geminate glide in a monosyllabic word. In addition, phonological processes such as hollow root coalescence e.g. /mawz/ “banana” → [mooz] or weak root glide vocalization e.g. /galj/ “frying”

→ ['ga.li], which were active in coda clusters containing glides, do not take effect, if the final glide is a geminate. Therefore, a final geminate glide in a monosyllabic word surfaces faithfully occupying two timing slots.

When a suffix attaches to a final geminate monosyllabic or polysyllabic root word, the geminate consonant surfaces faithfully by splitting into two syllables on the surface. Consider the examples /d̥ʒaw:<sup>u</sup>-u/ “his weather” → [ˈd̥ʒaw<sup>u</sup>.wu], /ħaj:<sup>u</sup>-u/ “his neighborhood” → [ˈħaj<sup>u</sup>.ju], /χad:<sup>u</sup>-u/ “his cheek” → [ˈχad<sup>u</sup>.du], /maħal:<sup>u</sup>-u/ “his location” → [ma.ˈħal<sup>u</sup>.lu], /ʕaduw:<sup>u</sup>-u/ “his enemy” → [ʕa.ˈduw<sup>u</sup>.wu] and /nabij:<sup>u</sup>-u/ “his prophet” → [na.ˈbij<sup>u</sup>.ju]. This suffixed final geminate consonant surfaces faithfully whether it is a glide or a non-glide consonant. The Hasse diagram in Figure (4.37) summarizes the constraint ranking of the final geminate in HA.



(4.37) Hasse Diagram of the Subgrammar of Gemimates

Table 4.3 provides an index for the constraint ranking in the Hasse diagram in Figure (4.37).

Table 4.3

*Index of Constraint Rankings for the Subgrammar of Geminate*

	Ranking	Tableaux	Section	Example Word(s)
a.	MINWORD >> *FGEMG	4.15	4.3	[d̄ʒaw <sup>h</sup> w]
b.	ONSET >> *GEMSPPLIT	4.16	4.3	[ʕa.duw <sup>h</sup> .wu]
c.	GEM-INTEG >> *FGEMG	4.15	4.3	[d̄ʒaw <sup>h</sup> w]
d.	*DEGEM >> *FGEMG	4.15	4.3	[d̄ʒaw <sup>h</sup> w]
e.	*GEMSPPLIT >> *FGEMG	4.15	4.3	[d̄ʒaw <sup>h</sup> w]
f.	*FGEMG >> MAX-μ-GEM	4.13	4.3	[ʕa.du]
g.	*FGEMG >> ANCHOR	4.13	4.3	[ʕa.du]
h.	*FGEMG >> MAX	4.13	4.3	[ʕa.du]
i.	ANCHOR >> DEP	Sound Grammar	Table 3.1	
j.	ANCHOR >> CONTIG	Sound Grammar	Table 3.1	
k.	MAX >> DEP	4.11	4.3	[r <sup>s</sup> u.z <sub>i</sub> uz <sub>j</sub> ], [tu.mun]
l.	MAX >> CONTIG	4.11	4.3	[r <sup>s</sup> u.z <sub>i</sub> uz <sub>j</sub> ], [tu.mun]
m.	OCP >> DEP	4.11	4.3	[r <sup>s</sup> u.z <sub>i</sub> uz <sub>j</sub> ]
n.	OCP >> CONTIG	4.11	4.3	[r <sup>s</sup> u.z <sub>i</sub> uz <sub>j</sub> ]
o.	OCP-[NAS] >> DEP	4.11	4.3	[tu.mun]
p.	OCP-[NAS] >> CONTIG	4.11	4.3	[tu.mun]
q.	DEP >> *NGLC <sup>108</sup>	Split Margin	3.1.1	
r.	DEP >> *G <sub>2</sub> G <sub>1</sub> σ	Split Margin	3.1.1	
s.	CONTIG >> *NGLC	Split Margin	3.1.1	
t.	CONTIG >> *G <sub>2</sub> G <sub>1</sub> σ	Split Margin	3.1.1	
u.	*G <sub>2</sub> G <sub>1</sub> σ >> ID-[F]-[VOC]	Glide Grammar	Table 4.1	
v.	*G <sub>2</sub> G <sub>1</sub> σ >> *MIDV	Glide Grammar	Table 4.1	
w.	MAX-V-[F] >> *MIDV	Glide Grammar	Table 4.1	
x.	AGREE-V-P >> *MIDV	Glide Grammar	Table 4.1	

<sup>108</sup> \*NGLC is a collective constraint for non-glide level clusters concerning the coda.

*Note.* Letters in the left column refer to labels in Figure (4.37).

Having provided the constraint ranking summary in Figure (4.37) regarding the status of final geminates in HA, Chapter 5 will be dedicated to sonority-driven epenthesis and how it interacts with neighboring consonants and vowels.

## **Chapter 5: Sonority-driven Epenthesis, High vowel spreading, and Consonant-to-Vowel Harmony in HA**

After providing the analysis of the role of sonority and the other subgrammars in shaping the coda cluster in HA, this chapter analyzes sonority-driven epenthesis, which operates whenever the coda cluster would exhibit a rising sonority profile. The quality of both stem vowels and the consonant in the coda cluster play a role in determining the quality of the epenthetic vowel, which breaks up a potential rising coda cluster. Several OT constraints, which have their own independent ranking, are used in the analysis of Sonority-Driven Epenthesis, High Vowel Spreading, and Consonant-to-Vowel Harmony. These constraints are connected with the main constraints used in the analysis of coda clusters via DEP and CONTIG. When DEP and CONTIG are dominated by any of the Split-Margin constraints, the sonority-driven epenthesis constraint ranking operates. In this way, DEP and CONTIG function as a bridge between two independent constraint rankings i.e. the Split-Margin constraints in addition to the other relevant Markedness and Faithfulness constraints on the one hand, and the Sonority-Driven Epenthesis, High Vowel Spreading, and Consonant-to-Vowel Harmony constraints on the other.

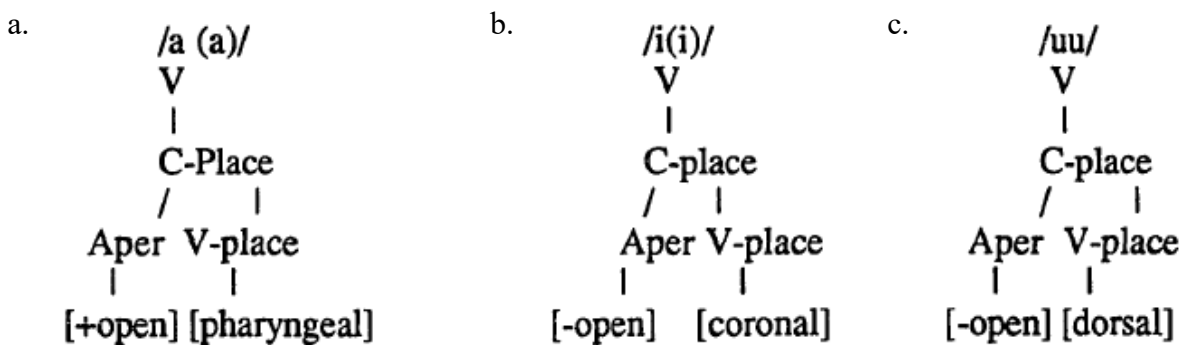
Section 5.1 provides a background of the feature geometry of the quality of the epenthetic vowels which break up a potential rising coda cluster in HA. Section 5.2 analyzes the spreading of underlying stem high vowels. Section 5.3 analyzes the coronal consonant-to-vowel harmony. Section 5.4 provides the analysis of pharyngeal consonant-to-vowel harmony. Section 5.5 analyzes the faithful surfacing of non-rising coda clusters, in spite of the harmony constraints. Section 5.6 provides the analysis of the coda clusters that end with emphatic [r<sup>ʕ</sup>] vs. plain [r]. Section 5.7 analyzes defaults for sonority-driven epenthesis and syllable-driven epenthesis. Finally, section 5.8 discusses and concludes the chapter.

### 5.1. Quality of the epenthetic vowel

As illustrated in Figure (4.5) in Chapter 4, HA has three short vowels: /i/, which is high front and [coronal]; /u/, which is high back and [dorsal]; and /a/, which is not specified for frontness or backness, but only specified as a low vowel and [pharyngeal]. Each of these three vowels can be epenthetic in sonority-driven epenthesis in the process of the harmony between these vowels and surrounding vowels and consonants. In HA, the default epenthetic vowel in sonority-driven epenthesis is the high front [i]. Regarding syllable-driven epenthesis, the low vowel [a] is the default epenthetic vowel.

In order to understand the harmony processes between the consonants and the epenthetic vowel in the output form, it is worth illustrating the feature geometry of the three basic short vowels /a i u/ in Arabic. Herzallah (1990) provides the feature representation of the three basic vowels in Arabic /a i u/, which is reproduced in Figure (5.1a–c).

(5.1) Herzallah’s (1990, p. 66), Figure 13: Arabic Vowel Feature Representations



We can observe from Figure (5.1a–c) that all vowels are represented by C-Place and V-Place. C-Place represents the degree of openness of the mouth during the production of these vowels, whereas V-Place represents the place of articulation of these vowels—that is, the position of the

tongue relative to a specific point in the vocal tract. Therefore, the low vowel /a/ is a pharyngeal and it harmonizes with pharyngeal consonants or consonants that include the pharyngeal feature. The high vowel /u/ is dorsal (i.e., back) and harmonizes with consonants that have the dorsal feature. Finally, /i/ is coronal and harmonizes with coronal consonants, as will be illustrated in §5.3. One can note that Herzallah did not include the short /u/ in her vowel feature representation, because she considers the short [u] as a derived segment rather than underlying in PA. However, I consider the short /u/ to be present underlyingly in HA rather than being derived. After presenting the feature representation of these three basic vowels in Arabic, now we turn back to discussing the quality of the epenthetic vowel.

## 5.2. High vowel spreading

In HA, when the stem contains a high vowel [i] or [u], the epenthetic vowel, which breaks up the potential rising-sonority coda cluster, is the result of the autosegmental spreading of the underlying high vowel in the stem, as shown in Figure (5.2a–b).

### (5.2) High Vowel Spreading in Potential Rising Coda Clusters in HA

	Underlying	Gloss	Surface	Possessive (3P.MASC.)
a.	/gidr/	“pot”	[gi.dir]	[gid.r <sup>s</sup> u]
	/ʔism/	“name”	[ʔi.sim]	[ʔis.mu]
	/sihr/	“magic, sorcery”	[si.ħir]	[siħ.r <sup>s</sup> u]
	/siʕr/	“price”	[si.ʕir]	[siʕ.r <sup>s</sup> u]
	/fiʕl/	“verb, action”	[fi.ʕil]	[fiʕ.lu]
b.	/ħukm/	“verdict, ruling”	[ħu.kum]	[ħuk.mu]
	/χuʕm/	“nose”	[χu.ʕum]	[χuʕ.mu]

/dufn/	“fat”	[du.fun]	[duf.nu]
/d̥zũhr/	“burrow, den”	[d̥zũ.hur̥]	[d̥zũh.r̥u]
/d̥ʰuf̥hr/	“afternoon”	[d̥ʰu.f̥hur̥]	[d̥ʰuf̥h.r̥u] <sup>109</sup>

As illustrated in Figure (5.2a–b), the sonority-driven epenthetic vowel has the same quality as the stem vowel, because the stem vowel is high; however, when the stem vowel is low, consonant-to-vowel harmony takes effect. Otherwise, the default epenthetic vowel is [i], as will be analyzed in detail in subsequent sections. I analyze the high vowel spreading epenthesis—loosely following the logic of Walker (2001) in her analysis of Altaic rounding harmony—as a process of autosegmental spreading: the [front] feature spreads to the epenthetic vowel if the stem contains a [high] [front] vowel, and the [back] feature spreads to the epenthetic vowel if the stem contains a [high] [back] vowel. In order to motivate the spreading of the [front] or [back] feature to the epenthetic vowel, the constraints in (5.3) are necessary.

(5.3) SPREAD-[F] Constraints adapted from Walker (2001, p. 845) and IDENT-IO(Vowel)

a. SPREAD-[front]:

“For any vowel in a word linked to a [front] autosegment, that same [front] autosegment must also be associated to all other vowels in the word. Assign a violation for any [front] autosegment that is not associated to all vowels in the word.”

b. SPREAD-[back]:

“For any vowel in a word linked to a [back] autosegment, that same [back] autosegment must also be associated to all other vowels in the word. Assign a violation for any [back] autosegment that is not associated to all vowels in the word.”

---

<sup>109</sup> In some of the words in Figure (5.2), the underlying plain /r/ is emphatic [r̥] next to the high back vowel [u]. The status of the emphatic/pharyngeal [r̥] will be elaborated in detail in sections 5.4 and 5.6.

c. IDENT-IO(Vowel):

“Let  $\alpha$  be a vowel in the input and  $\beta$  be a correspondent of  $\alpha$  in the output; then  $\alpha$  and  $\beta$  have identical featural specifications. Assign a violation for any discrepant featural specification between  $\alpha$  and  $\beta$ .”

Tableau 5.1 shows that the feature [front] spreads from the stem vowel to the epenthetic vowel.

*Tableau 5.1. Feature [front] Spreading in Stems with a High Vowel*

/fikir/ “thought, idea”	*O <sub>2</sub> L <sub>1</sub> ] <sub>σ</sub>	IDENT-IO(Vowel)	SPREAD-[back], SPREAD-[front]	DEP	CONTIG
a. [fikir]	*!				
b. [fi.kir]				*	*
c. [fi.kur <sup>s</sup> ]			*!	*!	*!
d. [fi.kar]			*!	*!	*!
e. [fu.kir]		*!	*	*	*
f. [fu.kur <sup>s</sup> ]		*!		*	*
g. [fi.ker]				*	*

Candidate (a) loses because it violates the Split Margin constraint, by having a rising-sonority coda cluster. Candidate (b) respects all constraints other than the low ranked DEP and CONTIG. Candidates (c) and (d) lose, because they violate the SPREAD-[front] constraint by not spreading their [front] feature to the epenthetic vowel. Candidate (e) loses, because it violates undominated IDENT-IO(Vowel) by changing the stem vowel from [i] to [u], as well as violating the SPREAD constraint. Candidate (f) loses, because it violates IDENT-IO(Vowel) by changing the quality of the stem vowel. Finally, candidate (g) ties with candidate (b), by spreading the [front] feature from the stem vowel to the epenthetic vowel. However, the quality of the epenthetic vowel in both (b) and (g) still differs; in (b), the epenthetic vowel has identical features to the stem vowel, whereas in (g), the epenthetic vowel has a different height specification than the stem vowel.

Therefore, there is a need to break this tie between the expected winner, candidate (b), and the incorrectly predicted winner (g), through an additional constraint, UNIFORM, which is defined in Figure (5.4).

(5.4) UNIFORM-[front]/[back] (adapted from Walker, 2001, p. 848):

“A [front] or [back] autosegment may not be multiply-linked to vowels that are distinctly specified for height.”

Tableau 5.2a illustrates that [fi.kir] wins because it respects UNIFORM-[front] by having the same front vowel in both syllables. The stem vowel spreads its [front] feature to the epenthetic vowel, which also has the same specifications as the stem vowel in terms of height and frontness.

Tableau 5.2a. No Discrepancy in Vowel Height with UNIFORM-[front]

/fikr/ “thought, idea”	*O <sub>2</sub> L <sub>1</sub> ] <sub>σ</sub>	IDENT- IO(Vowel)	SPREAD- [back], SPREAD- [front]	DEP	CONTIG	UNIFORM- [front]/[back]
a. [fikr]	*!					
☞ b. [fi.kir]				*	*	
c. [fi.ker]				*	*	*!
d. [fi.kar]			*!	*	*	

The faithful candidate (a) loses because it exhibits a rising-sonority coda cluster, violating the Split-Margin constraint. Candidate (b) wins because it respects all constraints other than DEP and CONTIG. Candidate (c), which tied with the winner in Tableau 5.1, loses even though the [front] feature spreads, because the epenthetic vowel has a different height specification than the stem vowel; therefore, it violates UNIFORM-[front]. Candidate (d) loses because it violates the SPREAD

constraint. Having provided an analysis for vowel spreading in stems containing a high front vowel, Tableau 5.2b provides an analysis for stems containing a high back vowel.

*Tableau 5.2b. High back vowel spreading with UNIFORM-[back]*

/fukr/ “thank”	*O <sub>2</sub> L <sub>1</sub> ] <sub>σ</sub>	IDENT- IO(Vowel)	SPREAD- [back], SPREAD- [front]	DEP	CONTIG	UNIFORM- [front]/[back]
a. [fukr]	*!					
b. [fu.kur <sup>s</sup> ]				*	*	
c. [fu.kir]			*!	*	*	
d. [fu.kar]			*!	*	*	
e. [fi.kur <sup>s</sup> ]		*!	*	*	*	
f. [fi.kir]		*!		*	*	
g. [fu.kor]				*	*	*!

The faithful candidate (a) loses, because it violates the high-ranked Split Margin constraint by exhibiting a rising-sonority coda cluster. Candidate (b) wins, because the high back specification spreads to the epenthetic vowel; therefore, both vowels are identical. Candidates (c) and (d) both fatally violate SPREAD-[back] in addition to DEP and CONTIG. For (c), the epenthetic vowel is a high front vowel, which does not harmonize with the stem vowel. For (d), the epenthetic vowel is a low vowel without any specification for [front] or [back], as shown in Figure (4.5) in Chapter 4; therefore, it also does not harmonize with the stem vowel. Candidate (e) fatally violates IDENT-IO(Vowel) by changing the stem vowel from /u/ to [i]. Candidate (f) loses, because it violates IDENT-IO(Vowel), even though the vowel features are shared by both syllables. Candidate (g) loses, even though the [back] feature spreads to the epenthetic vowel, because the height specifications of the vowels are different; therefore, it violates UNIFORM-

[back]. The high vowel spreading takes precedence over consonant-to-vowel harmony, such as laryngeal/pharyngeal consonant-to-vowel harmony and dorsal consonant-to-vowel harmony, even in words with a medial pharyngeal/laryngeal or nonguttural and final rhotic. Compare the words /siħr/ “magic, sorcery”, which surfaces as [si.ħir], with /baħr/ “sea” and /d̤ʒadr̤/ “wall”, which surface as [baħar] and [d̤ʒadur̤], respectively. The quality of the epenthetic [a] in [baħar] is a result of the laryngeal/pharyngeal progressive consonant-to-vowel harmony and the quality of the epenthetic [u] in [d̤ʒadur̤] is a result of the dorsal regressive consonant-to-vowel harmony.

Having provided the analysis for stem high vowel spreading in the previous tableaux, now we turn to explain consonant-to-vowel harmony in stems with an underlying low vowel. Section 5.3 analyzes mandatory coronal-to-vowel harmony in CaCC<sub>[coronal]</sub> syllables.

### 5.3. Coronal Consonant-to-Vowel Harmony

In HA, in underlying CaCC words, in which the stem vowel is a low vowel and the last consonant is coronal, the vowel [i] is epenthesized if the last two consonants would form a rising-sonority coda cluster. Consider the examples in Figure (5.5) below.

#### (5.5) Coronal Consonant-to-Vowel Harmony

	Underlying	Gloss	Surface	Possessive.3P.MASC
a.	/makr/	“cunning”	[ma.kir]	[mak.r <sup>ɕ</sup> u]
	/fagr/	“poverty”	[fa.gir]	[fag.r <sup>ɕ</sup> u]
	/gabr/	“grave, grave site”	[ga.bir]	[gab.r <sup>ɕ</sup> u]
	/tamr/	“date (fruit)”	[ta.mir]	[tam.r <sup>ɕ</sup> u]
b.	/sahl/	“valley”	[sa.fil]	[saf.lu]
	/ħabl/	“rope”	[ħa.bil]	[ħab.lu]

	/ħagl/	“field, meadow”	[ħa.gil]	[ħag.lu]
	/ʃakl/	“shape, appearance”	[ʃa.kil]	[ʃak.lu]
c.	/laʃn/	“cursing”	[la.ʃin]	[laʃ.nu]
	/ħagn/	“injection”	[ħa.gin]	[ħag.nu]
	/laħn/	“melody”	[la.hin]	[laħ.nu]
	/rakn/	“putting in the corner, cornering”	[ra.kin]	[rak.nu]
	/dafn/	“(act of) painting”	[da.fin]	[daf.nu]
	/rafn/	“collateral”	[ra.fin]	[raf.nu]
	/ʁabn/	“injustice”	[ʁa.bin]	[ʁab.nu]
d.	/χabz/	“baking”	[χa.biz]	[χab.zu]
	/lafz <sup>ʕ</sup> /	“word”	[la.fiz <sup>ʕ</sup> ]	[laf.z <sup>ʕ</sup> u]

As can be noted in (5.5), all words ending with a coronal segment require the preceding epenthetic vowel to be [i] in order to match the coronality (frontness) between the consonant and the epenthetic vowel. In addition, according to Padgett (2011, p. 4, 13-14), universally, there is a connection i.e. a harmonic effect between coronal consonants and front vowels. Note that all intermediate consonants in these words are noncoronal consonants. This confirms that the trigger of coronal harmony is the last consonant in the word. Therefore, there is a need for an additional constraint to regulate the relationship between the last coronal segment of the word and the epenthetic vowel in the environment of sonority-driven epenthesis in a rising-sonority coda cluster. Figure (5.6) provides the definition for the constraint necessary for the analysis of coronal consonant-to-vowel harmony.

(5.6) AGREE-FEAT-CORONAL (AGREE-F-COR):

“Segments immediately preceding and tautosyllabic with a coronal consonant must agree with it in the feature [coronal]. Assign a violation for any segment in the output which immediately precedes and is tautosyllabic with a coronal consonant and does not share the feature [coronal].”

Tableau 5.3 provides the analysis of CaCC words in which the last consonant is a coronal and requires the immediately preceding epenthetic vowel to be the coronal [i].

*Tableau 5.3. AGREE-F-COR in Coronal-Final CaCC Words*

/ʃakl/ “shape, appearance”	*O <sub>2</sub> L <sub>1</sub> ] <sub>σ</sub>	AGREE-F-COR	DEP	CONTIG
a. [ʃakl]	*!			
b. [ʃa.kil]			*	*
c. [ʃa.kul]		*!	*	*
d. [ʃa.kal]		*!	*	*

Candidate (a) loses because it violates the Split-Margin constraint by exhibiting a rising-sonority coda cluster in the output form. Candidate (b) wins because [i] harmonizes with [l] by agreeing in the feature [coronal]. Candidate (c) loses because [u], which is a dorsal vowel, does not agree with the following coronal consonant. In the same way, candidate (d) loses because the epenthetic pharyngeal [a] does not agree with the [l].

Note that, in a word like /sard/ “providing details,” the constraint AGREE-F-COR is violated when the stem vowel does not agree with the adjacent consonant in the feature [coronal]; however, this word surfaces faithfully as [sard] with no change in the stem vowel. This is because IDENT-IO-(VOWEL) is undominated, which means that the identity of the stem

vowel does not change in the output form. Therefore, AGREE-F-COR does not motivate the change of the stem vowel, because it is outranked by IDENT-IO-(VOWEL).

Having provided the analysis in which a final coronal consonant dictates the quality of the preceding epenthetic vowel in the process of sonority-driven epenthesis, now we turn to pharyngeal and laryngeal consonant-to-vowel harmony, in which these consonants dictate that [a] will be the surface form of the epenthetic vowel. This vowel can be followed by an emphatic [r<sup>ʕ</sup>], which also contains a pharyngeal feature in its segmental representation.

#### **5.4. Pharyngeal consonant-to-vowel harmony**

In HA stems with a low vowel in which a potential coda cluster contains a pharyngeal or laryngeal consonant followed by emphatic [r<sup>ʕ</sup>], the epenthetic vowel to avoid the surfacing of such a cluster is the vowel [a], which also has a [pharyngeal] component, as proposed by Herzallah (1990). The words in Figure (5.7) include medial pharyngeal or laryngeal consonants followed by emphatic [r<sup>ʕ</sup>]. These words receive a low epenthetic vowel in the output form in order to avoid a potential rising-sonority coda cluster, except for (5.7c), which exhibits a falling-sonority coda cluster, but still receives an epenthetic vowel because of the conjoined constraint \*ʕ<sub>σ</sub> & OCP-[son] (see §4.2 in Chapter 4).

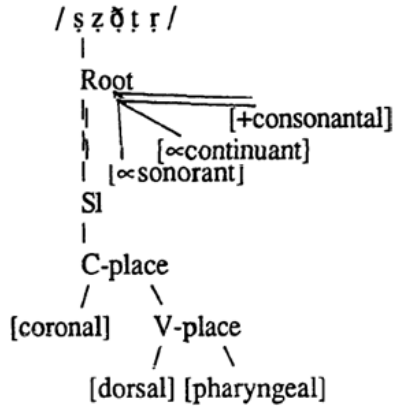
(5.7) Potential Coda Clusters with Pharyngeal Consonant-to-Vowel Harmony

	Underlying	Gloss	Surface	Possessive.3P.MASC
a.	/ʃaɦr/	“month”	[ʃa.ɦar <sup>s</sup> ]	[ʃaɦ.r <sup>s</sup> u]
	/naɦr/	“river”	[na.ɦar <sup>s</sup> ]	[naɦ.r <sup>s</sup> u]
	/maɦr/	“dowry”	[ma.ɦar <sup>s</sup> ]	[maɦ.r <sup>s</sup> u]
b.	/baɦr/	“sea”	[ba.ɦar <sup>s</sup> ]	[baɦ.r <sup>s</sup> u]
c.	/ʃaħr/	“hair”	[ʃa.ħar <sup>s</sup> ]	[ʃaħ.r <sup>s</sup> u]

As can be noticed from Figure (5.7), all potential coda clusters that start with laryngeals or pharyngeals followed by emphatic [r<sup>s</sup>] receive a low epenthetic vowel [a] instead of the default [i].

Before explaining the reason why these words receive the low vowel [a], it is worth explaining the status of /r/ in Arabic. In Arabic, /t<sup>s</sup> ð<sup>s</sup> d<sup>s</sup> s<sup>s</sup>/ are the main emphatic consonants, yet /r/ also has an emphatic allophone based on the dialect and some phonological conditions. Younes (1993, p. 121) argues that the status of the emphatic [r<sup>s</sup>] is not fully established. This can explain why many authors dealing with emphatic and pharyngealized consonants do not elaborate on the phonological behavior of the emphatic [r<sup>s</sup>]. According to Younes (1993, p. 121, fn. 3), emphatic [r<sup>s</sup>] causes lowering in adjacent vowels. Recall Herzallah’s (1990) representation of emphatics from Figure (2.35), reproduced here as Figure (5.8).

(5.8) Herzallah’s Representation of Emphatics



In Figure (5.8), emphatic consonants in PA, including underlyingly emphatic /r<sup>s</sup>/, have a secondary place of articulation, which itself has two components: pharyngeal and dorsal. However, in contrast to Herzallah’s proposal that emphatic /r<sup>s</sup>/ is underlying in PA, HA also has an emphatic [r<sup>s</sup>], but it is an allophonic variant of the underlying plain /r/. In HA, /r/ is emphaticized next to emphatics, pharyngeals, laryngeals, and low and back vowels; otherwise, it is only coronal (plain), as shown in Figure (5.9).

(5.9) Potential Coda Clusters with Plain [r] and Emphatic [r<sup>s</sup>]

	Underlying	Gloss	Surface	<i>Nisba</i> Adjective	<i>Nisba</i> Gloss
a.	/nabr/	“tone, accent”	[na.bir]	[nab.ri]	“tonal, accentuated”
	/kasr/	“fracture”	[ka.sir]	[kas.ri]	“fractional”
	/fikr/	“thought”	[fi.kir]	[fik.ri]	“intellectual”
	/s <sup>s</sup> aχr/	“rock, stone”	[s <sup>s</sup> a.χir]	[s <sup>s</sup> aχ.ri]	“stony, rocky”
b.	/fukr/ <sup>110</sup>	“thanking”	[fu.kur <sup>s</sup> ]		
	/ʕuzr/	“apology”	[ʕu.zur <sup>s</sup> ]		

<sup>110</sup> It is very rare to have a *nisba* form of CuCr<sup>s</sup> words with a rising-sonority coda cluster in Arabic. However, it is possible for a different suffix to attach to this form, which causes /r/ to surface as plain [r], e.g., [fuk.ri] “my thanking” and [ʕuz.ri] “my apology, my excuse.”

c.	/ʃaħr/	“month”	[ʃa.ħar <sup>ʕ</sup> ]	[ʃaħ.ri]	“monthly, lunar”
	/baħr/	“sea”	[ba.ħar <sup>ʕ</sup> ]	[baħ.ri]	“naval, nautical, marine”

In data set (5.9a), [r] is coronal because it is not preceded by a low or back vowel nor by a laryngeal or pharyngeal consonant. Therefore, the epenthetic vowel to break this rising-sonority coda cluster is the default [i]. In (5.9b), [r<sup>ʕ</sup>] is emphatic because it is adjacent to the high back vowel [u], which itself is the result of high vowel spreading from the stem vowel to the epenthetic vowel (Dorsal harmony in words ending with optional emphatic [r<sup>ʕ</sup>] will be presented in §5.6). In (5.9c), the underlying coronal (plain) /r/ becomes emphatic [r<sup>ʕ</sup>], because it is preceded by a laryngeal or pharyngeal consonant. Therefore, the epenthetic vowel to break up such a rising-sonority coda cluster is the low vowel [a], which itself agrees with the surrounding consonants in the feature [pharyngeal] (see feature representation of the low vowel in §5.1, Figure (5.1a)). We can conclude from Figure (5.9) that the trigger of the low vowel insertion in rising-sonority coda clusters ending with emphatic [r<sup>ʕ</sup>] is the pharyngeal and laryngeal consonants. In derived forms, when the *nisba* suffix /-i/ or the first-person possessive suffix /-i/ is attached to the /r/-final stem, the /r/ resyllabifies to form an onset for the syllable containing /-i/; therefore, it surfaces faithfully as the coronal (plain) [r].

Before starting the OT analysis of pharyngeal and laryngeal consonant-to-vowel harmony, it is necessary to present the definition for the constraints needed in this analysis. Figure (5.10) introduces two new constraints used for pharyngeal and laryngeal consonant-to-vowel harmony in coda clusters that include emphatic [r<sup>ʕ</sup>].

(5.10) The Constraints Necessary for Pharyngeal Consonant-to-Vowel Harmony

- a. AGREE-FEAT-PHARYNGEAL (AGREE-F-PHAR): Segments immediately following and tautosyllabic with pharyngeal and laryngeal segments must agree with them in the feature [pharyngeal]. Assign a violation for any segment in the output which immediately follows and is tautosyllabic with a pharyngeal or laryngeal segment and does not agree with it in the feature [pharyngeal].
- b. IDENT-IO-C-PLACE (IDENT-C-PLACE): A consonant's C-Place (i.e., primary place of articulation) in the output must be identical to its correspondent in the input. Assign a violation for any C-Place of a consonant in the output which differs from its correspondent in the input.

These new constraints, in addition to the Split-Margin constraint, DEP, and CONTIG, will be used for the analysis of pharyngeal and laryngeal harmony in coda clusters including [r<sup>s</sup>], as will be presented in Tableau 5.4.

Tableau 5.4. Pharyngeal and Laryngeal Consonant-to-Vowel Harmony

/bahr/ “sea”	*O <sub>2</sub> L <sub>1</sub> ] <sub>σ</sub>	IDENT-C-PLACE	DEP	CONTIG	AGREE-F-PHAR
a. [bahr]	*!				*
b. [bahr <sup>s</sup> ]	*!				
c. [ba.ħar <sup>s</sup> ]			*	*	
d. [ba.ħar]			*	*	*!
e. [ba.ħir]			*	*	*!
f. [ba.ħir <sup>s</sup> ]			*	*	*!
g. [ba.χar <sup>s</sup> ]		*!	*	*	
h. [ba.ʃar]		*!	*	*	*
i. [ba.ʃir]		*!	*	*	
j. [ba.ħur <sup>s</sup> ]			*	*	*!
k. [ba.ħur]			*	*	*!

The faithful candidate (a) loses because it fatally violates the Split-Margin constraint; in addition, it violates AGREE-F-PHAR by preserving the plain [r] next to the pharyngeal consonant.

Candidate (b) also loses, because it violates the Split-Margin constraint, even though the emphatic [r<sup>s</sup>] agrees with the preceding consonant in the feature [pharyngeal]. Candidate (c) is the winner, because it satisfies both undominated constraints, Split-Margin and Ident-C-Place; in addition, it satisfies low-ranked AGREE-F-PHAR, even though it violates DEP and CONTIG.

Candidate (d) is like the winner, except the [r] is not emphaticized, which creates a violation of the AGREE-F-PHAR constraint. Candidate (e) loses by inserting the default vowel [i], which does not agree with the preceding segment in the feature [pharyngeal]. In the same way, candidate (f) loses. Candidate (g) loses because it changes the identity of C-Place of the medial consonant by

adding a dorsal component, which causes the change from [ħ] to [χ] (see the uvular feature representations of Figures (2.32b) [Bin-Muqbil], (2.33b) [Zawaydeh], and (2.37) [Herzallah]).<sup>111</sup> Candidate (h) is the worst candidate, because, like the previous candidate, it violates IDENT-C-PLACE by changing the C-Place of /ħ/ to coronal ([ʃ]). In addition, it has one violation of AGREE-F-PHAR, because the [r] does not agree with the epenthetic vowel [a] in the feature [pharyngeal]. Candidate (i) still loses, even though the epenthetic vowel is the default vowel, which harmonizes with the surrounding consonants, because of the change in the C-Place identity of the medial consonant. Candidate (j) loses because [u] is epenthesized after [ħ], which is a pharyngeal consonant. Therefore, there is a violation of AGREE-F-PHAR between [ħ] and [u]. In the same way, candidate (k) loses even though the [r] is not emphatic, because [u] still does not agree with the preceding consonant.

Tableau 5.4 provided the analysis in which the word-medial consonant was a pharyngeal or laryngeal followed by /r/. Next we turn to the comparison of coronal harmony with pharyngeal harmony in coronal-final words. In HA, when a potential rising-sonority coda cluster contains a laryngeal or pharyngeal consonant, followed by a coronal (other than /r/), coronal harmony is the decisive harmony which predicts the right winner. The following tableau provides evidence that whenever a rising-sonority coda cluster occurs, the vowel [i] is inserted to break up such a cluster if the last consonant is a nonrhotic coronal. This is because AGREE-F-COR predicts the right winner even if it is low-ranked, as will be demonstrated in Tableau 5.5.

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<sup>111</sup> It can be noted from the feature representations of Bin-Muqbil (2006), Zawaydeh (1999), and Herzallah (1990) that they all agree on the complex representation of uvulars, which does not only include the [pharyngeal] feature but also includes the [dorsal] feature to represent these consonants; therefore, the change of [ħ] to [χ] is a significant change of identity of C-Place, which causes the change of the whole segment.

Tableau 5.5. Words with Coronal Harmony Win in Coronal-Final CaCC Words

/lahn/ “melody”	*O <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub>	DEP	CONTIG	AGREE-F-PHAR	AGREE-F-COR
a. [lahn]	*!			*	*
b. [la.hin]		*	*	*	
c. [la.han]		*	*	*	*!
d. [la.hun]		*	*	*	*!

The faithful candidate (a) loses because it fatally violates the Split-Margin constraint; in addition, it violates AGREE-F-PHAR and AGREE-F-COR. Candidate (b) wins because it satisfies the Split-Margin constraint and low-ranked AGREE-F-COR, in that the epenthetic vowel agrees with the following consonant in the feature [coronal]. Candidate (c) loses by fatally violating low-ranked AGREE-F-COR, because the [a] is not coronal in order to agree with the following consonant [n]; in addition, it violates DEP, CONTIG, and AGREE-F-PHAR. Candidate (d) loses because the epenthetic [u] vowel does not agree in the feature [coronal] with the following coronal consonant. From this tableau, we can conclude that whenever a potential underlying rising-sonority coda cluster contains a pharyngeal or laryngeal consonant followed by a coronal, the vowel [i] will be inserted to break up such a cluster in the output form as a result of the agreement between the coronal consonant and the preceding vowel.

This section has provided the analysis of those situations wherein a potential coda cluster includes a pharyngeal or laryngeal consonant followed by /r/, and how such a cluster is broken up by the appropriate [a] vowel, which also has a pharyngeal component. However, if the word-medial consonant is a pharyngeal or laryngeal and followed by a nonrhotic coronal consonant, the expected epenthetic vowel is [i], as this vowel agrees with the following consonant in the

feature [coronal]. Section 5.5 provides the analysis for words which surface faithfully without epenthesis, resisting the coronal/pharyngeal harmony.

### **5.5. Nonrising Coda Clusters Surface Faithfully with No Harmonic Change**

With regard to a final unresolved issue to discuss before starting the analysis of rhotic-final words in the following section, it is worth elaborating on the effect of the previously proposed AGREE constraints, such as AGREE-F-PHAR and AGREE-F-COR. One might argue that these constraints have a powerful implicational effect on any adjacent segment which does not agree in the feature [pharyngeal] or [coronal] in the output form. However, this effect can be restricted to target only the adjacent vowel in the output form. For example, in the word /wagt/ “time,” by the definition of AGREE-F-COR, the medial consonant /g/ is expected to become [t] or [d] to agree with the last consonant in the feature [coronal]. Similarly, AGREE-F-PHAR would necessitate that the last consonant in the word /laħd/ “grave” should become [d<sup>ħ</sup>] to agree with the preceding consonant in the feature [pharyngeal]. In order for the consonant to surface faithfully and not harmonize with the pharyngeal/laryngeal or coronal consonants in the output form, a new constraint such as IDENT-IO-PHONEME is needed.

(5.11) IDENT-IO-PHONEME (IDENT-IO-PHON):

“A segment’s phonemic value in the output must be identical to its correspondent in the input. Assign a violation for any segment in the output which differs from its correspondent in the input in its phonemic value.”

IDENT-IO-PHON outranks AGREE-F-COR and AGREE-F-PHAR, making sure that the words /wagt/ and /laħd/ surface faithfully with no change in the targeted consonant. This constraint protects

the identity of the consonant in words which surface faithfully without epenthesis. The analysis in which the pharyngeal and coronal segments surface faithfully without any change will be illustrated in Tableau 5.6.

*Tableau 5.6. Faithful Coronal and Pharyngeal Consonants in Nonepenthetic CaCC Words*

/wagt/ “time”	IDENT-IO-PHON	DEP	CONTIG	AGREE-F-PHAR	AGREE-F-COR	*O <sub>2</sub> O <sub>1</sub> ] <sub>σ</sub>
☞ a. [wagt]				*	*	*
b. [wadt]	*!			*		*
c. [wa.git]		*!	*!			
/laħd/ “grave”	IDENT-IO-PHON	DEP	CONTIG	AGREE-F-PHAR	AGREE-F-COR	*O <sub>2</sub> O <sub>1</sub> ] <sub>σ</sub>
☞ d. [laħd]				*	*	*
e. [laħd <sup>ɕ</sup> ]	*!				*	*
f. [la.ħid]		*!	*!	*!		
g. [la.ħad]		*!	*!	*!	*	

The faithful candidate (a) wins by respecting IDENT-IO-PHON and DEP and CONTIG, even though it violates AGREE-F-COR by preserving the identity of the medial consonant. Candidate (b) loses because it violates the undominated IDENT-IO-PHON constraint, even though the medial consonant matches the last consonant in the feature [coronal]. Both candidates (a) and (b) violate AGREE-F-PHAR because the consonant following the stem vowel does not have the feature [pharyngeal]. Candidate (c) loses because it violates both DEP and CONTIG, by inserting a coronal vowel before the coronal consonant. Candidate (d) is the winner for its set, because it respects IDENT-IO-PHON and DEP and CONTIG, even though the phoneme [d] does not have a

pharyngeal component to match that of the preceding consonant. Candidate (e) loses even though both consonants in the coda agree in the feature pharyngeal, because it violates undominated IDENT-IO-PHON by changing [d] to [d<sup>ʕ</sup>]. Candidate (f) loses because it violates DEP, CONTIG, and AGREE-F-PHAR. In the same way, candidate (g) loses even though the low vowel [a] harmonizes with the preceding consonant, because the candidate violates DEP, CONTIG, and AGREE-F-PHAR.

Section 5.6 provides an analysis of the rhotic in final position and the quality of the epenthetic vowel preceding it in the output form.

## 5.6. Final Plain [r] versus Emphatic [r<sup>ʕ</sup>]

This section provides the analysis of CaCr words with potential rising-sonority clusters ending with /r/. These words normally receive default [i]-epenthesis, as expected, in order to break up such a cluster. However, some speakers of HA, especially those of the older generation, pronounce this as emphatic [r<sup>ʕ</sup>], which necessitates the insertion of [u] as the most appropriate vowel, as this allows agreement in the feature [back] (dorsal) between the vowel and the emphatic [r<sup>ʕ</sup>]. According to Card (1983, p. 8), there is no doubt about the phonetic existence of emphatic [r<sup>ʕ</sup>] and [l<sup>ʕ</sup>] in Arabic, but their role in the phonological system is controversial. Youssef (2019, pp. 4-11) states that complex /r/ (i.e. emphatic [r<sup>ʕ</sup>]) could have V-place [dorsal] as well as C-place [coronal]. He also indicates that emphatic [r<sup>ʕ</sup>] shows pharyngeal constriction alongside dorsal lowering.<sup>112</sup> Youssef's description of the emphatic /r<sup>ʕ</sup>/ matches the feature representation of emphatic /r<sup>ʕ</sup>/ and other emphatic obstruents given by Herzallah (1990), which is

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<sup>112</sup> The description of the emphatic /r<sup>ʕ</sup>/ given by Youssef (2019) corresponds to Shahin's (2011) description of pharyngealized consonants. Shahin (2011, p. 12) indicates that "[s]econdary pharyngeal consonants have long been understood to have a primary articulation in the oral cavity and a secondary articulation in the pharynx. Data indicate that they have secondary aryepiglottic constriction...and also secondary uvular constriction (at first referred to as velar)."

presented in Figure (5.8). Therefore, I adopt the feature representation given by Herzallah (1990) in which /r<sup>s</sup>/ has primary [coronal] place, which is dominated by a C node, and secondary [dorsal] and [pharyngeal] places, which are dominated by a V node<sup>113</sup>. Consistent with the assumptions of OT, I propose that the use of emphatic [r<sup>s</sup>] and agreement between this consonant and the preceding epenthetic [u] happens simultaneously in the output form rather than positing an intermediate stage in which /r/ becomes [r<sup>s</sup>] followed by insertion of [u] to agree with this segment. I propose that, for the older generation of HA speakers, underlying /r<sup>s</sup>/ surfaces faithfully as [r<sup>s</sup>]. This necessitates the harmony between the emphatic [r<sup>s</sup>] and the preceding epenthetic [u].<sup>114</sup> See Figure (5.8) in §5.4 for emphatics and Figure (5.1c) in §5.1 for /u/. These figures show that the emphatic /r<sup>s</sup>/ is secondarily [pharyngeal] and [dorsal], while the vowel /u/ is a dorsal vowel. Therefore, [u] is the most appropriate vowel to be inserted before the emphatic [r<sup>s</sup>] used by this group in the process of sonority-driven epenthesis.<sup>115</sup> The data in Figure (5.12) illustrate the use of the plain [r] by the younger generation (i) and the emphatic [r<sup>s</sup>] by the older generation (ii).

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<sup>113</sup> Herzallah (1990) adopted the unified approach in her feature representation. According to Padgett (2011), the unified theory “capitalizes on the apparent articulatory parallelism between consonants and vowels: both labial consonants and round vowels involve a constriction at the lips; both coronal consonants and front vowels involve a constriction at the tip/blade/front of the tongue; both dorsal consonants and back vowels involve a constriction at the tongue dorsum; and both pharyngeal consonants and low vowels involve a constriction between the tongue root and the pharynx wall.” For a clearer illustration of the unified approach of feature representation, see Padgett’s (2011) Table 75.2 “Unified place features for consonants and vowels”, which is adapted from Clements (1991).

<sup>114</sup> The difference of r-realization between generations is not odd, as Wiese (2011, p. 9) made the same observation between flap /r/ and alveolar trill /r/ in Swiss German.

<sup>115</sup> Additional coarticulatory effects can also be observed between the [u] and [r<sup>s</sup>]; the [u] is pharyngealized in its pronunciation, becoming [u<sup>s</sup>]. See Herzallah (1990, p. 69) on this point. See also Ali and Daniloff (1972, pp. 88-90), who point out that emphatic vowels show half the amount of pharyngeal constriction in the environment of an emphatic consonant. In addition, it can be noted that the emphatic [r<sup>s</sup>] acquires secondary labialization, becoming [r<sup>sw</sup>]. See Lehn (1963), who noticed that labialization and muscular tension are associated with emphatic consonants in addition to pharyngeal constriction in Cairene Arabic.

(5.12) [r] / [r<sup>s</sup>] Consonant-to-Vowel Harmony

	Underlying	Gloss	Surface	Possessive.3P.SG. MASC	Possessive.1P.SG.
a.	i. /d̰ʒadr/	“wall”	i. [d̰ʒa.dir]	[d̰ʒad.r <sup>s</sup> u]	[d̰ʒad.ri]
	ii. /d̰ʒadr <sup>s</sup> /		ii. [d̰ʒa.dur <sup>s</sup> ]	“his wall”	“my wall”
b.	i. /s <sup>s</sup> agr/	“falcon”	i. [s <sup>s</sup> a.gir]	[s <sup>s</sup> ag.r <sup>s</sup> u]	[s <sup>s</sup> ag.ri]
	ii. /s <sup>s</sup> agr <sup>s</sup> /		ii. [s <sup>s</sup> a.gur <sup>s</sup> ]	“his falcon”	“my falcon”
c.	i. /fad̰ʒr/	“dawn, morning”	i. [fa.d̰ʒir]	[fad̰ʒ.r <sup>s</sup> u]	[fad̰ʒ.ri]
	ii. /fad̰ʒr <sup>s</sup> /		ii. [fa.d̰ʒur <sup>s</sup> ]	“his dawn, morning”	“my dawn, morning”
d.	i. /nas <sup>s</sup> r/	“victory”	i. [na.s <sup>s</sup> ir]	[nas <sup>s</sup> .r <sup>s</sup> u]	[nas <sup>s</sup> .ri]
	ii. /nas <sup>s</sup> r <sup>s</sup> /		ii. [na.s <sup>s</sup> ur <sup>s</sup> ]	“his victory”	“my victory”
e.	i. /badr/	“full moon / Proper Name”	i. [ba.dir]	[bad.r <sup>s</sup> u]	[bad.ri]
	ii. /badr <sup>s</sup> /		ii. [ba.dur <sup>s</sup> ]	“his full moon / Proper Name”	“my full moon / Proper Name”

The data in Figure (5.12) show words ending in /r/ for the younger generation, which receive [i] as the epenthetic vowel; in addition, they show the same words ending with /r<sup>s</sup>/ for the older generation, which receive [u] as the epenthetic vowel. This epenthetic vowel, regardless of its quality, breaks up the rising-sonority cluster, as is expected. When adding the 1<sup>st</sup> person possessive suffix [-i], [r] is not emphatic for speakers of either generation, because it forms the onset of the syllable which contains the vowel [i]. In the same way, when adding the 3<sup>rd</sup> person masculine possessive suffix [-u], the allophonic [r<sup>s</sup>] surfaces for both generations, because it falls in the onset position of the syllable containing the vowel [u]. From these data, when a speaker from the older generation has an underlying /r<sup>s</sup>/, it necessitates the insertion of the vowel [u] in the process of sonority-driven epenthesis, as both segments agree in the feature [dorsal]. In the same way, when a speaker of the younger generation has an underlying plain /r/, this /r/ surfaces

faithfully, necessitating the inserted vowel to be [i] in order to harmonize with it in the feature [coronal].

I propose that there is a difference of underlying form between the speakers of the older generation and those of the younger generation. The rhotic is underlyingly emphatic for the older group, and it surfaces faithfully, requiring the epenthetic vowel [u] so as to match the secondary component of the /r<sup>s</sup>/ in the feature [dorsal]. For speakers of the younger generation, the rhotic is underlyingly /r/; this /r/ also surfaces faithfully, requiring the epenthetic vowel [i] to match the feature [coronal] of the [r]. I propose that the disagreement between the generations' underlying forms of the rhotic can be understood as lexicon optimization, in which some output forms of the older generation with allophonic de-emphaticized [r] (e.g., the first person possessive suffix in Figure (5.12)) are reinterpreted as the underlying form of the rhotic by the younger generation (Holt, 2015, pp. 547–548). This reconstructed underlying form of the rhotic has an emphatic allophonic variant when it meets the condition of being next to a dorsal vowel (e.g., the masculine [-u] suffix in Figure (5.12)). This proposal is compatible with the Synchronic Base Hypothesis (Hutton, 1996).

(5.13) Synchronic Base Hypothesis (from Hutton, 1996; cited by Holt, 2015, p. 548)

All input candidates produced by GEN are based on the current output form. Earlier forms of the language are no longer available as underlying representations on which GEN operates.

This means that the younger generation of HA speakers has evidence of two surface forms of the rhotic: emphatic and plain. But they do not have access to the underlying form of the older generation, which is the emphatic /r<sup>s</sup>/; rather, they reconstruct their underlying form as being plain, based on one of the current surface forms of the rhotic. This plain /r/ is emphaticized for

the younger generation when it meets the condition of adjacency to [u] or an emphatic consonant. Furthermore, Wiese (2001, p. 360) indicates that “synchronic and diachronic changes in r-quality are frequent and ubiquitous and do not affect the phonological system.” I follow Wiese’s (2001) point of view regarding the change in the phonological system because 1) both emphatic /r<sup>s</sup>/ and non-emphatic /r/ are in complementary distribution for both generations of HA speakers, 2) non-emphatic /r/ and emphatic /r<sup>s</sup>/ are not contrastive in HA (i.e. there is no change in word meaning), and 3) I agree with Wiese (2001) that the different realization of rhotics does not have an effect on the sonority status of this consonant; therefore, emphatic /r<sup>s</sup>/ and non-emphatic /r/ in HA have the same sonority level.<sup>116</sup>

There are several arguments for the lexical optimization of rhotics in HA. First, plain [r] and emphatic [r<sup>s</sup>] are in complementary distribution for both age groups. The underlying emphatic /r<sup>s</sup>/ is an allophonic variant [r<sup>s</sup>] of the underlying plain /r/ for the younger group; and the converse is true for the older speakers. Plain [r] and emphatic [r<sup>s</sup>] are not separate phonemes (i.e. not contrastive), unlike the plain and emphatic obstruents (e.g., /s/ vs. /s<sup>s</sup>/, etc.). The difference between emphatic [r<sup>s</sup>] and plain [r] is less salient than the emphatic and plain obstruents (e.g., /s/ vs. /s<sup>s</sup>/, etc.).<sup>117</sup> That is, speakers of HA are not picky in distinguishing between emphatic [r<sup>s</sup>] and plain [r] since their primary place of articulation is [coronal]. The difference will become more perceptible when emphatic [r<sup>s</sup>] requires a [dorsal] harmony in the

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<sup>116</sup> One could argue against Wiese’s hypothesis, by saying that the change of an underlying form is itself a change in the phonological system for a given dialect/language. I would not dispute this, since this is based on a diachronic perspective. I rather understand Wiese’s (2001) point of view concerning the change in “phonological system” as a change in the current state of the language (i.e. I see this from a synchronic point of view).

<sup>117</sup> The status of /r/ in Arabic dialects is controversial. The controversy arises from voicing, place of articulation, manner of articulation, and emphatic and non-emphatic status of the /r/. Dialects differ based on these criteria (Youssef, 2019).

preceding epenthetic vowel.<sup>118</sup> In addition, Youssef (2019, p. 5) indicates that “Arabic R is typically allied with the emphatic consonants, but it stands out in two respects: (1) its influence on neighboring segments seems to be more restricted, and (2) it is known to alternate with a non-emphatic R cognate.” Furthermore, in his survey of rhotics in Arabic dialects, Youssef (2019, p. 6) indicates that plain /r/ is the only rhotic phoneme in dialects spoken on the Arabian Peninsula and some neighboring areas of the Levant.<sup>119</sup> Finally, considering the plain /r/ to be the underlying form is more compatible with the universal assumption of markedness theory, because plain /r/ has less feature structure than emphatic /r<sup>s</sup>/ (see also Rice 1992, pp. 64-65).

Since /r<sup>s</sup>/ has the same feature representation as the other emphatics (i.e., the obstruents), it is expected to have similar phonological behavior, especially in terms of the type of sonority-driven epenthetic vowel; however, this is not the case. Compare these examples: (a) /lafz<sup>s</sup>/ “word” → [la.fiz<sup>s</sup>], not \*[la.fuz<sup>s</sup>]; (b) /badr<sup>s</sup>/ “full moon / Proper Name” → [ba.dur<sup>s</sup>], not \*[ba.dir<sup>s</sup>] for speakers of the older generation of HA<sup>120</sup>. The word in example (a) mandatorily receives the default [i] vowel to break up the rising-sonority coda cluster; therefore, the [z<sup>s</sup>] does not require the preceding vowel to be a dorsal vowel, whereas in example (b), the /r<sup>s</sup>/ surfaces faithfully as emphatic [r<sup>s</sup>], which mandatorily requires the preceding vowel to match the dorsal component of the emphatic [r<sup>s</sup>]. From these two different behaviors between the emphatic

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<sup>118</sup> This difference between plain [r] and emphatic [r<sup>s</sup>] is less significant than rhotics in certain idiolects of Swedish, for example, as described by Ohlsson, Nielson and Schaltz (1977), where the difference between uvular *r* and tap-trill *r* is not discerned even by members of the same family (Lindau, 1985, p. 166).

<sup>119</sup> I assume that the realization of emphatic /r<sup>s</sup>/ in HA by older speakers is due to high dialect contact (the Hijaz being a large metropolitan region attracting many visitors all year round). In addition, many inhabitants of this area originally come from Egypt or the Levant where emphatic /r<sup>s</sup>/ is the dominant rhotic. See also Ingham (1971, pp. 273-274) and Sibā’i (1984, p. 527) for similar points in which people coming from these areas affect the realization of interdentals in Makkan / Hijazi dialect.

<sup>120</sup> The coronal consonant-to-vowel harmony between the primary coronal C-place of the emphatic /z<sup>s</sup>/ and the preceding vowel in the word [la.fiz<sup>s</sup>] is not odd, and this type of interaction is listed by Padgett (2011) as a cross-category interaction. In addition, dorsal consonant-to-vowel harmony, in which the secondary dorsal V-Place in the emphatic consonant affects the quality of the preceding vowel, e.g. [ba.dur<sup>s</sup>], is also common and it’s named by Padgett (2011) as within-category interactions.

obstruent and the emphatic [r<sup>s</sup>], we can understand that emphatic [r<sup>s</sup>] behaves differently than other emphatic consonants, in that it forces the epenthetic vowel to match its secondary articulation. This leads us to propose a constraint that requires agreement between emphatic [r<sup>s</sup>] and the segment next to it. Figure (5.14) provides the definition of the OT constraints used to analyze the dorsal harmony between emphatic [r<sup>s</sup>] and [u].

(5.14) Constraints Motivating Dorsal Consonant-to-Vowel Harmony

a. AGREE-FEAT-DORSAL-[r<sup>s</sup>] (AGREE-F-DORS-[r<sup>s</sup>]):

“Segments adjacent to and tautosyllabic with [r<sup>s</sup>] must agree with it in the feature [dorsal]. Assign a violation for any segment in the output which is adjacent to and tautosyllabic with [r<sup>s</sup>] and does not agree with it in the feature [dorsal].”

b. MAX-V-PLACE:

“The V-Place feature (secondary place of articulation) associated with a consonant in the input must have a correspondent in the output. Do not delete a V-Place feature (secondary place of articulation) from a consonant. Assign a violation mark for any secondary place of articulation feature which is deleted from a consonant in the output.”

Tableau 5.7a provides the analysis in which emphatic [r<sup>s</sup>] necessitates the epenthesis of [u] to match its dorsal feature.

Tableau 5.7a. Dorsal Harmony with Emphatic [r<sup>s</sup>] (Older Generation)

/ḍʒadr <sup>s</sup> / “wall”	*O <sub>2</sub> L <sub>1</sub> ] <sub>σ</sub>	DEP	CONTIG	MAX-V-PLACE	AGREE-F-DORS-[r <sup>s</sup> ]	AGREE-F-COR
a. [ḍʒadr <sup>s</sup> ]	*!				*	
b. [ḍʒadr]	*!			*		
c. [ḍʒa.dur <sup>s</sup> ]		*	*			*
d. [ḍʒa.dur]		*	*	*!		*
e. [ḍʒa.dir]		*	*	*!		
f. [ḍʒa.dir <sup>s</sup> ]		*	*		*!	

The faithful candidate (a) loses because it violates the Split-Margin constraint. In the same way, candidate (b) loses because it also violates the Split-Margin constraint, in addition to MAX-V-PLACE. Candidate (c), with [r<sup>s</sup>], wins because it respects the Split-Margin constraint as well as MAX-V-PLACE and AGREE-F-DORS-[r<sup>s</sup>]. This is because the dorsal [u] agrees with the following emphatic [r<sup>s</sup>], which also has a dorsal component. The following candidates (d) and (e) lose, because they violate MAX-V-PLACE in addition to DEP and CONTIG even though (e) respects lowest-ranked AGREE-F-COR. Candidate (f) loses because the emphatic [r<sup>s</sup>], which has a dorsal component, is preceded by [i], which is a coronal vowel. Tableau 5.7a demonstrates the OT analysis of [u]-epenthesis before the emphatic [r<sup>s</sup>] in potential rising-sonority coda clusters for the speakers of the older generation of HA. Tableau 5.7b provides the analysis of [i]-epenthesis before [r] for people of the younger generation of HA, which is the most common pronunciation of the /r/ in HA.

Tableau 5.7b. Coronal Harmony with Plain [r] (Younger Generation)

/d̥ʒadr/ “wall”	*O <sub>2</sub> L <sub>1</sub> ] <sub>σ</sub>	DEP	CONTIG	MAX-V-PLACE	AGREE-F-DORS-[r <sup>s</sup> ]	AGREE-F-COR
a. [d̥ʒadr]	*!					
b. [d̥ʒadr <sup>s</sup> ]	*!				*	
c. [d̥ʒa.dur]		*	*			*!
d. [d̥ʒa.dur <sup>s</sup> ]		*	*			*!
e. [d̥ʒa.dir]		*	*			
f. [d̥ʒa.dir <sup>s</sup> ]		*	*		*!	

Candidates (a) and (b) lose because they violate the Split-Margin constraint with an additional violation of AGREE-F-DORS-[r<sup>s</sup>] for (b). Candidates (c) and (d) both lose because they violate the lowest-ranked AGREE-F-COR. Candidate (e) wins because it only violates DEP and CONTIG, and it is better than (c) and (d) in that it satisfies the lowest-ranked AGREE-F-COR. Candidate (f) loses because it violates low-ranked AGREE-F-DORS-[r<sup>s</sup>].

One might argue that, since emphatic [r<sup>s</sup>] surfaces in the output form and has both [pharyngeal] and [dorsal] secondary features, the epenthetic vowel could be [a] to match the other secondary pharyngeal component of [r<sup>s</sup>]. However, I argue that the dorsal harmony of [r<sup>s</sup>] outranks its pharyngeal harmony; therefore, [u]-epenthesis obtains, rather than [a]-epenthesis, in the context of emphatic [r<sup>s</sup>]. Figure (5.15) introduces an additional constraint used in the analysis of the emphatic [r<sup>s</sup>], in which the dorsal harmony of [r<sup>s</sup>] outranks its pharyngeal harmony.

(5.15) AGREE-FEAT-PHARYNGEAL-[r<sup>s</sup>] (AGREE-F-PHAR-[r<sup>s</sup>]):

“Segments adjacent to and tautosyllabic with [r<sup>s</sup>] must agree with it in the feature [pharyngeal]. Assign a violation for any segment in the output which is adjacent to and tautosyllabic with [r<sup>s</sup>] and does not agree with it in the feature [pharyngeal].”

Tableau 5.8 zooms into the ranking argument between AGREE-F-DORS-[r<sup>s</sup>] and AGREE-F-PHAR-[r<sup>s</sup>] that predicts the same emphatic winner as Tableau 5.7a.

*Tableau 5.8. Dorsal over Pharyngeal Harmony with Emphatic [r<sup>s</sup>] (Older Generation)*

/ḍʒadr <sup>s</sup> / “wall”	AGREE-F-DORS-[r <sup>s</sup> ]	AGREE-F-PHAR-[r <sup>s</sup> ]
a. [ḍʒa.dur <sup>s</sup> ]		*
b. [ḍʒa.dar <sup>s</sup> ]	*!	

Candidate (a), which was the winner of Tableau 5.7a, still wins, because [u] as a dorsal vowel matches the [dorsal] feature of the emphatic [r<sup>s</sup>]. Candidate (b) loses, even though the low vowel [a], which is a pharyngeal, matches the secondary pharyngeal component of the emphatic [r<sup>s</sup>]. This is because the constraint AGREE-F-DORS-[r<sup>s</sup>] outranks the constraint AGREE-F-PHAR-[r<sup>s</sup>].

Now we turn to discuss the quality of the epenthesized vowel before the emphatic [r<sup>s</sup>] and after a pharyngeal or laryngeal consonant. Recall that, in a word like [ba.ħar<sup>s</sup>], the rhotic mandatorily surfaces as emphatic [r<sup>s</sup>] in order to agree with the preceding pharyngeal low vowel, which itself agrees with the trigger of pharyngeal harmony (see §5.4); therefore, we can conclude that the constraint AGREE-F-PHAR, used in the analysis in §5.4 to motivate pharyngeal and laryngeal harmony, outranks AGREE-F-DORS-[r<sup>s</sup>] in order to get the surface form [ba.ħar<sup>s</sup>], as will be illustrated in Tableau 5.9.

Tableau 5.9. [u] does not Surface after Pharyngeal and Laryngeal Segments

/bahr/ “sea”	AGREE-F-PHAR	AGREE-F-DORS-[r <sup>s</sup> ]
a. [ba.ħur <sup>s</sup> ]	*!	
b. [ba.ħar <sup>s</sup> ]		*

Candidate (a) loses because the epenthetic vowel [u] does not agree with the preceding pharyngeal consonant in the feature [pharyngeal], even though it agrees with the following consonant in the feature [dorsal]. Candidate (b) wins because the epenthetic vowel [a] agrees with the preceding consonant in the feature [pharyngeal]; in addition, the following consonant agrees with the epenthetic [a] in the same feature. Candidate (b) is the surface form for both generations of HA speakers, even though the underlying form of the rhotic is nonemphatic for the people of the younger generation; /r<sup>s</sup>/ surfaces faithfully for the people of the older generation.

In this section, phonemic emphatic /r<sup>s</sup>/ surfaces faithfully as [r<sup>s</sup>], necessitating the preceding epenthetic vowel to match its secondary dorsal component for speakers of the older generation of HA in words with no medial pharyngeal or laryngeal consonant; therefore, it is the trigger of the choice of the [u] vowel in the output form in Tableau 5.8. However, if the word includes a medial pharyngeal or laryngeal consonant followed by [r<sup>s</sup>], the epenthetic vowel is low [a], which harmonizes with the feature [pharyngeal] of the preceding and following consonants. In contrast, the /r/ for speakers of the younger generation changes to [r<sup>s</sup>] in the environment of pharyngeal harmony in order to agree with the preceding low vowel in the feature [pharyngeal]. The different representation of the underlying form of rhotics may be the most prominent divergence in the grammar of HA between speaker generations—especially from a diachronic perspective.

Finally, before wrapping up this section, it is worth elaborating on [u]-Epenthesis after a labial consonant and before [ɣ]. Ingham (1971) provided two examples from MA/HA in which [u] is epenthesis after /b/ and before /ɣ/. These are /sʰabɣ/ → [sʰa.buɣ] “dye” and /dabɣ/ → [da.buɣ] “tanning.” However, the [u]-Epenthesis in these two words is extremely uncommon and is associated mostly with older speakers of HA. Instead, [i] is epenthesis in these two words by most HA speakers. Consider /sʰabɣ/ → [sʰa.biɣ] “dye” and /dabɣ/ → [da.biɣ] “tanning.” I assume that the uncommon [u]-Epenthesis in these two examples is conditioned by the medial labial consonant. Youssef (2019) lists similar examples from Muslim Baghdadi Arabic in which the second consonant is a labial and the final consonant is dorsal, for example, [nafux] “inflating” and [dabuɣ] “tanning.”<sup>121</sup> According to him, Dorsal Consonant-to-Vowel Harmony in these examples is controversial. Instead, he suggests that these words get [u]-Epenthesis, since the epenthetic vowel follows a labial consonant. Similarly, I assume that the uncommon [u]-Epenthesis in the HA examples above is not affected by the uvular [ɣ]. This is because throughout the literature uvular consonants such as [ɣ] are mostly represented by one C-Place node, which is divisible into [dorsal] and [pharyngeal] (see Zawaydeh’s and Herzallah’s Figure in (2.33) and (2.37) in Chapter 2), but uvular [u] is always described as having one [dorsal] V-Place. According to Padgett (2011, p. 7), “cases in which a consonant’s primary place takes precedence over its secondary place in determining a vowel’s place features...seem non-existent.” Therefore, the place features do not match in order to force harmony between the root consonant /ɣ/ and the epenthetic vowel. In addition, Dorsal Harmony in HA occurs only between

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<sup>121</sup> The rounding harmony in these rare examples above from HA finds support from other languages. According to Padgett (2011, p. 4), “Numerous cases are known in which plain (not rounded) labial consonants cause vowels to be round. This happens, for example, in a dialect of Mapila Malayalam described by Bright (1972).” In addition, according to him (2011, p. 3), “Also in Nupe, consonants are rounded (or labial-velarized) before rounded vowels, e.g. [eg<sup>w</sup>ũ] and [eg<sup>w</sup>o] for /egũ/ ‘mud’ and /ego/ ‘grass’ (tones not shown).”

pharyngeal /r<sup>h</sup>/ and a preceding /u/ vowel. Since the dorsality in both segments is dominated by a V-Place node for each segment, they agree in V-Place. Before concluding this section, recall that high vowel spreading in stems containing high vowels takes precedence over all types of consonant-to-vowel harmony in stems with low vowels, as mentioned in section 5.2.

Having provided the analysis for rhotic consonant-to-vowel harmony, the next section will provide the analysis for default sonority-driven epenthesis, in which the vowel [i] is inserted to break up a potential rising-sonority coda cluster.

### **5.7. Default Epenthetic Vowel Quality**

This section discusses two types of default epenthesis in HA: sonority-driven epenthesis and syllable-driven epenthesis. De Lacy (2006) provides several universal sonority-based constraint hierarchies and relates them to different positions of prosodic constituents. These sonority-based constraint hierarchies provide the right tool to set up the analyses of both types of default epenthesis.

De Lacy (2006) argues that variation in the quality of the epenthetic vowel across languages can be analyzed as the result of competing constraints, imposed by different Designated Terminal Elements (DTEs). Designated Terminal Elements refer to the head of a given prosodic unit, such as a mora, syllable, or foot. He differentiates between the head and non-head positions of these constituents, which are the DTEs (also abbreviated as  $\Delta$ ) and non-Designated Terminal Elements (non-DTEs, also  $-\Delta$ ), respectively. According to de Lacy, universally, low vowels, which are higher in sonority than other vowels, tend to be favored as epenthetic vowels in DTE positions, i.e. the head position of the prosodic constituent, whereas

high peripheral vowels [i, u], tend to be epenthesized in non-DTE positions—that is, in unstressed syllables, moras, or feet.

According to de Lacy (2006, p. 305), vowel epenthesis in Arabic dialects cannot be accounted for in terms of DTE constraints alone. He provides an example of high vowel epenthesis in DTE position—that is, in a stressed syllable, which represents the head of the foot—in Cairene Arabic (CA), which is at odds with the prediction made by looking only at constraints on DTE positions. Instead, he suggests that other markedness values may restrict the quality of the epenthetic vowel for CA, as proposed by Lombardi (2003). For example, the universal preference for front vowels in epenthesis over back vowels may exclude [a] in positions where it is favored by the sonority hierarchy and its relationship with DTE/non-DTE positions.

However, in Cairene specifically, [i] is epenthesized to fill the nucleus of the degenerate syllable. For example, /katab-t-l-u/ → [katab.'t̪i.lu], \*[katab.'t̪a.lu] “I wrote to him” (de Lacy 2006, p. 305, following McCarthy, 1979). According to Farwaneh (1995), this epenthetic vowel is stressed by the default stress rule of CA, which states that the penult is stressed, unless both the antepenult and penult are light, in which case the antepenult is stressed. In CA, de Lacy proposes that the unexpected high vowel is the product of a higher-ranked preference for front vowels over back vowels, outranking the requirements imposed by DTE-sonority constraints.

Compare this with the same word, with low vowel epenthesis, in HA: [ka'tab.t̪a.lu]. In this word, the syllable containing the epenthetic vowel is not stressed. Instead, stress falls on the heavy antepenultimate syllable by the default rule of stress in HA, which states that penultimate syllables are stressed only if heavy (see also Farwaneh, 1995, pp. 134–135); otherwise, the antepenult is stressed. Therefore, de Lacy’s conclusion about the incompatibility of the DTE

constraints with CA is not quite accurate. This is because he considered only the DTE of the foot in CA in which the low-sonority epenthetic [i] falls in the stress position by the general stress rule in this dialect, not because of the sonority of the vowel relevant to this prosodic constituent. In other words, the sonority of the vowel does not interact with the DTE or non-DTE position. Cairene Arabic always has [i] as an epenthetic vowel, which could fall in either DTE or non-DTE position of the syllable or foot, and always has penultimate stress in words of this shape.<sup>122</sup>

Regarding stress in HA, the DTE of the prosodic constituents is in some way connected with the sonority of the epenthetic segments, in which the low sonority vowel [i] is epenthesized in the non-head position of the foot in sonority-driven epenthesis, whereas the high-sonority [a] is epenthesized in the DTE position of the syllable in syllable-driven epenthesis. Since HA has two types of default epenthesis, syllable-driven epenthesis and sonority-driven epenthesis, it is worth elaborating and differentiating between the two types of default epenthesis. I start by elaborating on syllable-driven default epenthesis then explain sonority-driven epenthesis and summarize some issues related to it.

*Syllable-driven default epenthesis.* Regarding the syllable-driven epenthetic vowel [a], following Farwaneh (1995, §4.4.2, pp. 126–129) and Gouskova (2003, §4.5, pp. 248–261), this vowel, which is higher in sonority than any other vowel in HA, is inserted as a way of strengthening a weak degenerate syllable, which consists of only a single consonant as a syllable onset. This also can be accounted for with the constraints proposed by de Lacy (2006, p. 68), in which this vowel ([a]) represents the DTE of the syllable. This epenthetic vowel could fall in DTE or non-DTE position of the foot. In other words, the DTE of the syllable takes priority, in which the high sonority vowel fills the nucleus of the degenerate syllable. The trigger of this

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<sup>122</sup> The epenthetic vowel in CA is mainly [i] ignoring minor issues of translaryngeal harmony over /ħ/. Compare the word /bint + fia/ → [bintafia] ‘her girl’ versus /bint + na/ → [bintina] ‘our girl’.

epenthetic vowel is the syllabic structure, in which an onset with an empty nucleus is not allowed in the dialect. Consider /ka.tabt.lu/ “I wrote for him”, which becomes [ka.tab.ta.lu], and /baab.na/ “our door”, which becomes [baa.ba.na]. The vowel [a] is inserted after the [t] in the first example, which forces resyllabification of the [t] into the onset of the new syllable. The same is true in the second example, when [a] forms a new syllable with the preceding [b] in the process of resyllabification. Thus, the constraint ranking for this type of epenthesis is  $*\Delta_{\sigma} \leq \{i, u\} \gg * \Delta_{\sigma} \leq a$ .

Gouskova (2003) elaborates on the status of the low vowel [a], regarding two phonological processes, syncope and epenthesis, in HA. According to her, [a] is epenthesized and is never syncopated under any circumstances, whereas [i], which is lower in sonority, syncopates in double-sided open syllables if this syncope does not incur other phonotactic violations, such as consonant clusters. This is because of the tendency of the language to avoid marked nuclei. Consider the examples /kibirat/ → [kib.rat], whereas /katabat/ → [ka.ta.bat],  $*[kat.bat]$ .

According to Gouskova, [a] does not delete, even if it falls in the foot margin—that is, the  $-\Delta_{F1}$  position in de Lacy’s terminology. This is because MAX dominates all constraints which favor syncope, except for  $*NUC/\{i, u\}$ , which dominates MAX, allowing [i] to syncopate in double-sided open syllables. Gouskova’s constraints concerning high vowel syncope in weak position further support the idea that de Lacy’s proposal about the DTE of the syllable is compatible with HA, in which [i] as the DTE of the syllable is eliminated if it does not violate syllable phonotactics.

Farwaneh (1995), Gouskova (2003), and de Lacy (2006) all relate the sonority of the vowel to the head of the syllabic constituent; however, both Gouskova’s and de Lacy’s proposals

have a wider scope, in which they consider several universal sonority hierarchies of segments and how they interact with the head or non-head position of different constituents.

*Sonority-driven default epenthesis.* In HA, the sonority-driven default epenthetic vowel [i] is inserted when it is not triggered by high vowel spreading, a pharyngeal/laryngeal, coronal, or dorsal segment. Consider the data in Figure (5.16), in which [i] is inserted to break up the rising-sonority cluster.

(5.16) Default Sonority-Driven Epenthesis

Underlying	Gloss	Surface	Possessive.3P.MASC
a. /lakm/	“punching”	[la.kim]	[lak.mu]
b. /tʰagm/	“set (of things)”	[tʰa.gim]	[tʰag.mu]
c. /ʃamʕ/	“wax”	[ʃa.miʕ]	[ʃam.ʕu]
d. /fagʕ/	“type of mushroom”	[fa.giʕ]	[fag.ʕu]
e. /ʃatm/	“cursing”	[ʃa.tim]	[ʃat.mu]
f. /nadʒm/	“star”	[na.dʒim]	[nadʒ.mu]
g. /waʃm/	“tattoo”	[wa.ʃim]	[waʃ.mu]

As can be noted from the data, epenthetic [i] is not triggered by the surrounding consonants.

Regarding (5.16e–f), the [t] and [dʒ] are not the trigger of [i]-Epenthesis, even though they agree with the vowel [i] in the feature [coronal]. This is because the epenthetic vowel is required to harmonize in coronality with the following consonant (see Figure (5.6)), and not with the preceding consonant. Therefore, [i] is epenthesized when there is no harmony requirement between it and the segments in the coda cluster. In this dialect, the only coda cluster permitted by the syllabic structure is the coda in CVCC. This monosyllabic word also consists of a trochaic foot, in which the stem vowel is the head of the foot, even if the coda cluster of this syllable

violates the sonority requirement and receives an epenthetic vowel. This epenthetic vowel is never stressed, and it falls in the non-head position of the foot—that is, the unstressed part. Therefore, adopting de Lacy’s DTE model mentioned above, we can determine the type of default epenthetic vowel in this position, following de Lacy’s constraint ranking in the non-DTE position of the foot, by having  $*-\Delta_{Ft} \geq a$  outrank  $*-\Delta_{Ft} \geq \{i, u\}$ . This leaves us with the two high vowels [i, u] as potential candidates for a default vowel.

On the basis of the Place of Articulation hierarchy, [u] is universally more marked than [i] (see de Lacy, 2006, pp. 35–36; Jakobson, 1941; Lombardi, 1995, 1998, 2002; Prince & Smolensky, 1993, Ch. 9, §§1.2, 2; among others). Consider Figure (5.17), which presents the universal Place of Articulation hierarchy.<sup>123</sup>

(5.17) Universal Place of Articulation Hierarchy (de Lacy, 2006)

$*[\text{DORS}] \gg *[\text{LAB}] \gg *[\text{COR}] \gg *[\text{PHAR}]$

Therefore, we can say that  $*[\text{DORS}]$  outranks  $*[\text{COR}]$ . By these two different rankings by de Lacy and Lombardi, we reach the conclusion that the most appropriate default epenthetic vowel is [i] in sonority-driven epenthesis in HA, shown in Tableau 5.10.

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<sup>123</sup> The labial place of articulation is redundant in HA, since the vowel [u] is dorsal, and labiality comes as an enhancement feature for all dorsal vowels in the dialect. De Lacy (2006) listed Glottal as the least marked place of articulation in the hierarchy; however, following Lombardi (2002) and McCarthy (1994), I list [Pharyngeal], which contains [Glottal], as the least marked place of articulation.

Tableau 5.10. Default Sonority-Driven [i]-Epenthesis

/lakm/ “punching”	* $-\Delta_{Ft} \geq a$	*[DORS]	* $-\Delta_{Ft} \geq \{i, u\}$	*[COR]	*[PHAR]
a. [la.kim]			*	*	
b. [la.kam] <sup>124</sup>	*!		*		*
c. [la.kum]		*!	*		

Candidate (a) wins because it respects both \* $-\Delta_{Ft} \geq a$  and \*[DORS] by epenthesizing a coronal vowel, even though it violates low-ranked \* $-\Delta_{Ft} \geq \{i, u\}$  and \*[COR]. Candidate (b) loses because the epenthetic vowel [a] violates \* $-\Delta_{Ft} \geq a$ ; in addition, it violates \* $-\Delta_{Ft} \geq \{i, u\}$  and \*[PHAR], because [a] as a pharyngeal vowel is greater in sonority than [i] and [u]. Candidate (c) loses because it epenthesizes a dorsal vowel, violating the high-ranked \*[DORS]; in addition, it violates \* $-\Delta_{Ft} \geq \{i, u\}$ . This tableau shows that whenever there is no harmony requirement between vowels or consonants and vowels, default [i] is epenthesized to break up a potential rising-sonority coda cluster.

A key difference between sonority-driven epenthesis and syllable-driven epenthesis in HA is the motivation of these types of epenthesis and the outcome of these processes. The motivation for sonority-driven epenthesis is the rising-sonority coda cluster, which is not tolerated by the grammar, and the outcome of this epenthesis is that the default vowel [i] is epenthesized between these two consonants, forming a CVC syllable after a light syllable (e.g., /t<sup>s</sup>agm/ → [t<sup>s</sup>a.gim] “set of things”). In contrast, the motivation for syllable-driven epenthesis is the tendency of the dialect to avoid word-internal superheavy syllables by epenthesis and resyllabification, in which the last stray consonant of the word-internal CVVC/CVCC is

<sup>124</sup> This candidate would also be eliminated by a potential additional constraint \*HOMOPHONY, because a homophonous form already occurs as the 3 Sg Perf form [la.kam] “he punched.”

resyllabified to form the onset of the default [a] epenthetic vowel. The outcome of this epenthesis is the new syllable, which is formed by the unsyllabified last consonant of the superheavy syllable and the epenthetic vowel, and this syllable is preceded by a heavy syllable (e.g., /ba:b-na/ → [ˈba:.ba.na] “our door;” /katab-t-l-u/ → [ka.ˈtab.ta.lu] “I wrote for him”). In both types of epenthesis, stress location is preserved, even after epenthesis (S. Davis, personal communication, May 28, 2019). Thus, we can conclude from all above that the default syllable-driven epenthetic [a] is higher in sonority than the default sonority-driven epenthetic [i], because [a], as the highest sonority vowel, strengthens the stray consonant by forming the nucleus of the consonant, i.e. the DTE of the syllable, whereas the lowest sonority high front vowel [i] is epenthesized in the default sonority-driven epenthesis in the non-DTE position of the foot.

Before leaving this section, it is worth elaborating on a group of words in HA in which the medial consonant of the word is a pharyngeal or laryngeal followed by a non-dorsal and non-coronal consonant. These words receive the default [i]-epenthesis in the output form as the predominant pronunciation; however, some speakers insert [a] as this vowel harmonizes with the preceding consonant. Consider the words in Figure (5.18).

(5.18) Incomplete Pharyngeal Consonant-to-Vowel Harmony

Underlying	Gloss	Typical Surface	Atypical	Possessive.3P.MASC
/laħm/	“meat”	[la.ħim]	[la.ħam]	[laħ.mu]
/tʰaʕm/	“taste”	[tʰa.ʕim]	[tʰa.ʕam]	[tʰaʕ.mu]
/saħm/	“arrow”	[sa.ħim]	[sa.ħam]	[saħ.mu]
/ʃaħm/	“noble, chivalrous”	[ʃa.ħim]	[ʃa.ħam]	[ʃaħ.mu]
/waħm/	“illusion, delusion”	[wa.ħim]	[wa.ħam]	[waħ.mu]

As we can notice from Figure (5.18), all coda clusters start with a pharyngeal or laryngeal consonant and end with /m/, which is the only non-coronal consonant in the rising-sonority environment in the grammar of HA, in which the first member of the cluster is a pharyngeal or laryngeal. Therefore, the pharyngeal and laryngeal harmony, which requires the segment following a pharyngeal or laryngeal segment to match in the feature [pharyngeal], is incomplete. As a consequence of the incomplete pharyngeal harmony, [i] is epenthesized to break up such a cluster as the default rule in the most common pronunciation of these words. Tableau 5.11 provides the analysis in which default epenthesis occurs, rather than the incomplete pharyngeal and laryngeal harmony.

Tableau 5.11. Incomplete Pharyngeal Harmony Loses

/safm/ “arrow”	*O <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub>	DEP	CONTIG	*-Δ <sub>F<sub>i</sub></sub> ≥a	*[DORS]	*-Δ <sub>F<sub>i</sub></sub> ≥{i,u}	*[COR]	AGREE-F-PHAR
a. [safm]	*!							*
☞ b. [sa.fim]		*	*			*	*	*
c. [sa.fiam]		*	*	*!		*		*
d. [sa.fum]		*	*		*!	*		*

Candidate (a) loses, as it violates the high-ranked Split-Margin constraint. All other candidates violate high-ranked DEP and CONTIG, and hence these constraints do not play a role in the quality of the epenthetic vowel, which determines the winner. Candidate (b) is the winner because it respects both \*-Δ<sub>F<sub>i</sub></sub>≥a and \*[DORS], even though it violates all low-ranked constraints.

Candidate (c) loses because it violates \*-Δ<sub>F<sub>i</sub></sub>≥a. In addition, it violates \*-Δ<sub>F<sub>i</sub></sub>≥{i,u}, and also AGREE-F-PHAR, because the vowel [a] is not followed by a consonant which has a pharyngeal

feature.<sup>125</sup> Candidate (d) loses because it violates high-ranked \*[DORS]. In addition, it violates  $*-\Delta_{Ft} \geq \{i, u\}$  and AGREE-F-PHAR.

Having provided the analysis for the default epenthetic vowel in HA, the following section discusses and concludes the chapter.

## 5.8. Discussion and Conclusion

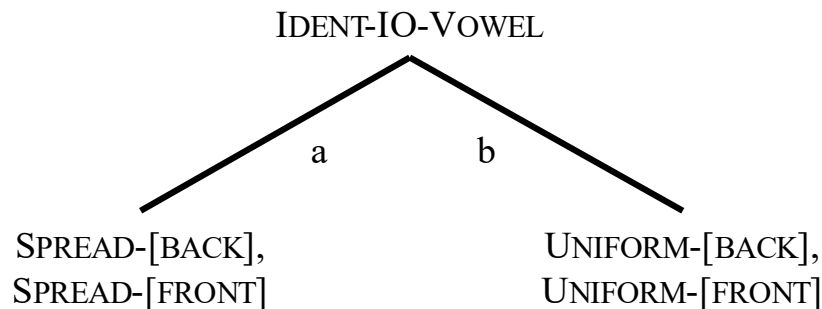
This section summarizes the findings related to sonority-driven epenthesis and how it interacts with neighboring consonants and vowels. The default sonority-driven epenthetic vowel in HA is /i/. However, all vowels, /a/, /i/, and /u/, can be epenthetic to break up a potential rising-sonority coda cluster. This is of course due to the harmony between the epenthetic vowel and the neighboring consonants and stem vowels<sup>126</sup>. If the stem contains a high vowel, /i/ or /u/, this vowel spreads its feature [front] or [back] to the sonority-driven epenthetic vowel. For example, /ʔism/ “name” surfaces as [ʔi.sim], and not \*[ʔisam] or \*[ʔisum]. This is because the high vowel spreads its feature to the epenthetic vowel to break up such a rising-sonority coda cluster, by inserting [i] in the newly created syllable after the process of epenthesis. Several constraints play a role in motivating such an output, among them are SPREAD-[BACK], SPREAD-[FRONT], which spreads the frontness or backness of the stem vowel to the epenthetic vowel, and IDENT-IO-VOWEL, which militates against changing the stem vowel in the output form. These two

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<sup>125</sup> A potential constraint, TRANSGUTTURAL HARMONY, can be proposed to motivate [a]-Epenthesis after pharyngeals and laryngeals as seen in the atypical forms in Figure (5.18). The constraint would outrank the constraints DEP, CONTIG,  $*-\Delta_{Ft} \geq a$  and \*[DORS]. However, this grammar is not considered in this analysis since it is not the dominant pronunciation in HA in these types of words. See Gafos and Lombardi (1999) for more on guttural transparency effects in Semitic.

<sup>126</sup> According to Padgett (2011, pg. 1), “Both consonants and vowels are formed with constrictions in the oral cavity, made by the lips, the tongue blade, the tongue body, and/or the tongue root. Since they make demands on the same organs, it should not be surprising that the place features of consonants can influence those of vowels and vice versa.”

constraints outrank DEP and CONTIG, which results in epenthesis of a vowel in the output form. Consider again the example /ʔism/, which could surface as [ʔi.sim] or [ʔi.sam] in the process of spreading the feature [front] from the high vowel in the stem to the epenthetic vowel. However, other constraints have been proposed to ensure that the epenthetic vowel has the same height specification in addition to the frontness/backness specification of the stem vowel. This constraint is UNIFORM-[BACK], UNIFORM-[FRONT], which militates against spreading a [back] or [front] feature that is multiply-linked to vowels that are distinctly specified for height. This constraint ensures that the output form of words such as /ʔism/ is [ʔi.sim], not \*[ʔi.sam]. Figure (5.19) summarizes the ranking argument for high vowel spreading in HA.



(5.19) Hasse Diagram of High Vowel Spreading.

Table 5.1 provides an index for the constraint ranking in the Hasse diagram in Figure (5.19).

Table 5.1

*Index of Constraint Rankings for High Vowel Spreading*

	Ranking	Tableaux	Section	Example Word
a.	IDENT-IO-VOWEL >> SPREAD-[BACK], SPREAD-[FRONT]	5.1,5.2ab	5.2	[fi.kir], [ʃu.kur <sup>ɛ</sup> ]
b.	IDENT-IO-VOWEL >> UNIFORM-[BACK], UNIFORM-[FRONT]	5.2ab	5.2	[fi.kir], [ʃu.kur <sup>ɛ</sup> ]

*Note.* Letters in the left column refer to labels in Figure (5.19).

In HA, coda consonants play an important role in determining the quality of the vowel in sonority-driven epenthesis. If the potential rising sonority coda cluster ends in a coronal consonant, the epenthetic vowel is the coronal [i] in the process of what is known as coronal consonant-to-vowel harmony. For example, the word /ħagl/ “field” surfaces as [ħa.gil]. The Split-Margin constraint,  $*O_2L_1]_{\sigma}$ , which dominates DEP and CONTIG, forces epenthesis in such a rising sonority cluster, but the quality of the epenthetic vowel is dictated by the constraint AGREE-F-[COR], which is ranked at the same level as DEP and CONTIG.

In a stem that ends with /r/ when the medial consonant is pharyngeal or laryngeal, [a] is epenthesized in the process of pharyngeal harmony. Medial pharyngeal and laryngeal consonants in such words are the trigger of the epenthesis of the low vowel, [a], which has a pharyngeal component, and which itself is the trigger of the pharyngealization of the [r<sup>ʕ</sup>]. For example, the words /baħr/ “sea”, /naħr/ “river”, and /jaħr/ “hair” surface as [ba.ħar<sup>ʕ</sup>], [na.ħar<sup>ʕ</sup>], and [ja.ħar<sup>ʕ</sup>]. However, when the stem ends with a coronal consonant other than /r<sup>ʕ</sup>/, coronal harmony wins over pharyngeal harmony, forcing the epenthetic vowel to be the coronal [i], and not the pharyngeal [a]. Consider, for example, /laħn/ “melody”, and /naħl/ “shoe”, which surface with [i] as [la.ħin], and [na.ħil], not \*[la.ħan] or \*[na.ħal]. Although AGREE-F-[COR] is low ranked and dominated by AGREE-F-PHAR, DEP, and CONTIG, it is still the decisive constraint that determines the quality of the epenthetic vowel. Both AGREE-F-[COR] and AGREE-F-PHAR do not change the quality of the coda consonants if the word surfaces with a faithful level or falling coda cluster. For example, the words /wagt/ “time”, and /laħd/ “grave” surface faithfully as [wagt], and [laħd], and not as \*[wadt] or \*[laħd<sup>ʕ</sup>]. This is because the high ranked constraint, IDENT-IO-PHON, protects coda consonants from changing in the output form.

The chapter also elaborated on the generation difference in the use of emphatic /r<sup>s</sup>/. /r<sup>s</sup>/ is the underlying form for speakers of the older generation of HA and is the uncommon realization of the rhotic. It is de-emphaticized when it is adjacent to a coronal segment e.g. /s<sup>s</sup>agr<sup>s</sup>-i/ “my falcon” → [s<sup>s</sup>ag.ri]. /r/ is the underlying form for speakers of the younger generation and is the most common realization of the rhotic in the dialect. It is emphaticized/ pharyngealized when it is adjacent to pharyngeal, laryngeal, emphatic or uvular segments e.g. /s<sup>s</sup>agr-u/ “his falcon” → [s<sup>s</sup>ag.r<sup>s</sup>u]. In a potential rising-sonority coda cluster ending with a rhotic, [u] is epenthesized in the process of dorsal consonant-to-vowel harmony to prevent such fatal coda clusters from surfacing for the speakers of the older generation e.g. /ḍʒadr<sup>s</sup>/ “wall” → [ḍʒa.dur<sup>s</sup>]. The feature [dorsal] for the emphatic /r<sup>s</sup>/ dictates the quality of the epenthetic vowel to be [u], matching in the feature [dorsal] between the emphatic rhotic and the epenthetic [u]. In this word, [u] is epenthesized, rather than [a], because the secondary [dorsal] feature of the emphatic [r<sup>s</sup>] outranks its secondary pharyngeal feature. Therefore, [ḍʒa.dur<sup>s</sup>] wins because it respects AGREE-F-DORS-[r<sup>s</sup>] and MAX-V-PLACE, even though it violates DEP and CONTIG and the lowest ranked constraint AGREE-F-[COR]. With regard to speakers of the younger generation, [ḍʒa.dir] wins by virtue of respecting the lowest ranked constraint AGREE-F-[COR] and the relatively low ranked constraint AGREE-F-DORS-[r<sup>s</sup>]. Other losing candidates violate one or the other of these two constraints. This is because the rhotic for the younger generation is underlyingly non-emphatic i.e. with only coronal place and the epenthetic vowel, [i], harmonizes with the consonant in the feature [coronal]. In words with medial laryngeal and pharyngeal gutturals and ending with the rhotic /r/, the vowel [a] is epenthesized between the pharyngeal/laryngeal consonant and the rhotic, harmonizing in the feature [pharyngeal] with the preceding guttural consonant. The trigger of the pharyngeal harmony is the medial pharyngeal/laryngeal consonant and the epenthetic vowel [a]

itself is the trigger of pharyngealizing the following [r] for the speakers of the younger generation.<sup>127</sup> For example, older generation /baħr<sup>s</sup>/ and younger generation /baħr/ both surface as [ba.ħar<sup>s</sup>] “sea”, the surface form for both the older and younger generation. This is because AGREE-F-PHAR outranks AGREE-F-DORS-[r<sup>s</sup>]. Therefore, the underlying pharyngeal /r<sup>s</sup>/ surfaces faithfully for the speakers of the older generation in the preceding example, whereas the underlying plain /r/ surfaces as a pharyngeal [r<sup>s</sup>] to match the feature [pharyngeal] in the preceding epenthetic vowel for the speakers of the younger generation, i.e. the surface form for both generations is the same, which is [r<sup>s</sup>], even though they differ in the underlying form. The chapter also tackled the difference between high vowel spreading and consonant-to-vowel harmony. High vowel spreading has a stronger effect than consonant-to-vowel harmony in words with low vowel stems in coloring the sonority-driven epenthetic vowel, such as laryngeal/pharyngeal consonant-to-vowel harmony and dorsal consonant-to-vowel harmony, even in words with a medial pharyngeal/laryngeal or nonguttural and final rhotic. For example, compare the words /ʃiħr/ “poetry”, which surfaces as [ʃi.ħir], with /baħr/ “sea” and /dʒadr<sup>s</sup>/ “wall”, which surface as [baħar<sup>s</sup>] and [dʒadr<sup>s</sup>], respectively. The quality of the epenthetic [a] in [baħar<sup>s</sup>] is dictated by the laryngeal/pharyngeal progressive consonant-to-vowel harmony and the quality of the epenthetic [u] in [dʒadr<sup>s</sup>] is dictated by the dorsal regressive consonant-to-vowel harmony.

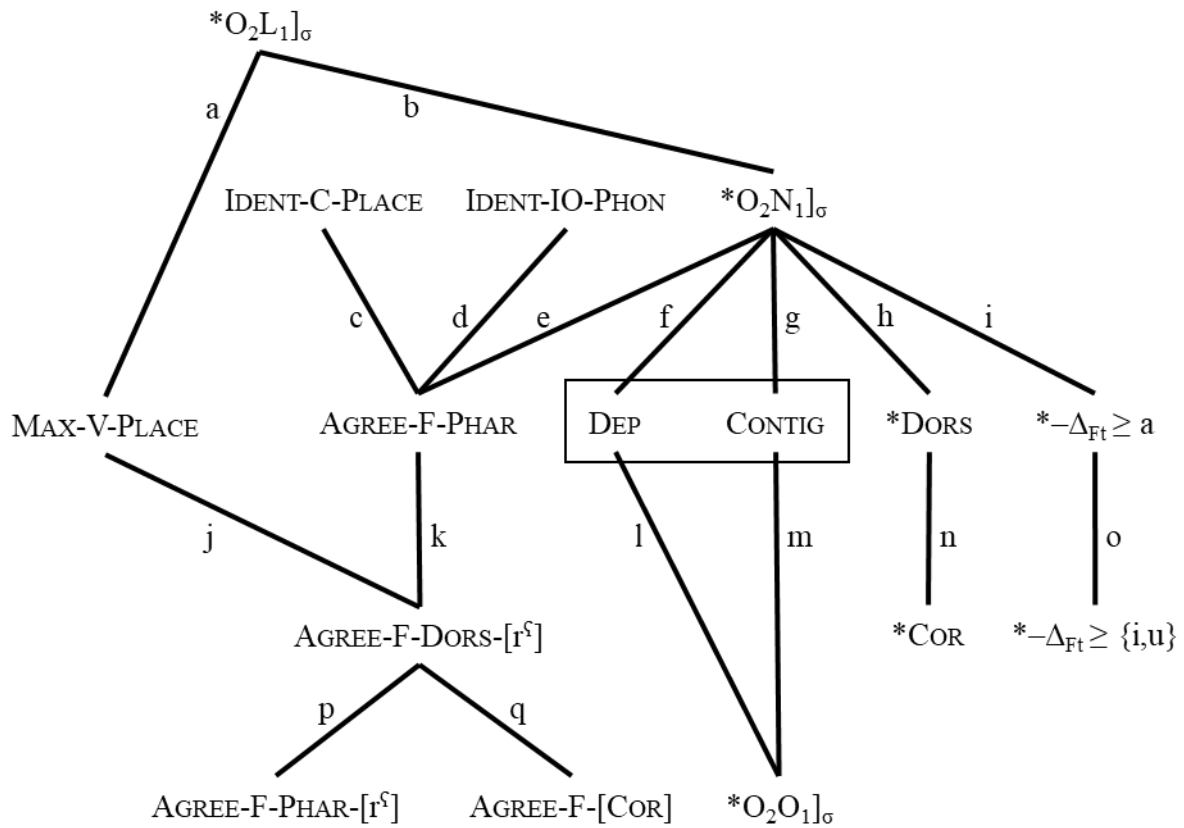
Finally, the chapter elaborated on both types of epenthesis in HA: syllable-driven epenthesis and sonority-driven epenthesis. In HA, in order to avoid word-internal superheavy syllables after suffixation, the vowel [a] is epenthesized in the process of resyllabification. For example, /ka.tabt.lu/ “I wrote for him” becomes [ka.'tab.ta.lu] and /baab.na/ “our door” becomes

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<sup>127</sup> According to Padgett (2011, p. 3), “Consonants commonly acquire vocalic secondary articulations by assimilating to adjacent vowels.”

['baa.ba.na]. The vowel [a], which has higher sonority than any other vowel, strengthens the weak degenerate syllable by forming the nucleus (i.e. the DTE) of the newly created syllable, which contains the previously unsyllabified consonant. Therefore, the constraint ranking for this type of epenthesis is  $*\Delta_{\sigma} \leq \{i, u\} \gg * \Delta_{\sigma} \leq a$ . With regard to default sonority-driven epenthesis, the high peripheral vowel, [i], which is less in sonority than the low vowel, is epenthesized in the non-head position i.e. the  $-\Delta$  position of the trochaic foot. For example, the word /lakm/ “punching” becomes ['la.kim]. The ranking of the DTE constraints is the opposite of that found in syllable-driven epenthesis i.e.  $*-\Delta_{Ft} \geq a \gg *-\Delta_{Ft} \geq \{i, u\}$ . In addition, the universal Place of Articulation Hierarchy plays a role in eliminating the high back vowel, [u], from getting epenthesized in the process of default sonority-driven epenthesis. [la.kim] wins by respecting the high-ranked constraints  $*-\Delta_{Ft} \geq a$  and \*[DORS], even though it violates the low-ranked  $*-\Delta_{Ft} \geq \{i, u\}$  and \*[COR] constraints. The chapter also elaborated on atypical, incomplete pharyngeal and laryngeal consonant-to-vowel harmony in which the final consonant in the word is not the emphatic rhotic. For example, /safim/ “arrow” is typically pronounced as [sa.fim] and atypically [sa.fiam]. This is because the typical winning candidate [sa.fim] does not violate  $*-\Delta_{Ft} \geq a$  or \*[DORS], even though it violates the low-ranked constraints  $*-\Delta_{Ft} \geq \{i, u\}$ , \*[COR] and AGREE-F-PHAR, whereas the atypical, losing candidate [sa.fiam] violates the relatively low-ranked  $*-\Delta_{Ft} \geq a$  as well as the lowest ranked  $*-\Delta_{Ft} \geq \{i, u\}$  and AGREE-F-PHAR, by not pharyngealizing the word-final [m].

Figure (5.20) summarizes Consonant-to-Vowel Harmony effect on coda clusters in HA.



(5.20) Hasse Diagram of Vowel Quality in Default Epenthesis and Consonant-to-Vowel Harmony Epenthesis.

Table 5.2 provides an index for the constraint ranking in the Hasse diagram in Figure (5.20).

Table 5.2

*Index of Constraint Rankings for Vowel Quality in Default Epenthesis and Consonant-to-Vowel Harmony Epenthesis*

	Ranking	Tableaux	Section	Example Word
a.	*O <sub>2</sub> L <sub>1</sub> ] <sub>σ</sub> >> Max-V-Place	5.7ab	5.6	[d̄ʒa.dur <sup>s</sup> ]
b.	*O <sub>2</sub> L <sub>1</sub> ] <sub>σ</sub> >> *O <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub>	Split Margin	3.1.1	
c.	IDENT-C-PLACE >> AGREE-F-PHAR	5.4	5.4	[ba.ħar <sup>s</sup> ]
d.	IDENT-IO-PHON >> AGREE-F-PHAR	5.6	5.5	[wagt], [laħd]
e.	*O <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub> >> AGREE-F-PHAR	5.5	5.4	[la.ħin]
f.	*O <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub> >> DEP	5.5	5.4	[la.ħin]
g.	*O <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub> >> CONTIG	5.5	5.4	[la.ħin]
h.	*O <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub> >> *DORS	5.11	5.7	[sa.him]
i.	*O <sub>2</sub> N <sub>1</sub> ] <sub>σ</sub> >> *-Δ <sub>Ft</sub> ≥ a	5.11	5.7	[sa.him]
j.	MAX-V-PLACE >> AGREE-F-DORS-[r <sup>s</sup> ]	5.7ab	5.6	[d̄ʒa.dur <sup>s</sup> ], [d̄ʒa.dir]
k.	AGREE-F-PHAR >> AGREE-F-DORS-[r <sup>s</sup> ]	5.4	5.4	[ba.ħar <sup>s</sup> ]
l.	DEP >> *O <sub>2</sub> O <sub>1</sub> ] <sub>σ</sub>	5.6	5.5	[wagt], [laħd]
m.	CONTIG >> *O <sub>2</sub> O <sub>1</sub> ] <sub>σ</sub>	5.6	5.5	[wagt], [laħd]
n.	*DORS >> *COR	Markedness	5.7	
o.	*-Δ <sub>Ft</sub> ≥ a >> *-Δ <sub>Ft</sub> ≥ {i,u}	DTE	5.7	
p.	AGREE-F-DORS-[r <sup>s</sup> ] >> AGREE-F-PHAR-[r <sup>s</sup> ]	5.8	5.6	[d̄ʒa.dur <sup>s</sup> ]
q.	AGREE-F-DORS-[r <sup>s</sup> ] >> AGREE-F-[COR]	5.7ab	5.6	[d̄ʒa.dur <sup>s</sup> ], [d̄ʒa.dir]

*Note.* Letters in the left column refer to labels in Figure (5.20).

Having provided a detailed analysis of sonority-driven epenthesis and how it interacts with neighboring consonants and vowels, Chapter 6 will discuss briefly residual issues relating to coda clusters in HA, discuss directions of future research and conclude the dissertation.

## Chapter 6: Conclusion and Future Directions

This dissertation investigated in a comprehensive and detailed manner the role of sonority and other subgrammars independent of sonority in constructing the coda cluster in HA. The study employed the Split-Margin Approach to the syllable within the framework of Optimality Theory to determine the most optimal coda clusters in terms of sonority.

Section 6.1 summarizes the most important findings and principles of Chapter 2: *Sonority in Hijazi Arabic*. Section 6.2 presents the main findings of Chapter 3: *The Sonority of Sound Coda Clusters in HA*. Section 6.3 summarizes the main findings of Chapter 4: *The Role of Glides, ‘Ayn and Geminates in Constructing the Coda Cluster of HA*. Section 6.4 presents the main findings of Chapter 5: *Sonority-driven Epenthesis, High vowel spreading, and Consonant-to-Vowel Harmony in HA*. Section 6.5 provides a general conclusion to the study and states the future directions for research.

### 6.1. Summary of Chapter 2: Sonority in Hijazi Arabic

This chapter established a solid background and strong base for the OT analysis of the sonority of coda clusters for subsequent chapters. It began by providing a thorough investigation of the nature of sonority by presenting several phonetic and phonological definitions of sonority from the literature. Sonority is usually defined as a scalar classificatory division of speech sounds based on something like loudness or intensity. Based on this definition and other definitions mentioned in the literature, the sonority scale of segments has been established. According to these scales and the behavior of segments in HA, especially the class of obstruents in coda clusters, I proposed the initial sonority scale of HA, which distinguishes the voiced

fricative obstruents from all other obstruents in having a higher sonority profile due to the features [continuant] and [voice].

(6.1) Initial Sonority Hierarchy for Hijazi Arabic (reproduced from Chapter 2, Section 2.1)

<i>Natural class</i>	<i>Sonority index</i>
Vowels	6
Glides	5
Liquids	4
Nasals	3
Voiced fricatives (including /z zʕ/)	2
Other obstruents (including /dʒ/)	1

After proposing the initial sonority scale in HA, I provided a detailed survey of the phonetic and phonological literature on guttural consonants, in order to determine the sonority status of these consonants. Throughout the literature, all six gutturals are defined as being produced in the rear broad zone of the vocal tract. This means that they all have phonetic and phonological common features, which provides evidence that they form a natural class of sounds. In addition, I derived several pieces of phonological evidence for this natural class from McCarthy (1991, 1994) and others. Among them is the cooccurrence restriction on gutturals in Semitic roots, vowel lowering preceding a guttural consonant in the imperfect verbal form and the avoidance of gutturals in syllable-final position via epenthesis following the guttural. Furthermore, I conducted a short typological survey of the sonority of gutturals in Arabic dialects such as Lebanese, Palestinian and previous studies of Makkan Arabic. They all show some examples of sonority-driven vowel epenthesis when gutturals would otherwise appear in a coda cluster. Although they all agree that guttural consonants are higher than other obstruents on the sonority scale, they do not agree on the exact sonority profile of these gutturals in the sonority scale, nor do they agree on whether all gutturals occupy the same level in the scale. Based on these findings, I proposed the second

sonority scale of HA assuming that the guttural class is higher in sonority than all other consonants except glides.

(6.2) Proposed Sonority Hierarchy for Hijazi Arabic (First Revision, reproduced from Section 2.2.3)

<i>Natural class</i>	<i>Sonority index</i>
Vowels	7
Glides	6
Gutturals	5
Liquids	4
Nasals	3
Voiced fricatives (including /z zʕ/)	2
Other obstruents (including /dʒ/)	1

After that, I provided the detailed phonetic evidence from the literature based on the specific and unique articulatory, perceptual, and acoustical features to differentiate between uvulars, pharyngeals and laryngeals, the subclass of gutturals. Furthermore, I further differentiated between each sound within these subclasses. In addition, I related this evidence to the different sonority levels of these segments in HA, by highlighting the relevant phonetic features of each and by analyzing the phonological patterning of these segments in coda position. Although Bin-Muqbil (2006), Catford (1977) and Ladefoged and Maddieson (1996) all confirmed that the pharyngeals /ħ/ and /ʕ/ are approximants, there is still controversy in the literature about the proximity of the voiceless pharyngeal consonant /ħ/. Careful looking at the details of the manner of articulation of these pharyngeal consonants led most phoneticians and phonologists to distinguish between them in terms of proximity. Butcher and Ahmad (1987), Alkhairy (1999) and Heselwood (2007) all confirm that /ħ/ is a fricative. However, there is almost unanimous agreement in the phonetic and phonological literature about the proximity of /ʕ/. Furthermore, according to the acoustic and laryngographic study conducted by Heselwood (2007) with several native speakers from the Middle East and North Africa about different realizations of /ʕ/ in

word-initial, word-medial and word-final positions, he found that /ʕ/ is mostly realized as a loose approximant, i.e. with a much wider passage of airflow in comparison to fricatives. According to Heselwood (2007, p. 5), the motivation behind classifying /ʕ/ as a fricative by some linguists “most likely comes from pairing it phonologically with /ħ/ which is typically realized as a voiceless fricative in all varieties, based on their shared place of articulation.” In addition, the wider degree of the constriction for /ʕ/ and voicing will add further support for the reason of the high sonority of /ʕ/. Furthermore, some studies confirm that /ʕ/ is accompanied by creakiness, which further adds to its sonority and its salient perception. Yet there are phonological pieces of evidence that /ʕ/ patterns with sonorant consonants. For example, in PA, /ʕ/ is classified as having the same sonority as glides. In the same vein, in HA, /ʕ/ resists sharing the coda cluster with another sonorant consonant. For example, /dirʕ/ surfaces as [di.riʕ] and /ʃiʕr/ surfaces as [ʃi.ʕir]. Based on all of these phonetic and phonological pieces of evidence and others, /ʕ/ is classified to be the most sonorant approximant consonant after the glides and above the liquids. With regard to uvulars /χ/ and /ʁ/, throughout the phonological and articulatory literature they are mostly considered continuant fricatives. In the same way, in HA, the uvular voiced fricative /ʁ/ patterns with other voiced fricatives as having a higher sonority profile than other obstruents due to the continuancy and voicing features. Regarding the voiceless fricative /χ/, it has the lowest sonority level among the gutturals because it lacks the voice feature. Therefore, they are considered obstruent consonants. With regard to the laryngeals /ʔ/ and /ħ/, according to Bin-Muqbil (2006), they trivially meet the definition for approximants. Although there is some controversy in the literature about the proximity of /ʔ/ and /ħ/, there is nearly unanimous agreement in phonology that these consonants pattern with obstruents. In HA, the laryngeal consonant /ħ/ patterns like any other voiced continuant fricative in such a way that when /ħ/ falls

as a second member of a coda cluster preceded by any other obstruent except a voiced continuant, epenthesis is required. For example, /wadʒfi/ surfaces as [wa.dʒifi] “face.” However, when /fi/ is followed by any obstruent other than a voiced fricative, it surfaces faithfully. For example, /nafid/ surfaces as [nafid] “chest, bosom.” Regarding the glottal stop, /ʔ/, it patterns like any other obstruent in terms of sonority. Historically, when /ʔ/ is the first consonant in a coda cluster, it deletes with compensatory lengthening of the preceding stem vowel. For example, /raʔs/ becomes [ra:s] “head.” However, there are still a few examples in which a glottal stop is the first consonant in a coda cluster followed by a sonorant consonant and epenthesis is required in the output form, confirming that /ʔ/ patterns like any other obstruent in terms of sonority. For example, /luʔm/ becomes [lu.ʔum] “vileness.” Whenever a glottal stop is the final consonant in a coda cluster, it surfaces faithfully. For example, /butʔ/ surfaces as [butʔ] “slowness.” Therefore, I consider /ʔ/ and /fi/ to be obstruent consonants because articulatorily and phonologically they pattern with obstruent consonants. All of these compiled phonetic and phonological findings help to construct the final sonority scale in Hijazi Arabic. Figure (6.3) presents the final, exhaustive sonority scale for Hijazi.

(6.3) Sonority Hierarchy for Hijazi Arabic (Final, reproduced from Chapter 2, Section 2.2.5)

<i>Natural class</i>	<i>Sonority index</i>
Vowels	7
Glides	6
Voiced pharyngeal /ʕ/	5
Liquids	4
Nasals	3
Voiced fricatives, including /z, zʕ, ʁ, fi/	2
Other obstruents, including /ʔ, h, ʁ, dʒ/	1

The chapter also reviewed and evaluated the previous work on sonority-driven epenthesis. The most detailed work about sonority-driven epenthesis is about MA/HA. Abu-Mansour (1991) and

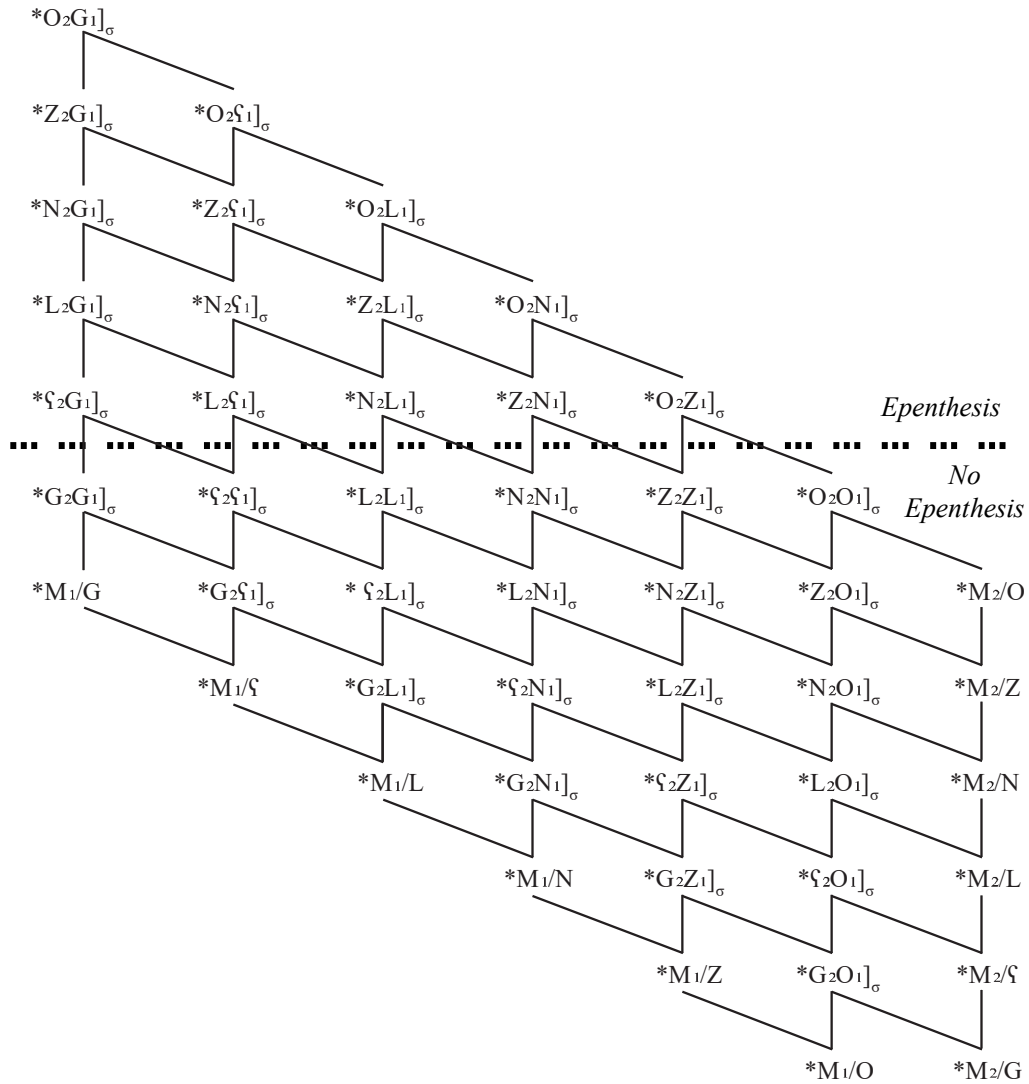
Kabrah (2004) account for sonority-driven epenthesis with a further elaboration on the type of the epenthetic vowel and consonant-to-vowel harmony in Kabrah (2004). In addition, a survey of the sonority scale in Arabic dialects is conducted. It has been found that there is a continuum of what is a permissible coda cluster in Arabic dialects based on their segment sonority profile. For example, on the one end of the continuum stand MSA and Cairene Arabic, which allow any two consonants regardless of their sonority profile to form a coda cluster. Whereas on the other end, in Hadhrami Arabic, no coda clusters are allowed. Between these two ends of the continuum, some dialects such as LA have an unusual sonority tree/scale by deconstructing the natural classes of liquids and nasals and further distributing the class of gutturals across several levels. Other sonority scales such as the scale for PA as analyzed by Farwaneh (2016), which tends towards the middle of the continuum, adhere to the basic sonority scale given by Clements (1990). However, she classified all gutturals as having the same sonority as nasals with the exception of /ʕ/, which is classified as having the same sonority as glides. The sonority scale for HA, as proposed in Section 2.2.5 falls right in the middle of the continuum. It adheres to the basic sonority scale given by Clements (1990) more clearly even than PA.

After surveying the typology of sonority scales in Arabic dialects, the chapter studies the role of SSP, MSD and OCP in constructing the consonant clusters in general and coda clusters specifically in HA and other Arabic dialects. According to Clements (1990), the SSP requires that the ideal syllable should exhibit a maximal sonority rise from the onset to the nucleus and a minimal drop in sonority from the nucleus to the coda, in what he calls the “Dispersion Principle.” Since most Arabic dialects lack onset clusters, SSP mainly applies to the syllable rhyme. Throughout the literature, SSP plays a role in preventing rising-sonority coda clusters in Arabic dialects such as MA/HA and PA. However, in MA/HA level coda clusters are allowed

with some exceptions, whereas in PA the case is more complicated because markedness and OCP play a further role in determining the coda cluster in the dialect. As a natural result of the SSP requirements, it has been found that MSD value differs from language to language and from dialect to dialect. For example, in Spanish the value for MSD is two, whereas it is zero in MA/HA. Not only SSP and MSD are the main factors in shaping the coda cluster, but also OCP plays a major role in determining the cluster shape. For example, in PA there is an unviolated OCP constraint, which militates against the occurrence of two sonorant consonants in the coda. Likewise, in MA/HA OCP militates against the occurrence of two nasal consonants and two coronal sonorant consonants in the coda. The findings obtained through my extensive literature review in Chapter 2 provide a solid background to start the analysis in subsequent chapters.

## **6.2. Summary of Chapter 3: The Sonority of Sound Coda Clusters in HA**

The sonority scale established in Chapter 2 was the baseline for the ranking of the universal Split-Margin constraints, which regulate the consonant clusters in the coda of HA. In addition, faithfulness constraints are used in the analysis to militate against any change in the output form. Figure (6.4) reproduces the Hasse diagram for the Split-Margin constraint hierarchy with the most dynamic faithfulness constraints, which play a role in determining which coda clusters get epenthesis and which surface faithfully.



(6.4) Hasse Diagram of Split-Margin Constraints for the Sonority Hierarchy of HA with the Decisive DEP and CONTIG Constraints.

The dotted line represents the location of DEP and CONTIG within the constraint hierarchy. As a result of the OT analysis of the sound coda cluster in this chapter, it has been found that HA does not tolerate rising sonority coda clusters, obeying the Split-Margin conjoined constraints above DEP and CONTIG. The only strategy to avoid such a cluster is through vowel epenthesis.

Therefore, a vowel is epenthesized after the second root consonant. For example, /naml/ “ants”

becomes [na.mil]. Other faithfulness constraints such as ANCHOR are ranked high ensuring that the vowel is not epenthesis at the right edge of the word; \*[nam.li] is ungrammatical. Yet other high-ranked faithfulness constraints such as MAX and ID-[son] prevent other phonological repairs to a potential rising sonority coda cluster such as consonant deletion e.g. \*[nam] or desonorizing the sonorant consonant e.g. \*[namd]. However, the dialect does allow level and falling sonority coda clusters to surface faithfully as long as they do not violate other high-ranked markedness constraints e.g. /χurm/ “hole” → [χur<sup>s</sup>m] and /nafs/ “soul” → [nafs]. These markedness constraints are OCP-[NAS], which militates against two nasal consonants in a coda cluster, and OCP-[SON, COR], which militates against two coronal sonorants in a coda cluster. For example, /samm/ “shortening, fat” becomes [sa.min] and /furn/ “furnace” becomes [fu.r<sup>s</sup>un]. There are also other types of level and falling sonority coda clusters that are prohibited from surfacing faithfully due to the high-ranked constraint MTS, which forces the output form of the word to resemble the CV.CVC template of the *Masdar*. For example, /d<sup>s</sup>iħk/ “laughing” becomes [d<sup>s</sup>i.ħik]. In addition, the constraint \*COMPLEX<sup>COD</sup>-L is also high-ranked, resulting in vowel epenthesis in the output form in certain lexical items. For example, /taħt/ “downstairs” becomes [ta.ħat].

For the complete summary of the OT analysis for Chapter 3, see Figure (3.24) and Table 3.1.

### **6.3. Summary of Chapter 4: The Role of Glides, ‘*Ayn* and Geminate in Constructing the Coda Cluster of HA**

After analyzing the role of sonority in the trilateral sound-root in Chapter 3, Chapter 4 provided the analysis of the role of glides, ‘*ayn* and geminate in constructing the syllable coda

in HA. HA's strategy of avoiding glides falling in a syllable coda is different than the strategy to avoid clusters in the sound-root. When a glide is word-final, it vocalizes in the output form. However, when a glide is word-medial, it coalesces with the preceding stem vowel, resulting in a mid front or back vowel. Several constraints have played a crucial role in the analysis of glide-final and glide-medial roots. Among them is the lowest-ranked ID-[F]-[VOC], which facilitates the vocalization of final glides by changing the feature value from [-vocalic] to [+vocalic]. For example, /ʃawj/ "grilling" and /farw/ "fur" become [ʃa.wi] and [fa.r<sup>h</sup>u]. Other candidates, including the near competitors [ʃawj] and [farw], lose because they violate a higher ranked Split Margin constraint, \*G<sub>2</sub>G<sub>1</sub>]σ or \*L<sub>2</sub>G<sub>1</sub>]σ. Still other candidates lose because they violate faithfulness constraints such as MAX, DEP and CONTIG, which protect the output form from further changes such as deleting one of the consonants and epenthesis between the medial and final consonant. In addition, the markedness constraint NODIPH militates against candidates that exhibit vocalization of the medial glide, such as \*[ʃauj]. Regarding word-medial glides, they do vocalize and coalesce, exchanging place features with the preceding stem vowel. For example, /bajʃ/ "sale" becomes [beeʃ]. As was the case with glide-final words, ID-[F]-[VOC] facilitated medial glide vocalization and, in the meantime, an additional higher ranked constraint such as AGREE-V-PLACE motivated the place feature exchange between the medial vocalized glide and the preceding vowel. As was its job for glide-final roots, MAX protected a glide-medial root from deletion. In addition, MAX-V-[F] protected against place feature deletion in the stem vowel or in the following glide. Finally, when the analysis of word-medial and word-final glides was updated by adding a new constraint militating against the occurrence of a mid vowel in the word stem, the lowest ranked constraint \*MIDV eliminated the near competitor [ʃooj] from winning

over [ʃa.wi]. For the complete summary of the subgrammar of glides in the syllable coda in HA, refer to Figure (4.35) and Table 4.1.

The chapter also has provided a detailed OT analysis for the status of /ʃ/ in the syllable coda of HA. /ʃ/ is the most sonorous consonant after glides and above liquids in the HA sonority scale. When /ʃ/ is word-medial and followed by any obstruent, including voiced fricative consonants, it surfaces faithfully with no epenthesis, forming a falling sonority coda cluster. For example, /waʃzʕ/ becomes [waʃzʕ] “sermon” and /ʃaʕb/ becomes [ʃaʕb] “people.” This is because the faithfulness constraints DEP and CONTIG outrank any falling sonority Split Margin conjoined constraint, preventing epenthesis from occurring. Furthermore, when /ʃ/ is word-final and preceded by any consonant other than glides, rising sonority Split Margin constraints, which outrank DEP and CONTIG, motivate epenthesis between the /ʃ/ and the preceding consonant, preventing a potential rising-sonority cluster in the output form. For example, /dirʃ/ becomes [dirʃ] “shield”. However, word-medial /ʃ/ followed by non-glide sonorant consonants does not surface faithfully, even though it would form a falling sonority coda cluster. For example, /ʃiʕr/ “poetry” does not surface as \*[ʃiʕr]. Instead a vowel is epenthesized between the /ʃ/ and the following sonorant consonant in the output form. For example, /ʃiʕr/ “poetry” becomes [ʃiʕir]. The vowel epenthesis is motivated by the high ranked, sonority-independent conjoined constraint \*ʃ]<sub>C0</sub> & OCP-[son], which outranks DEP and CONTIG, resulting in epenthesis in the output form. Thus, it can be concluded that there is an asymmetry between both types of epenthesis. Rising sonority Split Margin constraints were the trigger for epenthesis in word-final /ʃ/ preceded by a non-glide consonant, whereas the conjoined constraint \*ʃ]<sub>C0</sub> & OCP-[son] was the trigger in word-medial /ʃ/ followed by non-glide sonorant consonants. For the complete summary of the subgrammar of ‘*ayn* in the syllable coda in HA, refer to Figure (4.36) and Table 4.2.

Finally, Chapter 4 provided a detailed OT Analysis of the status of geminates in HA syllable codas. The chapter adopted the composite approach to geminates in which a geminate is underlyingly a long, moraic consonant that surfaces occupying two timing slots. Split Margin constraints do not discriminate between one underlying root occupying two C-slots in a syllable coda, i.e.  $M_2M_1$  as is the case with geminates nor do they discriminate between two independent identical root consonants, which would occupy the same margin positions. They all comprise a level-sonority coda cluster. What discriminates between them are other high-ranked sonority-independent constraints. These include GEM-INTEG, \*DEGEM and MAX- $\mu$ -GEM, which militate against unfaithful outputs of a geminate that either delete one of the timing slots of the geminate, have an epenthetic vowel between these timing slots or delete the mora of the geminate consonant. For example, /sum<sup>u</sup>:/ “poison” surfaces as [sum<sup>u</sup>m] and not \*[su.mum], \*[sum<sup>u</sup>] or \*[summ]. In addition, the faithfulness constraints DEP and CONTIG, which militate against epenthesis in a level and falling coda cluster, directly dominate any level sonority Split Margin constraint, regardless of whether this cluster is generated from one underlying root or from two identical or similar independent underlying roots, which would result in these level cluster types surfacing faithfully. However, DEP and CONTIG are outranked by the OCP constraint family such as OCP and OCP-[NAS], which forces epenthesis in the potential coda cluster if they were generated from two independent, similar or identical underlying roots. For example, /ruz<sub>i</sub>z<sub>j</sub>/ “(hypothetical word)” surfaces as [r<sup>s</sup>u.z<sub>i</sub>uz<sub>j</sub>], not \*[r<sup>s</sup>uz<sub>i</sub><sup>u</sup>z<sub>j</sub>], and /tumn/ “eighth” surfaces as [tu.mun], not \*[tum<sup>u</sup>n]. When the geminate grammar intersects with the glide grammar in polysyllabic words ending with a geminate glide, this geminate glide deletes in the surface form due to the high-ranking of the markedness constraint \*FGEMG. For example, /ʃadu<sup>u</sup>:/

“enemy” surfaces as [ʕa.du]. However, a final geminate glide in monosyllabic words surfaces intact, i.e. it does not delete fully or partially, or receive an epenthetic vowel, nor does it surface unfaithfully by vocalizing the glide or coalescing it with the stem vowel. For example, /d̪ʒaw<sup>h</sup>:/ “weather” surfaces as [d̪ʒaw<sup>h</sup>w], but not \*[d̪ʒa], \*[d̪ʒaw<sup>h</sup>], \*[d̪ʒa.waw], \*[d̪ʒoow], or \*[d̪ʒa.wu]. This is due to the high-ranked markedness constraint MINWORD, which militates against words surfacing with fewer than two moras. In addition, the high-ranked \*DEGEM and GEM-INTEG, prevent degemination, vowel epenthesis, or vowel vocalization from occurring. Nonetheless, suffixed glide-final mono- or polysyllabic words surface faithfully, i.e. it does not delete fully or partially, or receive medial epenthesis separating between its two timing slots. Instead, the geminate consonant splits in the surface resyllabified form into the coda of the preceding vowel and the onset of the vowel-initial suffix. For example, /ʕadu<sup>h</sup>:-u/ “his enemy” surfaces faithfully as [ʕa.duw<sup>h</sup>.wu] and /ħaj<sup>h</sup>:-u/ “his neighborhood” surfaces faithfully as [ħaj<sup>h</sup>.ju]. This is because the high-ranked markedness constraint ONSET outranks \*GEM-SPLIT, compelling the geminate glide to form the onset of the following vowel-initial suffix. In the meantime, the geminate glide forms the coda for the preceding vowel, again due to the high-ranked \*DEGEM and GEM-INTEG, which preserve the two adjacent timing slots of the geminates from partial deletion or epenthesis. For the complete summary of the subgrammar of geminates in the syllable coda in HA, refer to Figure (4.37) and Table 4.3.

#### **6.4. Summary of Chapter 5: Sonority-driven Epenthesis, High vowel spreading, and Consonant-to-Vowel Harmony in HA**

This chapter provided a detailed analysis for sonority-driven epenthesis, high vowel spreading, and consonant-to-vowel harmony in HA. HA has three underlying vowel qualities: /i/,

which is high front and [coronal]; /u/, which is high back and [dorsal]; and /a/, which is not specified for frontness or backness, but only specified as a low vowel and [pharyngeal].

Although the default sonority-driven epenthetic vowel is [i], any of these three vowels can be epenthesized by the processes of high-vowel spreading and consonant-to-vowel harmony.

Sonority-driven epenthesis operates when DEP and CONTIG are outranked by any of the rising-sonority Split Margin conjoined constraints. In the meantime, constraints dictating the quality of the epenthetic vowel take effect based on the quality of the stem vowel and the quality of the second and third consonant in the root.

SPREAD-[back], SPREAD-[front] constraint motivates high vowel spreading from the stem vowel to the epenthetic vowel in a word containing high vowels. For example, /fikr/ “thought, idea” becomes [fi.kir]. Additionally, IDENT-IO(Vowel) protects the stem vowel from changing and UNIFORM-[front]/[back] ensures that the same height feature of the stem vowel spreads to the epenthetic vowel. For the complete summary of the high vowel spreading grammar in HA, refer to Figure (5.19) and Table 5.1.

In words ending in coronal consonants excluding /r<sup>s</sup>/, AGREE-F-COR motivates coronal harmony in the epenthetic vowel. For example, /ʃakl/ “shape, appearance” becomes [ʃa.kil]. Moreover, a final coronal consonant motivates [i]-Epenthesis, even if the epenthetic vowel is preceded by a pharyngeal or laryngeal consonant. For example, /laħn/ “melody” becomes [la.ħin], not \*[la.ħan]. This happens by virtue of accumulating fewer constraint violations for [la.ħin] by respecting the low-ranked AGREE-F-COR, whereas \*[la.ħan] accumulates more violations by violating DEP, CONTIG, AGREE-F-PHAR and AGREE-F-COR.

The pharyngeal low vowel [a] is epenthesized in sonority-driven epenthesis before word-final /r/ in a word with a medial pharyngeal or laryngeal consonant. For example, /baħr/ “sea”

becomes [ba.ħar<sup>s</sup>] and not \*[ba.ħar]. The constraint AGREE-F-PHAR demands that the epenthetic vowel match in the feature [pharyngeal] with the preceding pharyngeal or laryngeal consonant and in the meantime triggers pharyngealization in the following /r/ becoming [r<sup>s</sup>]. In addition, the high-ranked constraint IDENT-C-PLACE protects the medial pharyngeal consonant from place changing on the surface.

However, the effect of coronal and laryngeal/pharyngeal harmony is suspended in words, which surface with a faithful falling-sonority coda cluster with no epenthesis. For example, /wagt/ “time” and /laħd/ “grave” surface as [wagt] and [laħd], i.e. the agree constraints do not force harmony between the consonants of the coda cluster. This is because any place or feature change in the consonant of the coda cluster changes the identity of the segment. For example, /wagt/ “time” and /laħd/ “grave” do not surface as \*[wadt] and \*[laħd<sup>s</sup>]. The high-ranked IDENT-IO-PHON militates against any surface change in the identity of the coda cluster phonemes.

The chapter also elaborated in detail on the two realizations of the rhotic sound in HA between generations. The rhotic phoneme is /r/ for the younger generation, the typical and common realization, and it is emphaticized to [r<sup>s</sup>] when it is adjacent to emphatic, pharyngeal and laryngeal segments, whereas it is /r<sup>s</sup>/ for the older generation, the atypical and uncommon realization, and it is deemphaticized to [r] when it is adjacent to non-emphatic, non-pharyngeal and non-laryngeal segments. For the older generation, the word /ḍʒadr<sup>s</sup>/ “wall” surfaces as [ḍʒa.dur<sup>s</sup>] and not \*[ḍʒa.dir<sup>s</sup>], \*[ḍʒa.dir] or \*[ḍʒa.dar<sup>s</sup>]. This is because the output form respects the relatively high-ranked MAX-V-PLACE, which protects the secondary [dorsal] feature of the /r<sup>s</sup>/ from deletion in the surface form. It also respects AGREE-F-DORS-[r<sup>s</sup>], which motivates the [dorsal] harmony between the /r<sup>s</sup>/ and the epenthetic vowel, at the expense of violating the lowest-ranked AGREE-F-COR and AGREE-F-PHAR-[r<sup>s</sup>] by not forcing coronal or pharyngeal

harmony on the epenthetic vowel. However, for the younger generation, the word /d̥ʒadr/ “wall” surfaces as [d̥ʒa.dir] and not \*[d̥ʒa.dur<sup>s</sup>] or \*[d̥ʒa.dur]. This is because the winner accumulates fewer violations than its closest competitors by obeying the lowest-ranked constraint AGREE-F-COR. Nonetheless, the active constraint AGREE-F-PHAR, which motivated pharyngeal and laryngeal consonant-to-vowel harmony, dictates that the following epenthetic vowel should be [a] and not \*[u] in words ending in a rhotic regardless of the different underlying forms for both generations. For example, /baħr/ “sea” and /baħr<sup>s</sup>/ both surface as [ba.ħar<sup>s</sup>] and not \*[ba.ħur<sup>s</sup>]. This is because AGREE-F-DORS-[r<sup>s</sup>] is outranked by AGREE-F-PHAR, which results in agreement between the [pharyngeal] feature of the epenthetic vowel and the secondary [pharyngeal] feature of [r<sup>s</sup>] rather than its secondary [dorsal] feature.

Finally, after providing a detailed analysis for vowel and consonant-to-vowel harmony in coloring the sonority-driven epenthetic vowel, the chapter provided a detailed analysis in differentiating between syllable-driven epenthesis and sonority-driven epenthesis. The low vowel [a], which is also the highest vowel in sonority in HA, is epenthesized in the DTE position of the syllable to form the nucleus of the stray unsyllabified consonant. For example, /baab.na/ “our door” becomes [ˈbaa.ba.na] and /ka.tabt.lu/ “I wrote for him” becomes [ka.ˈtab.ta.lu]. The high sonority epenthetic [a] strengthens the weak degenerate syllable and prevents it from being syllabified with the preceding heavy syllable to form an undesired word-internal superheavy syllable such as CVVC and CVCC, which are not allowed by the grammar of HA. In contrast to syllable-driven epenthesis, the low sonority high peripheral vowel [i] is the default epenthetic vowel in sonority-driven epenthesis. It gets epenthesized in the non-DTE position of the foot. For example, /lakm/ “punching” becomes [ˈla.kim]. The low sonority epenthetic vowel forms the nucleus of the unstressed second syllable in the trochaic foot of the word, i.e. it falls in the non-

DTE position of the foot. The default epenthetic vowel violates  $*-\Delta_{Ft} \geq \{i, u\}$  and  $*[COR]$ , but respects the high-ranked constraints  $*-\Delta_{Ft} \geq a$  and  $*[DORS]$ , resulting in  $['la.kim]$ , not  $*['la.kam]$  and  $*['la.kum]$ . This is because  $*['la.kam]$  and  $*['la.kum]$  violate one of the high-ranked constraints  $*-\Delta_{Ft} \geq a$  or  $*[DORS]$ . In addition, the default epenthetic vowel  $[i]$  is the dominant epenthetic vowel in words that have a medial pharyngeal or laryngeal and end with a non-rhotic consonant. For example,  $/safim/$  “arrow” is typically pronounced as  $[sa.fim]$  and less commonly as  $[sa.fiam]$ . This is because the low-ranked constraints  $*-\Delta_{Ft} \geq \{i, u\}$ ,  $*[COR]$  and  $AGREE-F-PHAR$ , which motivate pharyngeal and laryngeal harmony, are outranked by the higher ranked constraints  $*-\Delta_{Ft} \geq a$  and  $*[DORS]$ , which mandate default  $[i]$ -Epenthesis in the output form of the typical pronunciation. For the complete summary of the vowel quality in default epenthesis and consonant-to-vowel harmony epenthesis in HA, refer to Figure (5.20) and Table 5.2.

## 6.5. General conclusion and directions for future research

In conclusion, this study has provided a detailed OT analysis of coda types in HA, mainly by utilizing the Split Margin approach to the syllable, which organizes the consonants in the coda based on their sonority profile. Once the Split Margin constraints are violated in a potential rising coda cluster, the rising-sonority Split Margin constraints, which outrank  $DEP$  and  $CONTIG$ , force epenthesis in the output form to break up such a sonority-violating cluster. However, level and falling sonority coda clusters surface faithfully, because the faithfulness constraints  $DEP$  and  $CONTIG$  outrank any level or falling coda cluster, preventing epenthesis from occurring in the output form in these clusters. Besides Split Margin constraints, which function as the main regulators of the coda cluster in HA, there are still other subgrammars that play an important role in shaping the coda clusters in the dialect. The subgrammar of glides operates when any one of

the two consonants of the potential coda cluster or both of them contains a glide consonant. This operation results in word-final glide vocalization or a medial glide coalescing with the preceding stem vowel. The subgrammar of /ʃ/ operates when /ʃ/ falls as the first consonant in the potential coda cluster and is followed by a sonorant consonant. This operation results in epenthesis after /ʃ/ to prevent such an ungrammatical form from surfacing. The subgrammar of geminates is the only grammar in HA which is compatible with the Split Margin approach to the syllable. This is because the underlying geminate consonant occupies the two margins  $M_2$  and  $M_1$  in the syllable coda on the surface and treated by the Split Margin constraints as any level coda cluster which surfaces faithfully with no epenthesis. Beside the subgrammars above which play a major role in constructing the coda clusters in HA, there are still other high-ranked, sonority-independent constraints, such as the OCP family of constraints, which prevent any two identical or similar consonants from surfacing in the syllable coda of HA via vowel epenthesis, such as OCP, OCP-[NAS] and OCP-[SON, COR]. Yet other high-ranked constraints play a role in preventing some sound level or falling-sonority coda clusters from surfacing, such as MTS and \*COMPLEX<sup>COD</sup>-L. When DEP and CONTIG are outranked by any one of the rising-sonority Split Margin conjoined constraints, the default sonority-driven epenthesis, high vowel spreading and consonant-to-vowel harmony grammars operate, resulting in dictating the quality of the epenthetic vowel. An underlying high vowel spreads its features to the epenthetic vowel on the surface in the high vowel spreading operation. [i] is epenthesized agreeing with final coronal consonants, except emphatic [r<sup>ʃ</sup>]. [a] is epenthesized agreeing in the feature [pharyngeal] with a preceding pharyngeal/laryngeal consonant and a following pharyngeal rhotic. In words with no medial laryngeal/pharyngeal consonant, [u] is epenthesized agreeing with the final emphatic rhotic [r<sup>ʃ</sup>] for old generation speakers of the dialect. Low sonority [i] is epenthesized as a default in the

non-DTE position of the foot, if there are no high vowel spreading or consonant-to-vowel harmony forces.

This study has provided a comprehensive analysis of several grammars involved in shaping the coda cluster in Hijazi Arabic. One of the unique aspects of this dissertation in terms of its contribution to Arabic dialectal phonology is that it is the first of its kind to investigate the coda cluster and the sonority hierarchy in the framework of the Split-Margin approach to the syllable. It is also the first study of its kind on the phonetics and phonology of gutturals that relates them to the sonority scale of HA, by providing a unique method to study the articulatory features of each subclass within the broader class of gutturals and the intrinsic features that distinguish each sound within these subclasses. This leads to determining the position of /ʕ/ in the HA sonority scale, which helps in the OT analysis using the Split Margin approach to the syllable. Furthermore, it provides a new approach to the analysis of glide-vowel coalescence in trilateral roots containing a medial glide of what has been known in the literature as monophthongization. In addition, it is one of relatively few studies to discuss sonority- vs. syllable-driven epenthesis in HA. Other studies do not discuss this in as much detail and it is the only study to provide a detailed OT analysis for the default sonority-driven epenthesis.

Although the study covered most of the grammars that are involved in shaping the coda cluster in HA, I still aim, using an Optimality Theoretic approach, to study some other less prevalent phonological alternations in coda clusters such as voice assimilation in HA coda clusters and degemination of some geminate-final words caused by the suffixation of the *nisba* suffix /-awi/. In HA, a voiced obstruent devoices in rapid and casual speech if it is in the O<sub>2</sub>-O<sub>1</sub> margin with a voiceless obstruent, whether this cluster is word-final, e.g. /sabt/ “Saturday” → [sapt], or in a syllable contact position, e.g. /mazku:r/ “mentioned” → [mas.ku:r]. However, a

single voiced obstruent in M<sub>2</sub> position does not devoice. For example, /ba:b/ “door” surfaces faithfully as [ba:b] (see Abu-Mansour 1996). With regard to degemination with the *nisba* suffix /-awi/, biconsonantal roots in words like /dam/ “blood” geminate on the surface to fulfill the requirement set by the MINWORD constraint. This geminate surfaces faithfully even after suffixation in most morpho-phonology environments. For example, /dam<sup>h</sup>:-i/ “my blood” surfaces as [dam.mi]. However, in suffixation with the *nisba* suffix /-awi/, this root surfaces as [da.ma.wi] “bloody.”

One of the main achievements of this study is its contribution to the general understanding of the field of phonology by providing detailed, systematic data sets of coda cluster types in HA and words with a sonority-driven epenthetic vowel. In addition, it proposes a new level in the universal sonority scale with /ʕ/ as the most sonorous consonant after glides and above other sonorant consonants, distinguishing it from the other guttural consonants and all other obstruents, which is necessary, because of the unique behavior of the phonetics and phonology of /ʕ/ in HA. In addition, it is, to the best of my knowledge, the only study on the sonority hierarchy that sorts out voiced fricatives as having a higher sonority than other obstruents, due to the features voicing and continuancy, which is not universally odd as a criterion to distinguish between obstruents in terms of sonority. It also collapses the remaining obstruents on the lowest level of sonority in the HA sonority scale.

The study also implicitly tackles the appearance of mid vowels in the coalescence process. This coalescence process could be considered a sonority compromise between a glide, which has the same place features as a high vowel and has a lower sonority than vowels, and the preceding highest sonority low vowel in the stem. It seems that there is an implicit phonological tendency in the dialect to fill out the empty mid area in the HA vowel space via the process of

glide-stem vowel coalescence which results in mid vowels [ee] and [oo], reaching a well-dispersed 5 vowel system, which is the most common system universally (see Liljencrants & Lindblom, 1972 and Gordon, 2016).

Furthermore, the study utilized the universal DTE approach in distinguishing between the sonority-driven epenthesis as [i] and syllable-driven epenthesis as [a], based on the prosodic domain of the epenthesis. The result of this is compatible with the universal prediction that [a] is higher in sonority than [i].

Finally, the procedures conducted to investigate the sonority of consonants in this study, which utilized the Split Margin approach to the syllable along with other phonetic and phonological principles in shaping the coda cluster, can be used as a role model to study such clusters in other languages and dialects.

## Appendix A: Data for Hijazi Arabic Coda Clusters Types

(A-1) The Root Medial Consonant is more Sonorous than the Final Consonant in HA

Underlying Form	Gloss	Surface Form	Possessive Form (1 <sup>st</sup> singular Masc.)
a. /χurm/	“hole”	[χur <sup>ɕ</sup> m]	[χur <sup>ɕ</sup> .mu]
/ɕilm/	“knowledge”	[ɕilm]	[ɕil.mu]
b. /kanz/	“treasure”	[kanz]	[kan.zu]
/ramz/	“symbol”	[ramz]	[ram.zu]
c. /nazf/	“hemorrhage”	[nazf]	[naz.fu]
/ħizb/	“(political) party”	[ħizb]	[ħiz.bu]

(A-2) The Root Medial Consonant is less Sonorous than the Final Consonant in HA

Underlying Form	Gloss	Surface Form	Possessive Form (1 <sup>st</sup> singular Masc.)
a. /tamr/	“date”	[tamir]	[tam.r <sup>ɕ</sup> u]
/naml/	“ants”	[namil]	[nam.lu]
b. /ħuzn/	“sadness”	[ħuzun]	[ħuz.nu]
/ɕazm/	“determination”	[ɕazim]	[ɕaz.mu]
c. /χubz/	“bread”	[χubuz]	[χub.zu]
/gafz/	“jumping”	[gafiz]	[gaf.zu]

(A-3) Falling Sonority Clusters

1. liɕb	“playing”	42. s <sup>ɕ</sup> ulb	“steel”
2. ʃaɕb	“people”	43. fil	“small unit of currency”

3.	baʃd	“after”	44.	χalf	‘back’
4.	baʃd <sup>f</sup>	“some”	45.	milh	“salt”
5.	kaʃb	“heel”	46.	bulfi	“idiots”
6.	t <sup>f</sup> aʃd̄ʒ	“wrinkle, dent”	47.	tult	“third”
7.	daʃs	“stepping-over, crashing”	48.	mulk	“monarchy”
8.	faʃs <sup>f</sup>	squeezing, damaging	49.	kanz	“treasure”
9.	kaʃk	“cake”	50.	d̄ʒanb	“side”
10.	farm	‘grinding’	51.	band	“section”
11.	χur <sup>f</sup> m	‘hole’	52.	band̄ʒ	“anesthesia”
12.	karm	‘orchard’	53.	ʔins	“mankind”
13.	farz	“sorting”	54.	s <sup>f</sup> anf	“type, kind”
14.	bur <sup>f</sup> d̄ʒ	“tower”	55.	ʒunf	“violence”
15.	dur <sup>f</sup> d̄ʒ	“drawer”	56.	kunħ	“core, point”
16.	ward	“flower”	57.	manħ	“granting”
17.	far <sup>f</sup> d <sup>f</sup>	“commandment”	58.	ʔanf	“nose”
18.	gar <sup>f</sup> d <sup>f</sup>	“loan”	59.	ʔinj	“inch”
19.	gird	“monkey”	60.	winj	“crane”
20.	sirb	“swarm, flock”	61.	bint	“daughter”
21.	farg	“difference”	62.	bunt <sup>f</sup>	“font”
22.	ħarb	“war”	63.	bank	“bank”
23.	farf	‘furnishing’	64.	ramz	“symbol”
24.	z <sup>f</sup> arf	‘envelope’	65.	samκ	“glue”
25.	farx	“chick”	66.	ħamd	‘thanking, praise’
26.	fur <sup>f</sup> s	“Persians”	67.	ħimd <sup>f</sup>	‘acid’
27.	bur <sup>f</sup> s <sup>f</sup>	“lizard”	68.	ʔams	‘yesterday’

28.	xar <sup>s</sup> t <sup>s</sup>	“fixing a car engine, lies or falsehood”	69.	nims	“mongoose”
29.	kart	“card”	70.	rimf	“eyelash”
30.	ʃarḥ	“explanation”	71.	r <sup>s</sup> umḥ	“spear”
31.	kur <sup>s</sup> fi	“hatred”	72.	sumk	“thickness”
32.	ʃirk	‘polytheism’	73.	s <sup>s</sup> amt	“silent”
33.	ʕilm	“knowledge”	74.	kizb	“falsehood”
34.	ḥilm	“dream”	75.	mazd̪ʒ	“mixing”
35.	silm	“peace”	76.	nazf	‘hemorrhage’
36.	tald̪ʒ	“ice, snow”	77.	ʕazf	“playing an instrument”
37.	d̪ʒild	“leather, skin”	78.	mizḥ	“joking”
38.	χuld	“immortal”	79.	waxd	“scoundrel”
39.	kalb	“dog”	80.	max <sup>s</sup>	“stomach ache”
40.	galb	“heart”	81.	d <sup>s</sup> ax <sup>s</sup>	“pressure”
41.	salb	“robbery”	82.	bux <sup>s</sup> d <sup>s</sup>	“aversion”

(A-4) Potential Coronal Sonorant Clusters

1. [garin] “century; horn, antler”
2. [fur<sup>s</sup>un] “furnace”

(A-5) Level Sonority Clusters

1.	luɾz	“puzzle”	20.	kitf	“shoulder”
2.	naɾz	“poking”	21.	buks	“punch”
3.	ʕabd	“slave”	22.	ʃat <sup>ʕ</sup> f	“washing, mopping”
4.	nabd <sup>ʕ</sup>	“beating”	23.	bat <sup>ʕ</sup> ħ	“throw on the ground”
5.	gabd <sup>ʕ</sup>	“constipation, arresting”	24.	ʃat <sup>ʕ</sup> ħ	“going over”
6.	nagd	“cash”	25.	ʕat <sup>ʕ</sup> s <sup>ʕ</sup>	“sneezing”
7.	fagd	“losing, forfeiture”	26.	t <sup>ʕ</sup> aʃt	“tub, basin”
8.	maðɜd	“glory”	27.	ʃaft <sup>ʕ</sup>	“suction”
9.	naðɜd	“region in Saudi Arabia”	28.	baɣt	“luck, chance”
10.	maʃħ	“wiping, sweeping, survey”	29.	naɣðɜ	“weaving”
11.	naħs	“jinx”	30.	nags <sup>ʕ</sup>	“lacking, shortage”
12.	faħs <sup>ʕ</sup>	“check-up, test”	31.	labs	“clothing”
13.	nafs	“soul”	32.	ħabs	“prison”
14.	naɣf	“destroying”	33.	nut <sup>ʕ</sup> g	“pronunciation”
15.	r <sup>ʕ</sup> uɣs <sup>ʕ</sup>	“cheapness”	34.	sabt	“Saturday”
16.	naɣɣ	“copying”	35.	but <sup>ʕ</sup> ?	“slowness”
17.	was <sup>ʕ</sup> f	“description”	36.	fatk	“destruction”
18.	nat <sup>ʕ</sup> ħ	“kick (animal)”	37.	fiatk	“violating”
19.	bat <sup>ʕ</sup> ʃ	“violence”	38.	maðħ	“praising”

(A-6) Potential Nasal + Nasal Clusters

1.	/ʔamn/	[ʔamin]	“safety, security”
2.	/samn/	[samin]	“shortening, fat”
3.	/tumn/	[tumun]	“one-eighth”
4.	/ʕunm/	[ʕunum]	“plundering”

5. /dʕimn/ [dʕimin] “domain”

(A-7) Words in the Pattern of faʕil with Optional Epenthesis

1. [miziħ] ‘joking’  
 2. [liʕib] “playing”  
 3. [dʕiħik] “laughing”  
 4. [kizib], [kidib] ‘falsehood’

(A-8) Coda Clusters with Lexical Optional Epenthesis

- |                         |          |                       |              |
|-------------------------|----------|-----------------------|--------------|
| 1. [dʒurʕħ] ~ [dʒurʕuh] | “wound”  | 4. [muʕtʕ] ~ [muʕutʕ] | “comb”       |
| 2. [rʕuʕb] ~ [rʕuʕub]   | “horror” | 5. [taħt] ~ [taħat]   | “downstairs” |
| 3. [milħ] ~ [miliħ]     | “salt”   | 6. [subħ] ~ [subuħ]   | “morning”    |

(A-9) Epenthesis in Potential /ʕ/-Final Rising-Sonority Clusters

	Underlying Form	Surface Form	Possessed Form	Gloss
1.	/nazʕ/	[naziʕ]	[nazʕu]	“extraction, taking away”
2.	/razʕ/	[raziʕ]	[razʕu]	“slamming, bang”
3.	/nabʕ/	[nabiʕ]	[nabʕu]	“stream”
4.	/rubʕ/	[rʕubiʕ]	[rʕubʕu]	“quarter”
5.	/subʕ/	[subuʕ]	[subʕu]	“seventh”
6.	/dʕabʕ/	[dʕabiʕ]	[dʕabʕu]	“hyena”
7.	/tʕabʕ/	[tʕabiʕ]	[tʕabʕu]	“printing, nature”
8.	/radʕ/	[radiʕ]	[radʕu]	“deterrence”
9.	/ladʕ/	[ladiʕ]	[ladʕu]	“burning”
10.	/radʕʕ/	[radʕiʕ]	[radʕʕu]	“suckling”

11.	/tusʎ/	[tusʎ]	[tusʎu]	“ninth”
12.	/lasʎ/	[lasʎ]	[lasʎu]	“stinging, biting”
13.	/gatʎ/	[gatʎ]	[gatʎu]	“cutting, suspending”
14.	/dafʎ/	[dafʎ]	[dafʎu]	“pushing, paying”
15.	/nafʎ/	[nafʎ]	[nafʎu]	“benefit”
16.	/rafʎ/	[rafʎ]	[rafʎu]	“raising”
17.	/natʎ/	[natʎ]	[natʎu]	“shove”
18.	/gatʎ/	[gatiʎ]	[gatʎu]	“cutting, suspending”
19.	/sadʒʎ/	[sadʒiʎ]	[sadʒʎu]	“assonance”

(A-10) Epenthesis in Potential Liquid-Final Rising-Sonority Clusters

	Underlying Form	Surface Form	Possessed Form	Gloss
1.	/tamr/	[tamir]	[tamr <sup>s</sup> u]	“date”
2.	/nimr/	[nimir]	[nimr <sup>s</sup> u]	“tiger”
3.	/dʒamr/	[dʒamir]	[dʒamr <sup>s</sup> u]	“coal”
4.	/ʎumr/	[ʎumr <sup>s</sup> ]	[ʎumr <sup>s</sup> u]	“life”
5.	/ʔamr/	[ʔamir]	[ʔamr <sup>s</sup> u]	“command, order”
6.	/fazr/	[fazir]	[fazr <sup>s</sup> u]	“breaking, exploding”
7.	/s <sup>s</sup> uʁr/	[s <sup>s</sup> uʁr <sup>s</sup> ]	[s <sup>s</sup> uʁr <sup>s</sup> u]	“smallness, childhood”
8.	/badr/	[badr <sup>s</sup> ]	[badr <sup>s</sup> u]	“full moon / Proper Name”
9.	/gidr/	[gidir]	[gidr <sup>s</sup> u]	“pot”
10.	/dʒadr/	[dʒadir]	[dʒadr <sup>s</sup> u]	“wall”
11.	/sadr/	[sadir]	[sadr <sup>s</sup> u]	“chest”
12.	/gabr/	[gabir]	[gabr <sup>s</sup> u]	“grave”

13.	/hibr/	[hibir]	[hibr <sup>s</sup> u]	“ink”
14.	/jibr/	[jibir]	[jibr <sup>s</sup> u]	“inch”
15.	/kibr/	[kibir]	[kibr <sup>s</sup> u]	“pride”
16.	/s <sup>s</sup> agr/	[s <sup>s</sup> agir]	[s <sup>s</sup> agr <sup>s</sup> u]	“falcon”
17.	/fagr/	[fagir]	[fagr <sup>s</sup> u]	“poverty”
18.	/ḍizir/	[ḍizisir]	[ḍizir <sup>s</sup> u]	“bridge”
19.	/baħr/	[baħar]	[baħr <sup>s</sup> u]	“sea”
20.	/nasr/	[nasir]	[nasr <sup>s</sup> u]	“eagle”
21.	/naʃr/	[naʃir]	[naʃr <sup>s</sup> u]	“publication”
22.	/nas <sup>r</sup> /	[nas <sup>r</sup> ir]	[nas <sup>r</sup> r <sup>s</sup> u]	“victory”
23.	/ʃukr/	[ʃukur <sup>s</sup> ]	ʃukur <sup>s</sup> u	“thanks”
24.	/sukr/	[sukur <sup>s</sup> ]	sukur <sup>s</sup> u	“intoxication”
25.	/bakr/	[bakir]	[bakr <sup>s</sup> u]	“proper name”
26.	/fit <sup>r</sup> /	[fit <sup>r</sup> ir]	[fit <sup>r</sup> r <sup>s</sup> u]	“mushroom”
27.	/naml/	[namil]	[namlu]	“ants”
28.	/ʃaml/	[ʃamil]	[ʃamlu]	“included”
29.	/gaml/	[gamil]	[gamlu]	“lice”
30.	/himl/	[himil]	[himlu]	“burden, load”
31.	/raml/	[ramil]	[ramlu]	“sand”
32.	/ʃazl/	[ʃazil]	[ʃazlu]	“separating”
33.	/kazl/	[kazil]	[kazlu]	“yarn”
34.	/baʁl/	[baʁil]	[baʁlu]	“mule”
35.	/ʃuʁl/	[ʃuʁul]	[ʃuʁlu]	“work”
36.	/fiḍzil/	[fiḍzil]	[fiḍzlu]	“radish”
37.	/nadl/	[nadil]	[nadlu]	“scoundrel”
38.	/gabl/	[gabil]	[gablu]	“before”

39.	/nubl/	[nubul]	[nublu]	“noble”
40.	/nagl/	[nagil]	[naglu]	“moving”
41.	/hagl/	[hagil]	[haglu]	“field, city in northern Saudi Arabia”
42.	/nasl/	[nasil]	[naslu]	“generation, lineage”
43.	/faħl/	[faħil]	[faħlu]	“virile”
44.	/naħl/	[naħil]	[naħlu]	“bee”
45.	/fasˤl/	[fasˤil]	[fasˤlu]	“chapter, classroom, season”
46.	/ʔakl/	[ʔakil]	[ʔaklu]	“food”
47.	/gatl/	[gatil]	[gatlu]	“killing”

(A-11) Epenthesis in Potential Nasal-Final Rising-Sonority Clusters

	Underlying Form	Surface Form	Possessed Form	Gloss
1.	/ħuzn/	[ħuzun]	[ħuznu]	“sadness”
2.	/tibn/	[tibin]	[tibnu]	“hay”
3.	/hudˤn/	[hudˤun]	[hudˤnu]	“bosom, lap”
4.	/d̤ʒubn/	[d̤ʒubun]	[d̤ʒubnu]	“cowardliness”
5.	/ʔibn/	[ʔibin]	[ʔibnu]	“son”
6.	/dign/	[digin]	[dignu]	“chin”
7.	/taħn/	[taħin]	[taħnu]	“grinding”
8.	/faħn/	[faħin]	faħnu	“shipping, charging”
9.	/dufn/	[dufun]	[dufnu]	“fat, shortening”
10.	/d̤ʒifn/	[d̤ʒifin]	[d̤ʒifnu]	“eyelid”
11.	/tuxn/	[tuxun]	[tuxnu]	“obesity”
12.	/rukʌn/	[rukun]	[ruknu]	“corner”
13.	/ʕad̤ʒn/	[ʕad̤ʒin]	[ʕad̤ʒnu]	“making dough”
14.	/ʕazm/	[ʕazim]	[ʕazmu]	“determination”

15.	/luɤm/	[luɤum]	[luɤmu]	“mine”
16.	/radm/	[radim]	[radmu]	“filling, piling”
17.	/tagm/	[tagim]	[tagmu]	“set”
18.	/ħadm/	[ħadim]	[ħadmu]	“demolition, destruction”
19.	/ħadʕm/	[ħadʕim]	[ħadʕmu]	“digestion”
20.	/ʔism/	[ʔisim]	[ʔismu]	“name”
21.	/xuʃm/	[xuʃum]	[xuʃmu]	“nose”
22.	/ʃaħm/	[ʃaħim]	[ʃaħmu]	“fat”
23.	/laħm/	[laħim]	[laħmu]	“meat”
24.	/fiħm/	[fiħim]	[fiħmu]	“understanding”
25.	/rasm/	[rasim]	[rasmu]	“drawing”
26.	/daxm/	[daxim]	[daxmu]	“huge”
27.	/ħukm/	[ħukum]	[ħukmu]	“verdict, ruling”
28.	/xatm/	[xatim]	[xatmu]	“stamp, stamping”
29.	/latʕm/	[latʕim]	[latʕmu]	“slapping”
30.	/nadʒm/	[nadʒim]	[nadʒmu]	“star”
31.	/luʔm/	[luʔum]	[luʔmu]	“cunning”
32.	/ʃuʔm/	[ʃuʔum]	[ʃuʔmu]	“jinx”

(A-12) Epenthesis in Potential Voiced Fricative-Final Rising-Sonority Clusters

	Underlying Form	Surface Form	Possessed Form	Gloss
1.	/χubz/	[χubuz]	[χubzu]	“bread”
2.	/ħadʒz/	[ħadʒiz]	[ħadʒzu]	“booking, reservation”
3.	/ʕadʒz/	[ʕadʒiz]	[ʕadʒzu]	“disability, weakness”
4.	/χabz/	[χabiz]	[χabzu]	“baking”

5.	/wayɣz/	[wayɣiz]	[wayɣzu]	“pricking”
6.	/gafz/	[gafiz]	[gafzu]	“jumping”
7.	/lafzʕ/	[lafizʕ]	[lafzʕu]	“word”
8.	/tibɕ/	[tibiɕ]	[tibɕu]	“tobacco”
9.	/madʕɕ/	[madʕiɕ]	[madʕɕu]	“chewing”
10.	/ladɕ/	[ladiɕ]	[ladɕu]	“snake bite”
11.	/dabɕ/	[dabiɕ]	[dabɕu]	“tanning (leather)”
12.	/sʕabɕ/	[sʕabiɕ]	[sʕabɕu]	“dying (color)”
13.	/wadʒɸh/	[wadʒiɸh]	[wadʒɸhu]	“face”

(A-13) Final Glide Vocalization in Potential Consonant + Glide Clusters

	Underlying Form	Surface Form	Possessed Form	Gloss
1.	/ɸawj/	[ɸawi]	[ɸawju]	“grilling”
2.	/ɸawj/	[ɸawi]	[ɸawju]	“howling”
3.	/farw/	[farʕu]	[farʕwu]	“fur”
4.	/dalw/	[dalu]	[dalwu]	“bucket”
5.	/galj/	[gali]	[galju]	“frying”
6.	/ɕazw/	[ɕazu]	[ɕazwu]	“conquest”
7.	/laɕw/	[laɕu]	[laɕwu]	“chatter, small talk”
8.	/baɕj/	[baɕi]	[baɕju]	“oppression”
9.	/rabw/	[rabu]	[rabwu]	“asthma”
10.	/badw/	[badu]	[badwu]	“Bedouins”
11.	/naɸj/	[naɸi]	[naɸju]	“inhibition”
12.	/naɸw/	[naɸu]	[naɸwu]	“grammar”

(A-14) Vowel-Glide Coalescence in Hollow Noun and Adjective Roots

	Underlying Form	Gloss	Surface Form	Possessed Form	Related Form
1.	/bajʕ/	“sale”	[be:ʕ]	[be:.ʕu]	[baj.ja:ʕ] “salesperson”
2.	/χajr/	“blessing”	[χe:r]	[χe:.rʕu]	[aχ.ja:r] “blessing people”
3.	/χajl/	“horse, PL.”	[χe:l]	[χe:.lu]	[χaj.ja:l] “jockey”
4.	/layl/	“nighttime”	[le:l]	[le:.lu]	[la.ja:li] “nights”
5.	/bajt/	“house”	[be:t]	[be:.tu]	[bu.ju:t] “house, PL.”
6.	/bajdʕ/	“egg”	[be:dʕ]	[be:.dʕu]	[buju:dʕ] “egg, PL.”
7.	/ʕajm/	“cloud”	[ʕe:m]	[ʕe:.mu]	[ʕu.ju:m] “cloud, PL.”
8.	/lawn/	“color”	[lo:n]	[lo:.nu]	[al.wa:n] “color, PL.”
9.	/nawʕ/	“type, kind”	[no:ʕ]	[no:.ʕu]	[ʔan.wa:ʕ] “kinds”
10.	/mawd̪ʒ/	“wave”	[mo:d̪ʒ]	[mo:.d̪ʒu]	[am.wa:d̪ʒ] “wave, PL.”
11.	/mawt/	“death”	[mo:t]	[mo:.tu]	[am.wa:t] “dead people”
12.	/ħawdʕ/	“basin”	[ħo:dʕ]	[ħo:.dʕu]	[aħ.wa:dʕ] “basin, PL.”
13.	/lawħ/	“board”	[lo:ħ]	[lo:.ħu]	[al.wa:ħ] “board, PL.”

(A-15) Compensatory Lengthening with Glottal Stop

1.	/raʔs/	[ra:s]	“head”
2.	/faʔr/	[fa:r]	“mouse”
3.	/faʔs/	[fa:s]	“axe”
4.	/beʔr/	[bi:r]	“well”

(A-16) Verbal/Nominal Paradigm and the Realization of Underlying Medial Glides in HA and CA

a. Verbal Paradigm

Past 3P.MASC	Present 3P.MASC	Masdar	Gloss
[ba:ʕ]	[ji.bi:ʕ]	[be:ʕ]	“to sell”
[na:m]	[ji.na:m]	[no:m]	“to sleep”

b. Nominal Paradigm

Underlying Form	Gloss	Surface Form	Related Form
/bajʕ/	“sale”	[be:ʕ]	[baj.ja:ʕ] “salesperson”
/nawm/	“sleep (n)”	[no:m]	[naw.wa:m] “person who sleeps a lot”

(A-17) Verbal/Nominal Paradigm and the Realization of Underlying Final Glides in HA and CA

a. Verbal Paradigm

Past 3P.MASC	Present 3P.MASC	Masdar	Gloss
[sa.ʕa]	[jis.ʕa]	[sa.ʕi]	“to endeavor”
[ʕa.za]	[jiʕ.zu]	[ʕa.zu]	“to conquer”

b. Nominal Paradigm

Underlying Form	Gloss	Surface Form	Related Form
/saʃj/	“endeavor (noun)”	[sa.ʃi]	[saʃ.ju] “his endeavor”
/ʁazw/	“conquering (noun)”	[ʁa.zu]	[ʁaz.wu] “his conquering”

(A-18) ‘*ayn*-Final Potential Rising Sonority Coda Clusters

	Underlying	Gloss	Surface Form	Possessed Form
a.	/dirʃ/	“shield”	[diriʃ]	[dir.ʃu]
	/farʃ/	“branch”	[fariʃ]	[far.ʃu]
	/garʃ/	“pumpkin”	[gariʃ]	[garʃu]
b.	/balʃ/	“swallowing”	[baliʃ]	[bal.ʃu]
	/χalʃ/	“extracting”	[χaliʃ]	[χal.ʃu]
c.	/manʃ/	“forbidding, prohibiting”	[maniʃ]	[man.ʃu]
d.	/ʃamʃ/	“wax”	[ʃamiʃ]	[ʃam.ʃu]
	/samʃ/	“hearing”	[samiʃ]	[sam.ʃu]
	/damʃ/	“tear”	[damiʃ]	[damʃu]
e.	/nazʃ/	“extraction, taking away”	[naziʃ]	[naz.ʃu]
f.	/wad <sup>ʃ</sup> ʃ/	“position”	[wad <sup>ʃ</sup> iʃ]	[wad <sup>ʃ</sup> .ʃu]
	/radʃ/	“deterring”	[radiʃ]	[rad.ʃu]
	/rafʃ/	“raising”	[rafiʃ]	[raf.ʃu]

## (A-19) Words with Medial [ʕ] in Hijazi Arabic

	Underlying	Gloss	Surface Form	Possessed Form
a.	/siʕr/	“price”	[siʕir]	[siʕ.r <sup>ʕ</sup> u]
	/ʕiʕr/	“poem”	[ʕiʕir]	[ʕiʕ.r <sup>ʕ</sup> u]
	/gaʕr/	“bottom”	[gaʕar]	[gaʕ.r <sup>ʕ</sup> u]
	/ʕaʕr/	“hair”	[ʕaʕar]	[ʕaʕ.r <sup>ʕ</sup> u]
b.	/fiʕl/	“action, verb”	[fiʕil]	[fiʕ.lu]
	/naʕl/	“shoe”	[naʕil]	[naʕ.lu]
c.	/taʕn/	“stabbing”	[taʕin]	[taʕ.nu]
	/laʕn/	“cursing”	[laʕin]	[laʕ.nu]
d.	/daʕm/	“support”	[daʕim]	[daʕ.mu]
	/t <sup>ʕ</sup> aʕm/	“taste”	[t <sup>ʕ</sup> aʕim]	[t <sup>ʕ</sup> aʕ.mu]
e.	/waʕz <sup>ʕ</sup> /	“sermon”	[waʕz <sup>ʕ</sup> ]	[waʕ.z <sup>ʕ</sup> u]
f.	/kaʕk/	“cake”	[kaʕk]	[kaʕ.ku]
	/baʕd <sup>ʕ</sup> /	“some”	[baʕd <sup>ʕ</sup> ]	[baʕ.d <sup>ʕ</sup> u]
	/kaʕb/	“heel”	[kaʕb]	[kaʕ.bu]
	/ʕaʕb/	“people”	[ʕaʕb]	[ʕaʕ.bu]
	/daʕs/	“stepping-over, crashing”	[daʕs]	[daʕ.su]

## (A-20) Geminate Coda in HA

	Underlying	Surface	Gloss	1st Plural possessed
a.	/ħaj <sup>u</sup> :/	[ħajj]	“neighborhood, alive”	[ħaj.ja.na]
	/laj <sup>u</sup> :/	[lajj]	“hose”	[laj.ja.na]
	/d̥ʒaw <sup>u</sup> :/	[d̥ʒaww]	“weather, atmosphere”	[d̥ʒaw.wa.na]
b.	/ʃar <sup>u</sup> :/	[ʃarr]	“evil (noun)”	[ʃar.ra.na]
	/bar <sup>u</sup> :/	[barr]	“earth, ground”	[bar.ra.na]
	/χal <sup>u</sup> :/	[χall]	“vinegar”	[χal.la.na]
	/d <sup>ɕ</sup> il <sup>u</sup> :/	[d <sup>ɕ</sup> ill]	“shadow”	[d <sup>ɕ</sup> il.la.na]
c.	/fan <sup>u</sup> :/	[fann]	“art”	[fan.na.na]
	/bun <sup>u</sup> :/	[bunn]	“coffee beans”	[bun.na.na]
	/dam <sup>u</sup> :/	[damm]	“blood”	[dam.ma.na]
	/fiam <sup>u</sup> :/	[fiamm]	“sadness”	[fiam.ma.na]
d.	/ħaz <sup>ɕ</sup> z <sup>ɕ</sup> :/	[ħaz <sup>ɕ</sup> z <sup>ɕ</sup> ]	“fortune”	[ħaz <sup>ɕ</sup> .z <sup>ɕ</sup> a.na]
	/ruz <sup>u</sup> :/	[r <sup>ɕ</sup> uzz]	“rice”	[r <sup>ɕ</sup> uz.za.na]
	/ʕiz <sup>u</sup> :/	[ʕizz]	“glory”	[ʕiz.za.na]
e.	/χad <sup>u</sup> :/	[χadd]	“cheek”	[χad.da.na]
	/rab <sup>u</sup> :/	[rabb]	“God”	[rab.ba.na]
	/bag <sup>u</sup> :/	[bagg]	“bug”	[bag.ga.na]
	/ʃak <sup>u</sup> :/	[ʃakk]	“doubt”	[ʃak.ka.na]
	/kaf <sup>u</sup> :/	[kaff]	“palm”	[kaf.fa.na]
	/bat <sup>ɕ</sup> :/	[bat <sup>ɕ</sup> t <sup>ɕ</sup> ]	“ducks”	[bat <sup>ɕ</sup> .t <sup>ɕ</sup> a.na]
	/faχ <sup>u</sup> :/	[faχχ]	“trap”	[faχ.χa.na]
	/diʃ <sup>u</sup> :/	[diʃʃ]	“(satellite) dish”	[diʃ.ʃa.na]
	/ʕus <sup>ɕ</sup> :/	[ʕus <sup>ɕ</sup> s <sup>ɕ</sup> ]	“tailbone”	[ʕus <sup>ɕ</sup> .s <sup>ɕ</sup> a.na]

/χas <sup>h</sup> :/	[χass]	“lettuce”	[χas.sa.na]
/ʃu <sup>h</sup> :/	[ʃu <sup>h</sup> h]	“miserliness”	[ʃu <sup>h</sup> .ha.na]

**Appendix B: Sonority-driven Epenthesis, High Vowel Spreading, and Consonant-to-Vowel Harmony in HA**

(B-1) High Vowel Spreading in Rising Potential Coda Clusters

	Underlying	Gloss	Surface	Possessive
a.	/bizr/	“seed”	[bi.zir]	[biz.r <sup>s</sup> u]
	/fit <sup>r</sup> /	“mushroom”	[fi.t <sup>r</sup> ir]	[fit <sup>r</sup> .r <sup>s</sup> u]
	/295ird/	“pot”	[gi.dir]	[gid.r <sup>s</sup> u]
	/ħibr/	“ink”	[ħi.bir]	[ħib.r <sup>s</sup> u]
	/sihr/	“magic, sorcery”	[si.ħir]	[siħ.r <sup>s</sup> u]
	/fiʕl/	“verb, action”	[fi.ʕil]	[fiʕ.lu]
	/ʔism/	“name”	[ʔi.sim]	[ʔis.mu]
	/dign/	“chin”	[digin]	[dignu]
	/ʔibn/	“son”	[ʔibin]	[ʔib.nu]
b.	/ʃukr/	“thanks”	[ʃu.kur <sup>s</sup> ]	[ʃuk.r <sup>s</sup> u]
	/dʒuħr/	“burrow, den”	[dʒu.ħur <sup>s</sup> ]	[dʒuħ.r <sup>s</sup> u]
	/ħukm/	“verdict, ruling”	[ħu.kum]	[ħuk.mu]
	/ħuzn/	“sadness”	[ħu.zun]	[ħuz.nu]
	/ʃuʁl/	“work”	[ʃu.ʁul]	[ʃuʁ.lu]
	/ħud <sup>s</sup> n/	“bosom, lap”	[ħu.d <sup>s</sup> un]	[ħud <sup>s</sup> .nu]
	/ruk <sup>n</sup> /	“corner”	[r <sup>s</sup> u.kun]	[r <sup>s</sup> uk.nu]
	/χuʃm/	“nose”	[χu.ʃum]	[χuʃ.mu]
	/duf <sup>n</sup> /	“fat”	[du.fun]	[duf <sup>n</sup> .nu]

(B-2) Coronal Consonant-Vowel Harmony

	Underlying	Gloss	Surface	Possessive.3P.M
a.	/makr/	“cunning”	[ma.kir]	[mak.r <sup>ʕ</sup> u]
	/fagr/	“poverty”	[fa.gir]	[fag.r <sup>ʕ</sup> u]
	/gabr/	“grave, grave site”	[ga.bir]	[gab.r <sup>ʕ</sup> u]
	/tamr/	“date (fruit)”	[ta.mir]	[tam.ʕru]
b.	/sahl/	“valley”	[sa.fil]	[saf.lu]
	/ħabl/	“rope”	[ħa.bil]	[ħab.lu]
	/ħagl/	“field, meadow”	[ħa.gil]	[ħag.lu]
	/ʃakl/	“shape, appearance”	[ʃa.kil]	[ʃak.lu]
c.	/laʕn/	“cursing”	[la.ʕin]	[laʕ.nu]
	/ħagn/	“injection”	[ħa.gin]	[ħag.nu]
	/laħn/	“melody”	[la.ħin]	[laħ.nu]
	/rakn/	“putting in the corner, cornering”	[ra.kin]	[rak.nu]
	/dafn/	“(act of) painting”	[da.fin]	[daf.nu]
	/rafn/	“collateral”	[ra.fin]	[raf.nu]
	/ʁabn/	“injustice”	[ʁa.bin]	[ʁab.nu]
d.	/χabz/	“baking”	[χa.biz]	[χab.zu]
	/lafz <sup>ʕ</sup> /	“word”	[la.fiz <sup>ʕ</sup> ]	[laf.z <sup>ʕ</sup> u]

(B-3) Potential Coda Clusters with Pharyngeal Consonant-to-Vowel Harmony

	Underlying	Gloss	Surface	Possessive.3P.M
a.	/ʃaħr/	“month”	[ʃa.ħar <sup>ʕ</sup> ]	[ʃaħ.r <sup>ʕ</sup> u]
	/naħr/	“river”	[na.ħar <sup>ʕ</sup> ]	[naħ.r <sup>ʕ</sup> u]
	/maħr/	“dowry”	[ma.ħar <sup>ʕ</sup> ]	[maħ.r <sup>ʕ</sup> u]
b.	/baħr/	“sea”	[ba.ħar <sup>ʕ</sup> ]	[baħ.r <sup>ʕ</sup> u]
c.	/ʃaħr/	“hair”	[ʃa.ħar <sup>ʕ</sup> ]	[ʃaħ.r <sup>ʕ</sup> u]

(B-4) Potential Coda Clusters with Plain [r] and Emphatic [r<sup>ʕ</sup>]

	Underlying	Gloss	Surface	<i>Nisba</i> Adjective	<i>Nisba</i> Gloss
a.	/nabr/	“tone, accent”	[na.bir]	[nab.ri]	“tonal, accentuated”
	/kasr/	“fracture”	[ka.sir]	[kas.ri]	“fractional”
	/fikr/	“thought”	[fi.kir]	[fik.ri]	“intellectual”
	/s <sup>ʕ</sup> aħr/	“rock, stone”	[s <sup>ʕ</sup> a.ħir]	[s <sup>ʕ</sup> aħ.ri]	“stony, rocky”
b.	/d̤zuħr/	“burrow”	[d̤zu.ħur <sup>ʕ</sup> ]	[d̤zuħ.ri]	“related to burrows”
	/ħuzr/	“apology”	[ħu.zur <sup>ʕ</sup> ]		
c.	/ʃaħr/	“month”	[ʃa.ħar <sup>ʕ</sup> ]	[ʃaħ.ri]	“monthly, lunar”
	/baħr/	“sea”	[ba.ħar <sup>ʕ</sup> ]	[baħ.ri]	“naval, nautical, marine”

(B-5) [r] / [r <sup>s</sup> ] Consonant-to-Vowel Harmony					
	Underlying	Gloss	Surface	Possessive.3P.MAS C	Possessive.1P.SG
a.	i. /ḍʒadr/ ii. /ḍʒadr <sup>s</sup> /	“wall”	i. [ḍʒa.dir] ii. [ḍʒa.dur <sup>s</sup> ]	[ḍʒad.r <sup>s</sup> u] “his wall”	[ḍʒad.ri] “my wall”
b.	i. /badr/ ii. /badr <sup>s</sup> /	“full moon / Proper Name”	i. [ba.dir] ii. [ba.dur <sup>s</sup> ]	[bad.r <sup>s</sup> u] “his full moon / Proper Name”	[bad.ri] “my full moon / Proper Name”
c.	i. /s <sup>s</sup> adr/ ii. /s <sup>s</sup> adr <sup>s</sup> /	“chest/breast”	i. [s <sup>s</sup> a.dir] ii. [s <sup>s</sup> a.dur <sup>s</sup> ]	[s <sup>s</sup> ad.r <sup>s</sup> u] “his chest/breast”	[s <sup>s</sup> ad.ri] “my chest/breast”
d.	i. /s <sup>s</sup> agr/ ii. /s <sup>s</sup> agr <sup>s</sup> /	“falcon”	i. [s <sup>s</sup> a.gir] ii. [s <sup>s</sup> a.gur <sup>s</sup> ]	[s <sup>s</sup> ag.r <sup>s</sup> u] “his falcon”	[s <sup>s</sup> ag.ri] “my falcon”
e.	i. /gabr/ ii. /gabr <sup>s</sup> /	“grave”	i. [ga.bir] ii. [ga.bur <sup>s</sup> ]	[gab.r <sup>s</sup> u] “his grave”	[gab.ri] “my grave”
f.	i. /faḍʒr/ ii. /faḍʒr <sup>s</sup> /	“dawn, morning”	i. [fa.ḍʒir] ii. [fa.ḍʒur <sup>s</sup> ]	[faḍʒ.r <sup>s</sup> u] “his dawn, morning”	[faḍʒ.ri] “my dawn, morning”
g.	i. /nas <sup>s</sup> r/ ii. /nas <sup>s</sup> r <sup>s</sup> /	“victory”	i. [na.s <sup>s</sup> ir] ii. [na.s <sup>s</sup> ur <sup>s</sup> ]	[nas <sup>s</sup> .r <sup>s</sup> u] “his victory”	[nas <sup>s</sup> .ri] “my victory”
h.	i. /fagr/ ii. /fagr <sup>s</sup> /	“poverty”	i. [fa.gir] ii. [fa.gur <sup>s</sup> ]	[fag.r <sup>s</sup> u] “his poverty”	[fag.ri] “my poverty”
i.	i. /bakra/ ii. /bakra <sup>s</sup> /	“proper name”	i. [ba.kir] ii. [ba.kur <sup>s</sup> ]	[bak.r <sup>s</sup> u] “his Bakir/Bakur”	[bak.ri] “his Bakir/Bakur”
j.	i. /ʔamr/ ii. /ʔamr <sup>s</sup> /	“order”	i. [ʔa.mir] ii. [ʔa.mur <sup>s</sup> ]	[ʔam.r <sup>s</sup> u] “his order”	[ʔam.ri] “my order”

(B-6) Default Sonority-Driven Epenthesis

	Underlying	Gloss	Surface	Possessive.3P.M
a.	/lakm/	“punching”	[la.kim]	[lak.mu]
b.	/t <sup>ʰ</sup> agm/	“set (of things)”	[t <sup>ʰ</sup> a.gim]	[t <sup>ʰ</sup> ag.mu]
c.	/famʃ/	“wax”	[fa.miʃ]	[fam.ʃu]
d.	/fagʃ/	“type of mushroom”	[fa.giʃ]	[fag.ʃu]
e.	/fatm/	“cursing”	[fa.tim]	[fat.mu]
f.	/nadʒm/	“star”	[na.dʒim]	[nadʒ.mu]
g.	/wafm/	“tattoo”	[wa.fim]	[waf.mu]

(B-7) Incomplete Pharyngeal Consonant-to-Vowel Harmony

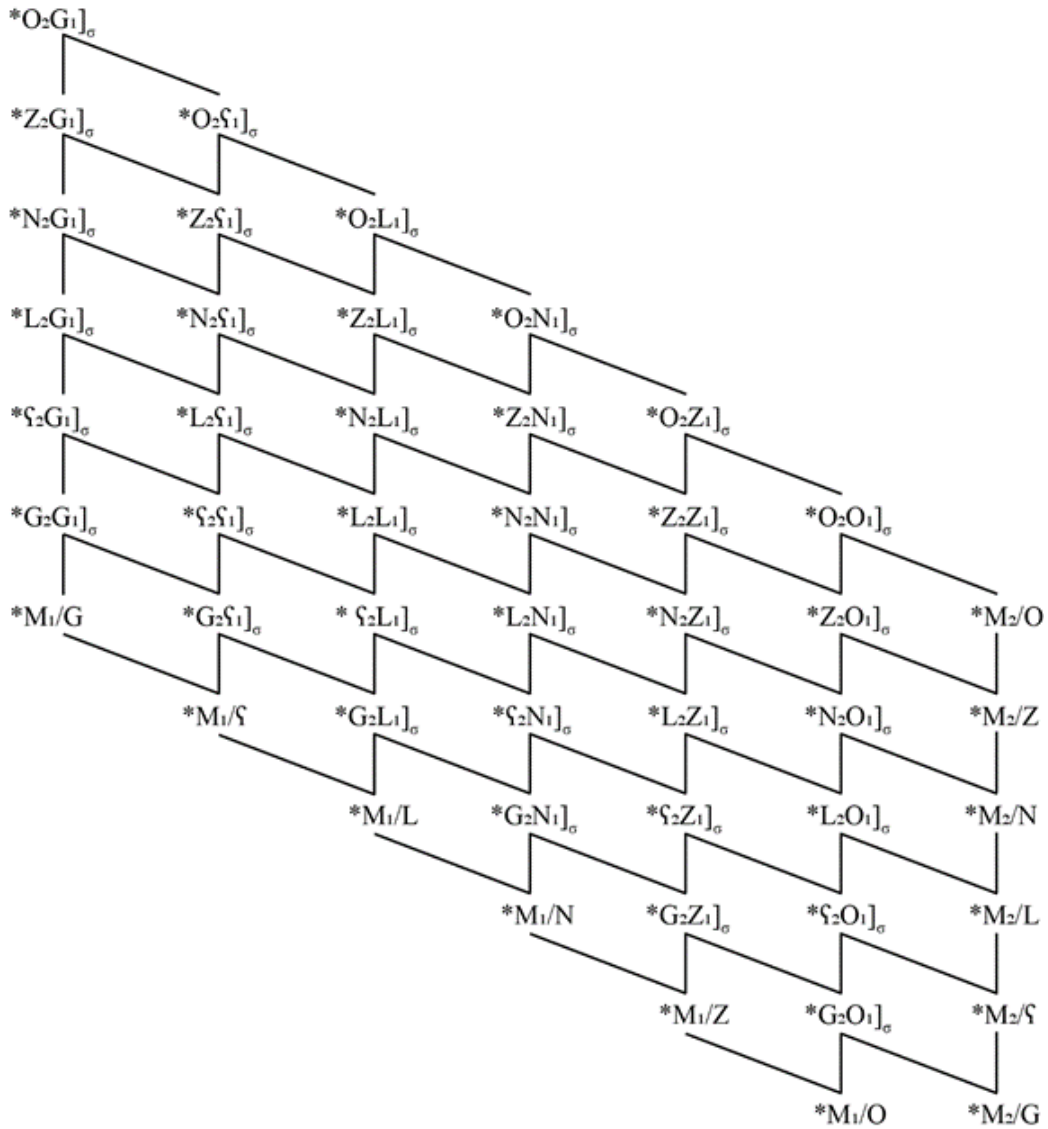
	Underlying	Gloss	Typical Surface	Atypical	Possessive.3P.M
	/laħm/	“meat”	[la.ħim]	[la.ħam]	[laħ.mu]
	/t <sup>ʰ</sup> aʃm/	“taste”	[t <sup>ʰ</sup> a.ʃim]	[t <sup>ʰ</sup> a.ʃam]	[t <sup>ʰ</sup> aʃ.mu]
	/safm/	“arrow”	[sa.fim]	[sa.fam]	[saf.mu]
	/fafm/	“noble, chivalrous”	[fa.fim]	[fa.fam]	[faf.mu]
	/wafm/	“illusion, delusion”	[wa.fim]	[wa.fam]	[waf.mu]

## Appendix C: OT Constraints

(C-1) \*M<sub>1</sub>/Glide & \*M<sub>2</sub>/Obs]<sub>σ</sub>:

“A coda may not contain a glide in M<sub>1</sub> and an obstruent in M<sub>2</sub>. Assign a violation if a glide occurs in M<sub>1</sub> within a coda and an obstruent occurs in M<sub>2</sub> within the same coda.”

(C-2) Hasse Diagram of Conjoined \*M<sub>2</sub> and \*M<sub>1</sub> Hierarchies in Hijazi Arabic.



(C-3) IDENTITY[sonorant]-IO (ID-[son]):

“Correspondent segments in the input have identical values for the feature [±sonorant] in the output (Kager, 1999, p. 250). Assign a violation any time an output consonant has a different value for [±sonorant] than its corresponding input segment.”

(C-4) DEPENDENCY-IO (DEP):

“Output segments must have input correspondents (Kager, 1999, p. 101). Assign a violation for the epenthesis of a segment.”

(C-5) MAXIMALITY-IO (MAX):

“Every element of the input must have a correspondent in the output (Kager, 1999, p. 205). Assign a violation for the deletion of a segment.”

(C-6) RIGHT-ANCHOR-IO (ANCHOR):

“Any element at the right periphery of the input has a correspondent at the right periphery of the output (Kager, 1999, p. 251). Assign a violation for epenthesis or deletion at the right edge of a form.”

(C-7) CONTIGUITY-IO (CONTIG):

“Elements adjacent in the input must be adjacent in the output (Gouskova, 2001, p. 178). Assign a violation for any epenthesis or deletion between segments (i.e., no medial epenthesis or deletion).”

(C-8) OBLIGATORY CONTOUR PRINCIPLE – [SONORANT, CORONAL] (OCP-[SON, COR]):

“Two segments with the features [+coronal] and [+sonorant] cannot be adjacent in the output of the syllable coda. Assign a violation for any two [+coronal, +sonorant] consonants which are adjacent in the output of the syllable coda.” (Kabrah, 2004, p. 190; see also Davis & Shin, 1999, for a similar constraint in Korean).

(C-9) OBLIGATORY CONTOUR PRINCIPLE – [NASAL] (OCP-[NAS]):

“Two consonants with the feature [nasal] cannot be adjacent in the output of the syllable coda. Assign a violation for any two [nasal] consonants which are adjacent in the output of the syllable coda.” (Kabrah, 2004, p. 190)

(C-10) MASDAR-TEMPLATE-SATISFACTION (MTS):

“The output must match the prosodic shape of the *masdar* template, CVCVC. Assign a violation for any *masdar* in the output which is not of the prosodic shape CVCVC.”

(C-11) IDENT-IO-V (IDENT-V):

“A vowel in the output must be identical to its correspondent in the input. Assign a violation for any vowel in the output which differs from its correspondent in the input.”

(C-12) ANCHOR-IO-RIGHT (ANCHOR):

“Any element at the right periphery of the input has a correspondent at the right periphery of the output (Kager, 1999, p. 251). Assign a violation for epenthesis or deletion at the right edge of a form.”

(C-13) IDENTITY[sonorant]-IO (ID-[son]):

“Correspondent segments in the input have identical values for the feature [ $\pm$ sonorant] in the output (Kager, 1999, p. 250). Assign a violation any time an output consonant has a different value for [ $\pm$ sonorant] than its corresponding input segment.”

(C-14) NO-DIPH (Rosenthal, 1994, p. 21; 2006, p. 410; Trask, 1996, p. 114; McCarthy, 2008, p. 229):

“No diphthongs. Assign a violation for any two vowels of nonidentical quality which occur in a single syllabic nucleus in the output.”

(C-15) IDENTITY-[FEAT]-[VOCALIC] (ID-[F]-[VOC]) (Kager, 1999):

“Assign a violation for any segment in the output which has a different value for [ $\pm$ vocalic] from its correspondent in the input.”

(C-16) NO-WEAK-CLUSTER (\*M<sub>2</sub>G<sub>1</sub>]<sub>σ</sub>):

“No glides in the M<sub>1</sub> position of a coda cluster. Assign a violation mark for any glide which occurs in M<sub>1</sub> position in the coda cluster.”

(C-17) MAX-VOCOID-[PLACE-FEATURE] (MAX-V-[F]):

“The place features associated with vocoids in the input must have correspondents in the output. Do not delete a place feature from a vowel or glide. Assign a violation mark for any vowel or glide place feature which is deleted.”

(C-18) AGREE-VOWEL-PLACE (AGREE-V-PLACE):

“Adjacent tautosyllabic vowels agree in Place. Assign a violation for any place feature in the output which is not shared between adjacent vowels in a syllable.”

(C-19) \*MIDVOWEL:

“A word stem does not surface with a mid vowel. Assign one violation for any mid vowel occurring in a word stem.”

(C-20) NOHOLLOWCLUSTER (\*G<sub>2</sub>M<sub>1</sub>]<sub>σ</sub>):

“No hollow coda clusters. Assign a violation for any glide which occurs in M<sub>2</sub> position in a coda cluster.”

(C-21) OCP-[HIGH]:

“No two adjacent [high] features in a syllable rhyme. Assign a violation any time two adjacent [high] features occur in a syllable rhyme.”

(C-22) CODA CONDITION (\*[ɣ]<sub>Co</sub>):

“No [ɣ] in a syllable coda. Assign a constraint violation for every segment [ɣ] which occurs in a syllable coda in the output (reformulated from McCarthy, 1994). This constraint does not target stem or word-final [ɣ].”

(C-23) \*COMPLEX<sup>ONS</sup> (\*<sub>σ</sub>[CC]):

“Onsets are simple (Kager, 1999, p. 97).”

(C-24) OBLIGATORY CONTOUR PRINCIPLE-[sonorant] (OCP-[son]):

“Two consonants with the feature [+sonorant] cannot be adjacent in the syllable rhyme of the output. Assign a violation for any two [+sonorant] consonants which are adjacent in the syllable rhyme in the output (adapted from Kabrah, 2004, p. 190).”

(C-25) \*[ɣ]<sub>Co</sub> & OCP-[son]:

“No [ɣ] followed by a sonorant consonant in a coda cluster. Assign a violation any time [ɣ] is followed by a sonorant consonant in a coda cluster.”

(C-26) GEMINATE-INTEGRITY (GEM-INTEG):

“A geminate consonant cannot be split. Assign a violation for any geminate that is split via an epenthetic vowel (modified from Noamane 2018, p. 146).”

(C-27) \*DEGEMINATION (\*DEGEM):

“An underlying geminate consonant cannot be degeminated in the surface form occupying only one timing slot. Assign a violation when an underlying geminate is degeminated in the surface form, occupying only one C-slot.”

(C-28) MAX- $\mu$ -GEMINATE (MAX- $\mu$ -GEM):

“An underlying mora associated with a geminate consonant in the input must have a correspondent in the output. Do not delete a mora from a geminate consonant in the output. Assign a violation mark for a mora which is deleted from a geminate consonant in the output.”

(C-29) OBLIGATORY CONTOUR PRINCIPLE (OCP):

“Adjacent identical elements are prohibited. Assign a violation for any two identical consonants which are adjacent in the output.” (Leben 1973, Myers and Carleton 1996, p. 48)

(C-30) \*WORDFINALGEMINATEGLIDE (\*FGEMG):

“Word-final geminate glides are not allowed to surface. Assign a violation any time that a geminate glide surfaces word-finally.”

(C-31) \*GEM-SPLIT:

“Root-final geminate does not split. Assign a violation any time a root-final geminate splits into two syllables in the surface form.”

(C-32) MINIMUMWORD (MINWORD):

“The minimum word is bimoraic. Assign a violation any time when a word surfaces with fewer than two moras (adapted from Borowsky and Harvey 1997).”

(C-33) ONSET:

“Syllables must have onsets. Assign a violation any time a syllable surfaces with no onset (Prince and Smolensky 1993).”

(C-34) SPREAD-[front]:

“For any vowel in a word linked to a [front] autosegment, that same [front] autosegment must also be associated to all other vowels in the word. Assign a violation for any [front] autosegment that is not associated to all vowels in the word.”

(C-35) SPREAD-[back]:

“For any vowel in a word linked to a [back] autosegment, that same [back] autosegment must also be associated to all other vowels in the word. Assign a violation for any [back] autosegment that is not associated to all vowels in the word.”

(C-36) IDENT-IO(Vowel):

“Let  $\alpha$  be a vowel in the input and  $\beta$  be a correspondent of  $\alpha$  in the output; then  $\alpha$  and  $\beta$  have identical featural specifications. Assign a violation for any discrepant featural specification between  $\alpha$  and  $\beta$ .”

(C-37) UNIFORM-[front]/[back] (adapted from Walker, 2001, p. 848):

“A [front] or [back] autosegment may not be multiply-linked to vowels that are distinctly specified for height.”

(C-38) AGREE-FEAT-CORONAL (AGREE-F-COR):

“Segments immediately preceding and tautosyllabic with a coronal consonant must agree with it in the feature [coronal]. Assign a violation for any segment in the output which immediately precedes and is tautosyllabic with a coronal consonant and does not share the feature [coronal].”

(C-39) IDENT-IO-PHONEME (IDENT-IO-PHON):

“A segment’s phonemic value in the output must be identical to its correspondent in the input. Assign a violation for any segment in the output which differs from its correspondent in the input in its phonemic value.”

(C-40) AGREE-FEAT-DORSAL-[r<sup>s</sup>] (AGREE-F-DORS-[r<sup>s</sup>]):

“Segments adjacent to and tautosyllabic with [r<sup>s</sup>] must agree with it in the feature [dorsal]. Assign a violation for any segment in the output which is adjacent to and tautosyllabic with [r<sup>s</sup>] and does not agree with it in the feature [dorsal].”

(C-41) MAX-V-PLACE:

“The V-Place feature (secondary place of articulation) associated with a consonant in the input must have a correspondent in the output. Do not delete a V-Place feature (secondary place of articulation) from a consonant. Assign a violation mark for any secondary place of articulation feature which is deleted from a consonant in the output.”

(C-42) AGREE-FEAT-PHARYNGEAL-[r<sup>s</sup>] (AGREE-F-PHAR-[r<sup>s</sup>]):

“Segments adjacent to and tautosyllabic with [r<sup>s</sup>] must agree with it in the feature [pharyngeal]. Assign a violation for any segment in the output which is adjacent to and tautosyllabic with [r<sup>s</sup>] and does not agree with it in the feature [pharyngeal].”

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