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The Analysis of Coda Clusters in Jizani Arabic: An OT Perspective

Raneem Bosli[1,2] & Lynne Cahill[2]

[1] English Department, Arts and Humanities Faculty, Jazan University, Saudi Arabia

[2] English Department, School of Media, Arts and Humanities, University of Sussex, United Kingdom

Correspondence: Raneem Bosli, English Department, School of Media, Arts and Humanities, University of Sussex, Brighton BN1 9RH, United Kingdom. E-mail: rb531@sussex.ac.uk

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Abstract

This paper explains how native speakers of Jizani Arabic (henceforth, JA) treat final consonant clusters in superheavy syllables (CVCC) using a parallel Optimality Theory (Prince & Smolensky, 1993, 2004) to show how the theory can account for the cross-linguistic variations of coda clusters through the ranking of different constraints. JA is a Saudi dialect spoken in the southwestern part of Saudi Arabia in Jizan city. It is common among many Saudi Arabic dialects like Najdi, Hijazi, Taifi and Qassimi that rising sonority in coda clusters is avoided by using vowel epenthesis to comply with the Sonority Sequencing Principle (henceforth, SSP), where there is no difference between nasals and liquids. However, in JA, we observe that vowel epenthesis occurs only if the last segment in CVCC is a liquid (/l/ or /ɾ/); for instance, /tˤifl/→ [tˤifil] 'child' and /ħibɾ/→ [ħibiɾ] 'ink'. The vowel has been epenthesized because the last consonant in both examples is more sonorous than the preceding obstruents. However, the vowel will not be inserted if the final consonant is a nasal preceded by an obstruent; for instance, /laħm/→[laħm] 'meat' and /gutˤn/→[gutˤn] 'cotton'. Although the universal sonority scale ranks nasals as more sonorous than obstruents, nasals in JA behave as they are equally sonorous as obstruents. In other words, nasals in this dialect group with stops and fricatives in the sonority scale.

Keywords: syllable structure, Jizani Arabic, coda clusters, sonority constraints, vowel epenthesis

1. Introduction

There are three linguistic varieties of Arabic: Classical Arabic (CA), Modern Standard Arabic (MSA) and Colloquial Arabic. CA is the language of the Holy Quran and old Arabic literature, and it is no longer the native language of any Arabic speaker. MSA is considered the modernised version of CA (Al-Ani, 1970), and it is the language used in schools and many official situations such as Academic lectures, journals, TV news, radio, conferences, and official meetings. In turn, Colloquial Arabic or regional Arabic dialects are spoken in different regions of the Arab world. It is acquired as a mother tongue and used in all informal communication, among family members and friends and in daily communication. The paper here seeks to analyse the syllable structure (CVCC) of Jizani Arabic (henceforth, JA) using a parallel Optimality Theory (hereafter, OT) (Prince & Smolensky, 1993, 2004). JA is a Saudi dialect spoken in the southwestern part of the Kingdom of Saudi Arabia in Jizan city which is considered the capital of Jazan province.

Although there are at least three published papers on Jazani Arabic (Durvasula, Ruthan, Heidenreich, & Lin, 2021; Hamdi, 2015; Ruthan, Durvasula, & Lin, 2019), the data were different from the data that this paper provides, and the analyses of those papers are different, too. Those papers did not use Optimality Theory (Prince & Smolensky, 1993, 2004) to analyse syllable structure of JA. Hamdi (2015) described in his paper the phonological aspects of Jizani Arabic including glottal stop deletion, /m/ neutralisation in suffix final position, and /m/ insertion in the definite article, but he did not account for the analysis of superheavy syllable (CVCC) in JA. The data used in (Durvasula et al., 2021; Ruthan et al., 2019) were from Samtah governorate in Jazan region on the Yemen boarder, but not from Jizan city where the data this paper analyse. There is no single study in the available literature that provides an OT analysis for the coda clusters in this dialect and this dialect is not documented phonologically.

We claim that the treatment of final clusters differs based on the sonority class of the segments (nasals and liquids). This study attempts to analyse the combination of consonants in coda position in terms of sonority. The data of this paper is based on analysing the recording of Jizani speakers reading a word list that has different types of sonority for the consonants in coda position. The data was free from any diacritics (*kasra*, *damma* and *fatħa*)

that used in Arabic orthography (Arabic script) to indicate a short vowel to ensure that the participants' pronunciation was not influenced by Arabic writing.

The remainder of this paper is structured as follows. In Section 2, the phonemic inventory of JA is discussed briefly, including consonants, vowels, diphthongs, and the distribution of syllables. Section 3 provides some information about the data of this paper and the participants. The coda clusters is explained in Section 4 in terms of sonority. Section 5 is dedicated to the OT analysis of coda clusters in JA with the consideration of the contrast between liquids and nasals. Finally, Section 6 offers the concluding remarks of this paper.

2. Phonemic Inventory in JA

2.1 Consonants

According to Ruthan (2020) who studied phonological aspect of Samti Jazani Arabic, JA has 25 consonantal phonemes in different places of articulation lacking /θ/ and /ð/ as well as /ðˤ/, compared with MSA. In JA, the fricative phonemes /θ/, /ð/ and /ðˤ/ are replaced by stops /t/, /d/ and /dˤ/, respectively (Ruthan, 2020). The speakers of Jizan city and the Farasan Islands alternate between [θ] and [t], [ð] and [d], and [ðˤ] and [dˤ]. That is, fricatives are found in formal setting speech, while stops are in informal speech.

According to Mustafawi (2018), the alternation between fricatives to stops is common in languages and they could be the result of early Aramaic influence in the East's major cities. The same alternation occurs in Hijazi Arabic (Alfaifi, 2019; Bokhari, 2020), Egyptian Arabic and Maghrebi Arabic where the speakers of those dialects replace /θ/, /ð/ and /ðˤ/ with /t/, /d/ and /dˤ/, respectively (Mustafawi, 2018). The following examples are quoted from Ruthan (2020) to show the alternations between fricatives and stops in JA.

Table 1. Sound alternations in JA

Sound alternations	MSA	JA	Translation
θ~t	[θo:m]	[tom]	'garlic'
ð~d	[ða:b]	[da:b]	'melted'
ðˤ~dˤ	[naðˤðˤa:rah]	[nadˤdˤa:rah]	'eyeglasses'

The rest of the consonantal phonemes are counterparts of those in MSA. However, Jizani native speakers replace MSA /q/ with /g/, which is characterised as a voiced velar stop. Replacing /q/ with /g/ is considered one of the key phonological features that characterise Bedouin dialects generally (Versteegh, 1997). This alternation is found in many Arabic dialects like Najdi (Alqahtani, 2014), Hijazi (Bokhari, 2020), Taifi (Al-Mohanna, 1994) and Qassimi (Al Motairi, 2015). The consonantal phonemes of JA are given in Table 2, organised by place and manner of articulation. The right consonant in the table is voiced, while the left one is voiceless.

Table 2. Phonemic inventory of JA

	Bilabials	Labio-dental	Dental	Alveolar	Post alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal
Stops	b			t d			k g			ʔ
Emphatic stop				tˤ dˤ						
Fricatives		f			s z	ʃ		x ɣ	ħ ʕ	h
Emphatic fricative					sˤ					
Affricate						ʤ				
Nasals	m				n					
Lateral					l					
Flap					ɾ					
Glides	w					j				

We observed in Ruthan's phonemic inventory (2020) of Samti Jazani Arabic that he considered the rhotic to be a trill. However, based on linguistic knowledge, observation, experience, and native intuition of one of the co-authors, we consider /r/ to be flap instead of trill in JA.

2.2 Vowels and Diphthongs

Regarding the vowels, all the vowels in Arabic are considered oral and fully voiced (Newman, 2002). JA has eight vowels in its inventory. All modern dialects of Arabic have at least three long vowels (Watson, 2002). That is true in this dialect, which has three long vowels /a:, i:, u:/ and three short vowels /a, i, u/. The short vowels are represented in the orthography by using diacritics in Arabic. The difference between short and long vowels is not in vowel quality (the frequencies emphasised in articulation) but in quantity (duration of the vowel). There are also two long mid vowels /e:/ and /o:/, corresponding to the two diphthongs /aj/ and /aw/ in MSA, respectively. So, the two diphthongs monophthongise to long mid vowels /e:/ and /o:/. The vowels of JA are shown in Figure 1. Then, Table 3 gives an example of each vowel from this dialect.

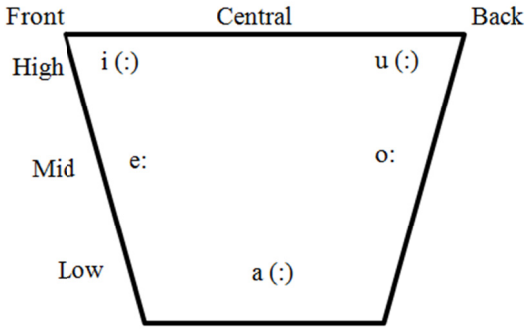

Figure 1. The vowel phonemes in JA

Table 3. Examples of vowels in JA

Type of a vowel	Example	Translation
/i/	[bint]	'girl'
/i:/	[ħali:b]	'milk'
/a/	[ħarb]	'war'
/a:/	[ga:l]	'He said'
/u/	[gutˁn]	'cotton'
/u:/	[gu.ru:d]	'monkeys'
/e:/	[be:t]	'house'
/o:/	[sˁo:m]	'fast'

2.3 The Distribution of Syllable Structure in JA

The syllable types found in this dialect are not very different from those in MSA. All Arabic dialects have universal light syllable CV and heavy syllables CVC and CVV (Farwaneh, 1995). However, the distribution of superheavy syllables CVVC and CVCC is more restricted. A dot is used to indicate syllable boundaries. Thus, the syllable types found in JA are:

1) CV	as in	[sa.na:]	'a year'
2) CVV	as in	[ka:.tib]	'writer. M'
3) CVC	as in	[lik]	'for you. F'
4) CVVC	as in	[jo:m]	'a day'
5) CVCC	as in	[gabl]	'before'
6) CVVG	as in	[ʕa:mm]	'general'

The syllables CV, CVC and CVV are unmarked syllables in terms of distribution since they occur in initial, medial, and final positions. However, it should be mentioned that these types of superheavy syllables, CVCC and CVVC, restricted to the word-final position in JA (marked syllables) as in MSA (Al-Ani 1970), Najdi Arabic (Alqahtani, 2014), Cairene Arabic (Boselow, 1976) and Madinah Hijazi Arabic (Jarrah, 1993), to name just a few.

In syllable CVVG, G stands for geminates. When the consonants are doubled in pronunciation, they are called

geminates. In Arabic, geminates are represented orthographically by one letter and a certain diacritic above. This diacritic is called '*shadda*', and it is symbolised as ◌ّ. These consonants are longer in duration, and they do not lose their strength in connected speech. In MSA and many Arabic dialects, including JA, geminates tend to occur in word-medial and word-final positions like [xaz.za:n] 'tank' and [ħagg] 'right'.

3. Participants and Recording

To analyse coda clusters in JA, we recruited 20 native speakers of JA. The participants were born and raised in Jizan city and using JA for everyday conversations. We confirmed that the participants were from Jizan city and never left the area for a long time to minimise any social factors that might affect the participants' pronunciation. They were informally interviewed to confirm that they spoke naturally and did not have speech problems. The participants were from both genders. Ten of them were female and the other ten were male between 20–45. They are all educated, and the education level of the participants was varied. To analyse consonant clusters in coda position -CC of JA, we prepared sixty real words that used frequently in Jizan city. These words end with different types of consonants based on sonority (see Appendix A). We asked each participant to read the list twice using JA, not MSA. We used Olympus DS-9500 voice recorder to record the data from the participants in Jizan city. After data collection, we transcribed the words using the IPA convention. Transcription of the collected data is, therefore, done manually by the researchers after listening many times to the recordings. Then, we analysed these words phonologically, focusing on the combination of consonants in coda position in this dialect.

4. Coda Clusters and Sonority in JA

Cross-linguistically, it is known that the combinations of consonants in syllable onset and coda are governed by Sonority Sequencing Principle (SSP), where the sonority value falls from the nucleus towards both margins of the syllable. However, this universal tendency (SSP) has some exceptions, and it is violated in some languages like French, English and Spanish (Parker, 2011). Many languages, including MSA, have this syllable type CVCC in the underlying representation (UR). However, it surfaces differently in some Arabic dialects due to the analysis of the two consonants in coda position in terms of sonority. Thus, sonority rising in coda position is avoided by using different repairing strategies like vowel epenthesis, metathesis, syllabic consonant, deletion, and lenition (Parker, 2011; Hall, 2011). Vowel epenthesis is used frequently in many Arabic dialects to avoid sonority rising in coda position, for instance, Najdi, Hijazi, Qassimi, and Tihami, to comply with SSP (Al Motairi, 2015; Alahmari, 2018; Alqahtani, 2014; Bokhari, 2020; Kabrah, 2004). Another repairing strategy used to avoid sonority rising in coda position is metathesis, which is applied in Sabzevari Persian, Welsh and Judeo-Spanish (Alqahtani, 2019). Assigning syllabic consonants at the right edge is also a strategy used to avoid SSP violation in English and Chamicuro (Parker, 2011). Deleting the last unsyllabified consonant is also used in some languages like Ancient Greek to fix SSP violations. Lenition is also a repair strategy used to avoid sonority rising for coda clusters in Welsh (Hall, 2013).

JA has two consonants in the coda position maximally. According to Mitchell (1993, p. 69), "Final clusters of more than two consonants are rare outside Morocco". In terms of sonority, the combination of consonants in this dialect shows all the three types of sonority in surface representation: sonority falling, sonority plateau and sonority rising. The following table gives a brief explanation of each type of sonority.

Table 4. Types of sonority

Sonority falling	Sonority plateau	Sonority rising
If the two consonants in the coda position satisfy the SSP, that means they fall in sonority when the first consonant is more sonorous than the second consonant CVC_1C_2.	When the two consonants in the coda position bear the same sonority value, CVC_1C_2. The first consonant is equally sonorous as the second consonant.	When the second consonant in CVC_1C_2 is higher in sonority than the first consonant near the nucleus, having this sonority profile violates the SSP.

Based on the distinction between the three types of sonority given in the table above, both sonority plateau and sonority rising violate the ideal sonority profile. Although sonority rising in coda position is avoided in surface representation in many Arabic dialects, it does exist in JA, as will be explained later in this paper. Although there are many sonority scales that have been proposed in the literature, the sonority hierarchy scale that is used in this paper adopts from Clements (1990) because it is the most frequently cited scale (Parker, 2011), where the stops and fricatives belong to one sonority class which is called obstruents. It is considered the least sonorous class compared with glides being the most sonorous, as shown in Table 5.

Table 5. Sonority scale (Clements, 1990)

Glides (G)	Liquids (L)	Nasals (N)	Obstruents (O)
3	2	1	0

Thus, the sequences of a stop followed by fricative will be considered as sonority plateau, not sonority rising since both segments belong to obstruents. As stated earlier, JA has the three types of sonority that can surface in this dialect, as exemplified in Table 6.

Table 6. Final-CC in JA

1. Sonority falling		2. Sonority plateau		3. Sonority rising	
UR	**SR**	**UR**	**SR**	**UR**	**SR**
/galb/	[galb] 'heart'	/samn/	[samn] 'ghee'	/ħibɾ/	[ħibiɾ] 'ink'
/ʃams/	[ʃams] 'sun'	/ʔamn/	[ʔamn] 'security'	/faħm/	[faħm] 'coal'
/furn/	[furn] 'oven'	/nafs/	[nafs] 'soul'	/ʃakl/	[ʃakil] 'shape'
/kalb/	[kalb] 'dog'	/masħ/	[masħ] 'deletion'	/tˤifl/	[tˤifil] 'child'
/gird/	[gird] 'monkey'	/nazf/	[nazf] 'bleeding'	/faxm/	[faxm] 'luxury'
/gaɾdˤ/	[gaɾdˤ] 'loan'	/waqt/	[waqt] 'time'	/laħm/	[laħm] 'meat'
/milħ/	[milħ] 'salt'	/zaħf/	[zaħf] 'crawling'	/gutˤn/	[gutˤn] 'cotton'
/ʕaɾʃ/	[ʕaɾʃ] 'throne'	/xubz/	[xubz] 'bread'	/sidʒn/	[sidʒn] 'prison'
/ɾamz/	[ɾamz] 'code'	/ʕaks/	[ʕaks] 'reverse'	/dafn/	[dafn] 'burial'

From the table above, especially data given in the column of sonority falling, it can be noticed that all the examples of coda clusters show sonority falling regardless of the sonority distance between the first and the second consonant. Namely, the clusters of consonants that differ by two sonority intervals have the same result as those differing by one sonority interval, for instance, [galb] and [ʃams], respectively. All the participants produced all the words in the first column without any modification because these coda clusters obey sonority parameter. Thus, coda clusters with falling sonority are left intact in JA.

In the second column where sonority plateau exists, all the examples show a violation of SSP because the two segments in the syllable margin (coda) have the same level of sonority, but they can be tolerated in JA without any repairing strategy as in many other Arabic dialects that accept sonority plateau to surface without any modification. The two consonants that have the same level of sonority in coda position can be nasals, stops, fricatives, or stop followed by fricatives (obstruents), as shown in the table above.

In the third column, although based on SSP coda clusters must fall in sonority, sonority rising is not avoided in all examples. Some words have obeyed SSP by using vowel epenthesis while others surface with sonority rising. We observe some variations when two consonants show sonority rising where the nasals and liquids behave differently in JA. The sonority rising is not tolerated in JA only when the last segment in CVCC is a liquid (either /l/ or /ɾ/), the vowel epenthesis must be used to avoid violation of SSP, for instance, /tˤifl/ → [tˤifil] 'child' and /ħibɾ/ → [ħibiɾ] 'ink'. The vowel has been epenthesized because the last consonant in both examples is more sonorous than the preceding obstruents. Thus, vowel epenthesis is utilised to comply with SSP. However, if the final consonant in CVCC is a nasal (either coronal /n/ or labial /m/) preceded by an obstruent, the vowel will not be inserted (see examples in third column of Table 6), despite both clusters (consonant followed by either nasals or liquids) violating SSP. Thus, in the grammar of JA, sonority rising is tolerated when the last segment is nasal, whereas it is avoided when it is liquid. This variation between nasals and liquids in JA reminds us with the phenomenon of muta-cum-liquida in Romance languages, where only Cr and Cl (any consonant followed by liquids) are allowed as branching onsets.

The vowel epenthesis between two consonants that violate SSP in JA cannot be attributed to Minimum Sonority Distance (MSD). Based on the numeric sonority scale given above in Table 5, consonant clusters within the syllable can be separated by a certain minimal sonority distance. However, the same sonority distance between the first and second consonants varies based on the last consonant, as illustrated below.

MDS1 (NL)	/naml/ → [namil]	vowel epenthesis used
MSD 1 (ON)	/laħn/ → [laħn]	no repairing strategy used

From the two examples given above, the sonority distance between first and second consonant is the same in both examples (one sonority interval between C_1 and C_2). However, the surface representations are different. One occurs with vowel epenthesis, and the other without, although both show the same sonority distance between two consonants. Thus, MSD is not sufficient to generalise coda clusters variations in JA. Therefore, the difference between nasals and liquids in coda clusters is attributed to the sonority class of each segment. Table 7 illustrates the difference between nasals and liquids in surface representation in JA.

Table 7. Variations of sonority rising between nasals and liquids in JA

CN] σ	***CL] σ**
[laħm] 'meat'	[baħar] 'sea'
[faħm] 'coal'	[ʃaharɾ] 'a month'
[tˁagm] 'set'	[ʃakil] 'shape'
[rasm]'drawing'	[namil] 'ants'
[ʕadˁm] 'bone'	[faguɾ] 'poverty'
[duxn] 'wheat'	[sˁabuɾ] 'patience'
[diɣn] 'chin'	[ħibiɾ] 'ink'
[dʒifn] 'eyelid'	[siʕiɾ] 'price'
[ħuzn] 'sadness'	[guful] 'lock'
[ʁusˁn] 'branch'	[ʕuduɾ] 'excuse'

Note. **C** consonant, **N** nasals, **L** liquids.

It can be noticed from the table above that it is not just the case of vowel epenthesis when the last segment in CVCC is a liquid because there are some variations also in the quality of the inserted vowel. In some examples, the inserted vowel is [a] while in others is [i] and in some others is [u]. The identity of the epenthetic vowel is determined in one of two ways relying on Hall's observation (2011, p. 1581): "it is either a fixed, default quality (which may, of course, be subject to normal allophonic variation according to the language's phonology), or else the quality is determined by some part of the phonological context." (Hall, 2011). In Levant dialects, the epenthetic vowel between two consonants in coda position is fixed, and it is always [i] in Lebanese Arabic, [ə] in Damascus, and [e] in Palestine (Hall, 2013) while it is conditioned by phonological environments in Baghdadi Arabic (Youssef, 2015). However, this paper will not account for the quality of the epenthetic vowel when the last segment is liquid in JA.

5. OT Analysis of CVCC in JA

This section accounts for the analysis of coda clusters in JA using OT constraints related to sonority. To explain the variations of coda clusters in this dialect, we found that the constraint of SSP is too general to account for sonority rising when last consonant is liquid. Thus, we propose a new constraint to analyse the variations of coda clusters in JA. The constraint that occurs without any references is the proposed one by the authors.

PARSE-SEG → All the segments must be parsed into a syllable (Prince & Smolensky, 2004).

ALIGN-R → The right edge of the input must coincide with the right edge of the output (McCarthy & Prince, 1993).

***RISE-SON-L] σ** → Sonority rising is not allowed when last consonant is liquids.

SSP → Sonority increases towards the syllable peak and decreases towards the syllable margins (Selkirk, 1984).

DEP-IO → Output segments must have input correspondents ('No epenthesis') (Kager, 1999).

MAX-IO → Every segment in the input has a correspondent in the output ('No deletion') (Kager, 1999).

***Complex Coda (*COMP CODA)** → A syllable must not have more than one coda segment (Prince & Smolensky, 1993).

It should be mentioned that the proposed constraint should belong to highly ranked constraints in the grammar of JA to account for the variation of coda clusters. The analysis starts with an example that follows sonority parameter when the coda clusters show falling sonority where first consonant is higher in sonority than the second consonant.

1) /galb/ → [galb] 'heart'

Table 8. PARSE-SEG, ALIGN-R, MAX-IO>> SSP >> *COMP CODA

/galb/	PARSE-SEG	ALIGN-R	MAX-IO	SSP	*COMP CODA
a. [gal.b]	*!				
b. [gal.bi]		*!			
c. [gab]			*!		
☞d. [galb]					*

Candidates (a), (b) and (c) are ruled out because they incur fatal violations of PARSE-SEG, ALIGN-R, and MAX-IO, respectively, which are considered highly ranked constraints in the grammar of JA. Candidate (d) is the faithful optimal output because it obeys all the high ranked constraints.

The following table explains the behaviour of coda clusters when they have the same level of sonority where the first consonant is equally sonorant as the second consonant. To account for sonority plateau in JA, SSP is considered to be violable and low ranked relative to other constraints in the grammar of JA.

2) /nafs/ → [nafs] 'soul'

Table 9. PARSE-SEG, ALIGN-R, MAX-IO>> SSP >> *COMP CODA

/nafs/	PARSE-SEG	ALIGN-R	MAX-IO	SSP	*COMP CODA
a. [naf.s]	*!				
b. [naf.si]		*!			
c. [nas]			*!		
☞d. [nafs]				*	*

Candidates (a), (b) and (c) are ruled out from the competition because they incur fatal violations of the three high ranked constraints PARSE-SEG, ALIGN-R and MAX-IO, respectively. Candidate (d) is the optimal actual output because it obeys all the high ranked constraints. Although it has two violation marks, it is still optimal because both violated constraints are ranked low in the constraint hierarchy of JA grammar.

The next table accounts for the sonority rising in coda clusters when the last consonant is nasal. In most Arabic dialects, when the last consonant is a nasal preceded by an obstruent, vowel epenthesis is utilised to obey SSP because it is ranked high in those dialects. However, in JA, nasals behave as they are equally sonorous as obstruents. In the following table, we use the same constraints that were used for Table 9 where the SSP is violated since it is ranked low.

3) /faħm/ → [faħm] 'coal'

Table 10. PARSE-SEG, ALIGN-R , MAX-IO>> SSP>> *COMP CODA

/faħm/	PARSE-SEG	ALIGN-R	MAX-IO	SSP	*COMP CODA
a. [faħ.m]	*!				
b. [faħ.mi]		*!			
c. [fam]			*!		
☞d. [faħm]				*	*

Candidates (a), (b) and (c) are eliminated due to the violations of PARSE-SEG, ALIGN-R and MAX-IO, respectively, which are considered highly ranked constraints in the grammar of JA and the violations are fatal. Candidate (d) is the faithful optimal actual output because it obeys all the high ranked constraints.

The following table illustrates the analysis of coda clusters where that last segment is liquid. First, we use the same constraints that were used for the analysis of the examples in (1), (2) and (3) and see if these constraints are sufficient to generate the true-surface output.

4) /tˤifl/ → [tˤi.fil] ‘a child’

Table 11. PARSE-SEG, ALIGN-R, MAX-IO>> SSP >> *COMP CODA

/tˤifl/	PARSE-SEG	ALIGN-R	MAX-IO	SSP	*COMP CODA
a. [tˤif.l]	*!				
b. [tˤif.li]		*!			
c. [tˤil]			*!		
☞ d.[tˤifl]				*	*

The Table 11 above fails to determine the optimal candidate of the input /tˤifl/. Based on the constraints given in this table, candidate (d) is the optimal because the violations of both constraints SSP and *COMP CODA are not fatal in the grammar of JA. However, this candidate is not the actual output in JA as we have explained earlier when the last segment is a liquid, the vowel must break up the consonant clusters. Thus, a new constraint should be used to eliminate candidate (d) from being optimal and that constraint must be ranked higher than SSP.

5) /tˤifl/ → [tˤi.fil] ‘a child’

Table 12. PARSE-SEG, ALIGN-R, MAX-IO, >>*RISE-SON-L]σ >> SSP >> DEP-IO, *COMP CODA

/tˤifl/	PARSE-SEG	ALIGN-R	MAX-IO	*RISE-SON-L] σ	SSP	DEP-IO	*COMP CODA
a. [tˤif.l]	*!						
b. [tˤif.li]		*!					
c. [tˤil]			*!				
d.[tˤifl]				*!			*
☞e. [tˤi.fil]						*	

Candidates (a), (b), (c) and (d) fail to be optimal because of the fatal violations they incur for the highly ranked constraints PARSE-SEG, ALIGN-R, MAX-IO and *RISE-SON-L] σ, respectively. Candidate (e) is the most harmonic output because it obeys all the high ranked constraints and has only one violation mark for the violable constraint DEP-IO which is ranked low in the grammar of JA because it is violable.

Using the proposed constraint *RISE-SON-L]σ will not make any difference for the analysis given above in the other Tables 8, 9 and 10 because they do not violate it since it only affects the clusters that end with liquids. However, there is a problem that might occur if we use the same constraint hierarchy given in Table 12 because this hierarchy makes these candidates [faħam] or [nafis] with the vowel epenthesis win over the actual candidates. Therefore, to solve such a problem SSP must be outranked by DEP-IO as exemplified in the following table.

6) [faħm] vs. [fa.ħam] ‘coal’

Table 13. DEP-IO >> SSP

/faħm/	DEP-IO	SSP
a. [faħam]	*!	
☞b. [faħm]		*

If we keep the same domination between SSP and DEP-IO used in Table 12, the Evaluator is not able to choose the true-surface output without vowel epenthesis. Thus, DEP-IO must be ranked higher than SSP in the grammar of JA. The ranking of the constraints of coda clusters in superheavy syllables (CVCC) in JA is repeated below.

PARSE-SEG, ALIGN-R, MAX-IO >>*RISE-SON-L]σ >> DEP-IO>> SSP, *COMP CODA

6. Conclusion

This paper has investigated the behaviour of final superheavy syllables CVCC in JA. JA has different types of sonority that can be tolerated in surface representation (sonority falling, sonority plateau and sonority rising), which is unusual among many Saudi dialects that respect SSP, especially when the two consonants show sonority rising. The coda cluster is divided in terms of sonority into two types in JA. The first type includes sonority falling, plateau and rising with nasal. Nasals are grouped with stops and fricatives in sonority scale of

this dialect. In this type, the SSP is ranked low, and it is violable in the grammar of JA. However, in the second type when the last consonant is liquid preceded by any consonant (obstruents or nasals), a vowel is epenthesized, as they occur in [ʃakil] 'shape' and [namil] 'ant'. In this case, the new proposed constraint should be included in the grammar of JA to account for this variation. This constraint is *RISE-SON-L]σ which eliminates the sonority rising when last consonant is liquid. In sum, the difference between nasals and liquids in coda clusters is attributed to the sonority class of each segment. Sonority rising with nasal is tolerated, but sonority rising with liquid is not tolerated in JA.

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Appendix A

No.	**Sonority falling**	**Sonority plateau**	**Sonority rising**
1	/ɢalb/ 'heart	/samn/ 'ghee'	/laħm/ 'meat'
2	/ʃams/ 'sun'	/ʔamn/ 'security'	/faħm/ 'coal'
3	/fuɾn/ 'oven'	/nafs/ 'soul'	/tˁagm/ 'set'
4	/kalb/ 'dog'	/masħ/ 'deletion'	/ɾasm/ drawing'
5	/gɪɾd/ 'monkey'	/nazf/ 'bleeding'	/wazn/ 'weight'
6	/gaɾdˁ/ 'loan'	/waqt/ 'time'	/duxn/ 'wheat'
7	/milħ/ 'salt'	/zaħf/ 'crawling'	/dɪgn/ 'chin'
8	/ʕaɾʃ/ 'throne'	/xubz/ 'bread'	/ʤɪfn/ 'eyelid'
9	/ɾamz/ 'code'	/ʕaks/ 'reverse'	/ħuzn/ 'sadness'
10	/gaɾn/ 'century'	/ʕagd/ 'contract'	/ʁusˁn/ 'branch'
11	/ðanb/ 'sin'	/kiðb/ 'lying'	/baħɾ/ 'sea'
12	/ʤanb/ 'side'	/liʕb/ 'playing'	/ʃahɾ/ 'a month'
13	/baɾd/ 'cold'	/ʕabd/ 'slave'	/ʃakl/ 'shape'
14	/kanz/ 'treasure'	/sˁaʕb/ 'difficult'	/naml/ 'ants'
15	/waɾd/ 'roses'	/taħt/ 'under'	/faqɾ/ 'poverty'
16	/ʃaɾtˁ/ 'condition'	/baʕdˁ/ 'some'	/sˁabɾ/ 'patience'
17	/kaɾt/ 'card'	/dˁiħk/ 'laughter'	/ħibɾ/ 'ink'
18	/rimʃ/ 'eyelash'	/katabt/ 'I wrote'	/siʕɾ/ 'price'
19	/dˁilʕ/ 'rib'	/nabdˁ/ 'pulse'	/gufl/ 'lock'
20	/ʔaɾdˁ/ 'floor'	/kitf/ 'shoulder'	/mitɾ/ 'meter'