FULL LENGTH ARTICLE

Is the phonotactics of the Arabic complex coda sonority-based?

Yasser A.S. Al Tamimi a,*, Yousef Al Shboul b

a Alfaisal University, Riyadh, Saudi Arabia
b Hashemite University, Zarqa, Jordan

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Abstract The study investigates the phonotactics of coda consonant clusters in Modern Standard Arabic CVCC syllable from the perspective of the Sonority Sequencing Principle (SSP). Based on around 500 CVCC lexical items listed in The Hans Wehr Dictionary of Modern Written Arabic, and on Hogg and McCully’s (1987) sonority scale, the study provides an exhaustive quantitative account of all possible coda manifestations which have been found in this study to fall into three major categories: conformity (42%), sonority reversals (49%), and sonority plateaus (9%). The study specifies and thoroughly exemplifies the patterns and subpatterns under each, and concludes, given the 58% of violation, that SSP is not a reliable phonological predictor for the sequencing of the consonant clusters in Modern Standard Arabic CVCC coda, contrary to long standing phonological assumptions that put much weight on the explanatory adequacy of this principle.

Keywords Sonority Sequencing Principle; Modern Standard Arabic; CVCC syllable; Conformity; Sonority reversals; Sonority plateaus

1. Introduction

Segments are said to be organized into well-formed sequences according to universal principles. Whether within the syllable or across syllables, this sequencing is traditionally held to be driven by principles of sonority, a property that ranks segments a long a hierarchy from most sonorous to least sonorous. Amongst such principles is the Sonority Sequencing Principle (SSP), which stipulates that onsets rise in sonority toward the nucleus, while codas fall in sonority. (Clements, 1990; Parker, 2002).

SSP is claimed to account for strong cross-linguistic distributional and sequential tendencies (Geirut, 1999), and different syllable structures in different languages have been studied within its framework since Sievers (1881). Whether this claim is true or not for Modern Standard Arabic (MSA) coda in the extra heavy CVCC# syllable is a question that has remained, to our knowledge, unsatisfactorily answered, as the available literature, if not impressionistic, lacks for the most part a thorough and an exhaustive investigation based on quantitative evidence. The general indication one can obtain from this literature is that Modern Standard Arabic CC coda normally conforms to the principle, and if it does not, a vowel epenthetic rule applies (See Section 3 below). This generalization, though insightful, leaves much uncertainty about the extent to which the phonotactics of the coda clusters is canonical from the perspective of the Sonority Sequencing Principle. It is

* Corresponding author. Tel.: +966 561252200; fax: +966 12157730.
E-mail addresses: yaseraltamimi@hotmail.com, yaltamimi@alfaisal-u.edu (Y.A.S. Al Tamimi), yshbool@hu.edu.jo (Y. Al Shboul).
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the endeavor of the present descriptive and quantitative research to bridge this gap in the literature.

The findings of a pilot study we performed revealed many incidence of CC clusters that can be categorized under what might be called “sonority reversals” and “plateaus” (Morellie, 1999: 20, Section 2.2 below), in addition to conformity, which encouraged us to widen the scope of the data of the present study to include all the CVCC lexical items listed in The Hans-Wehr Dictionary of Modern Written Arabic – around 500 words in number.

Based on this exhaustive dictionary-based data, and adopting Hogg and McCully (1987) sonority scale for relevance (see Section 2 below), the study aims to thoroughly and quantitatively answer the following questions related to the CC clusters of Modern Standard Arabic CVCC lexical items:

1. What are the coda clusters that conform to the Sonority Sequencing principle? What are their different patterns and subpatterns? How frequent is each?
2. What are the coda clusters that demonstrate sonority reversals? What are their different patterns and subpatterns? How frequent is each?
3. What are the coda clusters that exhibit sonority plateaus? What are their different patterns and subpatterns? How frequent is each?
4. In view of the findings, is the Sonority Sequencing Principle a reliable phonological predictor for Modern Standard Arabic complex coda?

Given the purely descriptive and quantitative approach it adopts and the ample evidence it provides, the study is meant to be a detailed reference for researchers on the sonority of Arabic complex coda in CVCC syllables.

2. Background

2.1. Modern Standard Arabic

Modern Standard Arabic is the standard form of the Arabic contemporary era, and the written record of its modern culture (Al Soswah, 2002). Presented in Table 1 below is the consonant inventory of this standard, as adapted from Amayreh (2003).

Modern Standard Arabic has a simple vowel system: three short monophthongs: open /a/, close back /u/, and close front /i/, and their long equivalents /a:/, /u:/ and /i:/, respectively (Al Otaibi and Hussain, 2010), and its syllable types include CV, CVV, CVC, CVVC, CVCC (our emphasis), and CVVCC (Holes, 2004), where C and V represent a consonant and a vowel, respectively. Its syllable is similar to that of English in having a nucleus (an obligatory segment either short or long), onset, and an optional coda, but different in allowing no more than one consonant in the onset.

2.2. Sonority Sequencing Principle

Complex onsets and codas are claimed to be governed by the Sonority Sequencing Principle (SPS), which suggests, as stated above, that sonority increases monotonically the closer one gets to the sonority peak (the nucleus), and decreases as one gets away from that peak (Goldsmith, 1990: 110). Since sonority can be best defined in terms of intensity, in addition to airflow obstruction and voice (Ladefoged, 1993; Moreton et al., 2008), preference in sonority research has been given to the sonority scales which are supported by intensity measurement, such as those put forward by Kiparsky (1979), Hogg and McCully (1987), Clements (1990) and Parker (2002). However, in addition, Hogg and McCully’s scale, shown in Table 2

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Modern standard Arabic consonant inventory.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSA</td>
<td>Bilabial</td>
</tr>
<tr>
<td></td>
<td>Labio-dentals</td>
</tr>
<tr>
<td></td>
<td>Dental</td>
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<tr>
<td></td>
<td>Alveolar</td>
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<td></td>
<td>Postal-alveolar</td>
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<td>Palatal</td>
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<td></td>
<td>Velar</td>
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<td></td>
<td>Uvular</td>
</tr>
<tr>
<td></td>
<td>Pharyngeal</td>
</tr>
<tr>
<td></td>
<td>Glottal</td>
</tr>
<tr>
<td>Plosive</td>
<td>b</td>
</tr>
<tr>
<td>Nasal</td>
<td>m</td>
</tr>
<tr>
<td>Flap</td>
<td>f</td>
</tr>
<tr>
<td>Fricative</td>
<td>ß</td>
</tr>
<tr>
<td>Glides</td>
<td>w</td>
</tr>
<tr>
<td>Liquid</td>
<td>l</td>
</tr>
<tr>
<td>(lateral)</td>
<td></td>
</tr>
</tbody>
</table>

/ß/, /ð/, /s/, and /ð/ represent emphatic sounds, and, according to the IPA guidelines, they can be also transcribed as /ý/, /ð/, /s/ and /ð/, respectively.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Hogg and McCully’s Sonority Scale (1987).</th>
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</thead>
<tbody>
<tr>
<td>Sound</td>
<td>Sonority value</td>
</tr>
<tr>
<td>Low vowels</td>
<td>10</td>
</tr>
<tr>
<td>Mid vowels</td>
<td>9</td>
</tr>
<tr>
<td>High vowels</td>
<td>8</td>
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</table>
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3. Review of related literature

The phonotactics of Modern Standard Arabic consonant clusters in the CVCC syllable have been handled in a few studies of different phonological interests. For instance, in his study of the role of h in repairing syllable structures, Obeidat (2010) handles the CVCC syllable, considering its complex coda “difficult to pronounce” in some instances, including /s'abr/ ‘patience’, /hid3l/ ‘anklet’ and /nuqr/ ‘sound’. Such codas, he adds, were even variably epenthized by vowels in Classical Arabic as he traced in Amr bin Al'alaa’s Reading of the Holy Qur’an; in the poetry of Al Rajiz, and in Tamim Arabic. In the same vein, Kenstowics (1986), in his “Notes on Syllable Structure”, presents a set of CVCC lexical items representing Bedouin Jordanian Arabic, though many of which sound standard, and concludes that the Sonority Sequencing Principle can operate on the codas of /dars/, ‘lesson’, and /bint/, ‘girl’, but not on that of /himl/, ‘load’, realized consequently as [him][l]. Since the ml coda does not demonstrate “a falling sonority profile” (Kenstowics, p. 120), as stipulated by the principle, it is vowel-epenthized. The indication one may obtain from such studies is that it is the norm for the coda consonant clusters to conform to the principle, and if it does not in some instances, vowel epenthesis regularly applies. In this context, it is worth citing Labov (1966: 49) who contends that “such terms as ‘regularly’, ‘rarely’ and ‘sometimes’, etc. are of limited value in a scientific discipline and a quantitative treatment based on frequency of occurrence is called for”.

The same indication can be obtained from the abundant research on the subject matter in different non-standard dialects (e.g., Haddad, 1983; Mansour, 1991; Kiparsky, 2003; Btoosh, 2006; Al Jumah, 2008; Daana, 2009). However, research based on quantitative evidence, which is comparatively few, provides more specific conclusions. Watson (2002), for instance, finds that 30% of the San’ani Arabic complex coda exhibits sonority reversals, and far less incidence of sonority plateaus. Similar conclusions were drawn for Modern Standard Hebrew (e.g. Gishri, 2009), a genetically related language.

In brief, despite its insightful observations, the available research provides no exhaustive and quantitative account of Modern Standard Arabic coda clusters that conform to SSP, or violate it in the manner of sonority reversals and plateaus. It neither identifies the different patterns and sub patterns under each category, nor does it provide their frequency of occurrence. This constitutes the rationale behind conducting the present research, which attempts to bridge these gaps by answering the research questions stated in section 1.

4. Methodology

4.1. Data collection

Dictionary-based data can be used in sonority research. Kambuziya and Serish (2006), for instance, based their analysis of vowel epenthesis in the Persian CVCC syllable on dictionary data and so did Orzechowska and Wiese (2011) in their investigation of the phonotactics of German initial clusters. Consistently, all the CVCC lexical items listed in The Hans-Wehr Dictionary of Modern Written Arabic were collected and considered in the present study. The 493 words found were either deverbal nouns or undersived nouns. According to Kenstowics (1986), “deverbal nouns are a good place to study the formation of such syllables since CVCC happens to be the underlying canonical shape for a large class of deverbal nominalization. CVCC class is also populated by an equally large number of basic nonderived nouns” (p. 101).

One main advantage of this dictionary is that it is “compiled on scientific descriptive principles: only words and expressions that are attested in context are included” (Hans Wehr and Cowan, 1994: VII). However, as dictionary items, these words appear in their citation or pausal forms. For example, the deverbal CVCC noun ‘karb’ (misfortune) is a pausal form that can be found in the dictionary and can also be heard in formal speech if the speaker prefers not to use the word’s inflectional forms, i.e. ‘karbun’; ‘karban’ or ‘karbin’ (where -un, -an, and -in represent the nominative, accusative and dative case endings, respectively). In fact, many MSA speakers, we observe, often use the pausal form even in connected speech in order to avoid some inflectional complexities, and this gives us the legitimacy of considering the CC coda of this form. Moreover, it is only in this form that one can straightforwardly identify the CC clusters of the CVCC syllable.

4.2. Data analysis

The CVCC lexical items were phonemically transcribed and analyzed in terms of onset, nucleus, coda first consonant, and coda second consonant in order to encompass each syllable examined. The coda consonants in their phonemic forms were identified and checked against Hogg and McCully’s Sonority Scale presented in Table 2 above. Each coda cluster in each lexical item was categorized where it fits under any of the three sonority possibilities: conformity, reversals and plateaus, and the patterns and subpatterns of each category were identified. Consistent with the sonority scale used, affricates were treated as stop consonants. Coarticulation, which may have some influence on consonant clustering (e.g. Jongstra, 2003) has not been considered in this study as it uses dictionary lexical items in the first place, and it, in the second, adopts Hogg and McCully’s sonority scale that excludes coarticulatory effects. As such, the study is more concerned with the coda consonant phonemes rather than with their different phonetic realizations. MSA lexical items after all
are typically taken as the underlying representations for their different phonetic forms that exist in different Arabic dialects.

5. Results and discussion

As checked against Hogg and McCully’s sonority scale, the consonant clusters of the 493 CVCC lexical items appear to fall into the three major categories: conformity, sonority reversals and sonority plateaus. Conformity has been observed in 208 cases (42%); sonority reversals in 241 (49%); and sonority plateaus in only 44 instances (9%), as demonstrated in Fig. 1 below.

5.1. Conformity to SSP

As stated above, (42%) of the CC codas appear to conform to SSP. These “core clusters” or the “unmarked clusters” (Morellie, 1999: 20) have been found to fall into six major patterns: 1) flap + consonant, 2) lateral + consonant, 3) nasal + consonant, 4) voiced fricative + consonant, 5) voiceless fricative + consonant, and 6) voiced stop + voiceless stop, as exhibited in Fig. 2.

A part from the voiced stop + voiceless stop pattern, each other conformity patterns has been found to comprise a number of subpatterns, as specified below.

5.1.1. Flap + consonant

Fifty-six CC coda instances out of 208 (27% of the conforming codas) were found to follow the pattern flap + consonant, where the second consonant can be nasal (2 instances), voiced fricative (2), voiceless fricative (23), voiceless stop (7), voiced stop (20), and glottal stop (2), as shown in Fig. 3 below.

5.1.2. Lateral + consonant

The lateral + consonant coda pattern has been observed in 27 cases (13%) that can be categorized into 5 subpatterns: 1) lateral + nasal (3 cases), 2) lateral + voiced fricative (3), 3) lateral + voiceless fricative (11), 4) lateral + voiced stop (5), and 5) lateral + voiceless stop (5 instances), as demonstrated in Fig. 4 below.

5.1.3. Nasal + consonant

The nasal + consonant coda pattern has been seen in 39 instances out of 208 (19%) distributed into four basic subpatterns: 1) nasal + voiced fricative (11 instances), 2) nasal + voiceless fricative (17), 3) nasal + voiced stop (8), and 4) nasal + voiceless stop (3), as illustrated in Fig. 5 below.

5.1.4. Voiced fricative + consonant

The voiced fricative + consonant coda pattern has been observed in 20 cases (10%) that spread out in three subpatterns: 1) voiced fricative + voiced stop (10 instances), 2) voiced fricative + voiceless stop (4), and 3) voiced fricative + voiceless fricative (6 instances), as demonstrated in Fig. 6 below.

5.1.5. Voiceless fricative + consonant

The voiceless fricative + consonant coda pattern has been seen in 53 cases (25%) unfolding in three subpatterns: 1) voiceless fricative + voiceless stop (25 instances), 2) voiceless fricative + voiced stop (26) and 3) voiceless fricative + glottal stop (2), as shown in Fig. 7 below.

5.1.6. Voiced stop + voiceless stop

Only a voiceless stop can function as a second consonant in the conforming codas whose first consonant is a voiced stop. This clustering has been observed in 13 instances out of 208 (6%), as represented in Fig. 8 below.

Having identified the different CC patterns and subpatterns that conform to SSP, and shown that this conformity can only appear in 42% of the data (thus answering the first research question), we can conclude that the CC coda of MSA CVCC syllable is only partially conditioned by this principle, and this provides an answer to the forth research question. The results lend no support to the indications obtained from some studies (e.g. Kenstowics, 1986; Obeidat, 2010) which suggest that MSA CC coda normally complies with SSP. They also disfavor the conclusions of general conformity to SSP drawn for dialectal Arabic (e.g. Haddad, 1983; Kiparsky, 2003; Btoosh, 2006; Al Jumah 2008; Daana, 2009). Legitimate MSA CC codas that violate SSP in the manner of sonority reversals and plateaus are discussed below.

5.2. Reversals

As mentioned above, almost half of the CC clusters in the data can be regarded as sonority reversals: 241 cases out of 493 (49%). This category has been found to include the following six patterns, which are the reverse of the conforming patterns:
1) consonant + flap, 2) consonant + lateral, 3) consonant + nasal, 4) consonant + voiced fricative, 5) consonant + voiceless fricative, and 6) voiceless stop + voiced stop, as demonstrated in Fig. 9 below.
Figure 5  Conformity of nasal + consonant.

Figure 6  Conformity of voiced fricative + consonant.
5.2.1. Consonant + flap

Fifty-nine CC coda instances out of 241 (2.4.5%) have been found to follow the pattern: consonant + flap, where the first consonant can be: nasal (1 incidence), voiced fricative (6), voiceless fricative (26), voiced stop (10), voiceless stop (14), and glottal stop (2), as shown in Fig. 10 below.

5.2.2. Consonant + lateral

The lateral + consonant coda pattern has been observed in 46 CVCC lexical items (19%) that can be categorized into the following six subpatterns: 1) nasal + lateral (4 cases), 2) voiced fricative + lateral (8), 3) voiceless fricative + lateral (18 cases), 4) voiced stop + lateral (6), 5) voiceless stop + lateral (8), and 6) glottal stop + lateral (2 cases); as demonstrated in Fig. 11 below.

Figure 7 Conformity of Voiceless Fricative + Consonant.

Figure 8 Conformity of voiced stop + voiceless stop clusters.

Figure 9 Reversal patterns.
Figure 10  Sonority reversals of consonant + flap.

Figure 11  Sonority reversals of consonant + lateral.
5.2.3. Consonant + nasal
The consonant + nasal pattern has been observed in 58 instances out of the 241 (24%) that can be categorized into four subpatterns: 1) voiced fricative + nasal (13 instances), 2) voiceless fricative + nasal (25), 3) voiced stop + nasal (12), 4) voiceless stop + nasal (6), and 5) glottal stop + nasal (2), as displayed in Fig. 12 below.

5.2.4. Consonant + voiced fricative
The consonant + voiced fricative coda pattern has been seen in 29 cases (12%) that can appear in three subpatterns: 1) voiced stop + voiced fricative (15 instances), 2) voiceless stop + voiced fricative (7), and 3) voiceless fricative + voiced fricative (7 instances), as shown in Fig. 13 below.

5.2.5. Consonant + voiceless fricative
The consonant + voiceless fricative coda pattern has been observed in 39 cases (16%) that can be observed in three subpatterns: 1) voiceless stop + voiceless fricative (13 cases), 2) voiced stop + voiceless fricative (25) and 3) glottal stop + voiceless fricative (one case), as shown in Fig. 14 below.

5.2.6. Voiceless stop + V voiced stop
The reversal pattern of voiceless stop + voiced stop has been seen in only 10 cases out of 241 (4%), as represented in Fig. 15 below.

Having identified the different CC patterns and subpatterns that exhibit sonority reversals, and shown that this drastic violation occurs in 49% of the data (thus answering the second research question), we can confirm our previous conclusion that SSP is not a reliable phonological predictor for the CC coda of MSA CVCC syllable. In principle, the existence of incidence of sonority reversals reported by Kenstowics (1986), Obeidat (2010) is supported, though quantitatively revealed here to be much greater than implied in their indications. The results also back up Watson (2002) findings of 30% of ‘reversals’ incidence in San‘ani Arabic.

According to Carlisle (2001): (5), the reversal patterns are regarded as “a more serious departure from the sonority sequencing Principle than sonority plateaus”. Indeed, 49%
Figure 13 sonority reversals of consonant + voiced fricative.

Figure 14 sonority reversals of consonant + voiceless fricative.
of sonority reversals for the MSA CC coda casts doubt on the explanatory adequacy of SSP, traditionally held to account for strong cross-linguistic distributional and sequential tendencies (Geirut, 1999). Sonority Plateaus to be handled below can provide a further insight.

Figure 15  sonority reversals of voiceless stop + voiced stop.

Figure 16  Plateau patterns.

Figure 17  Identification of sonority plateau patterns.

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5.3. Sonority plateaus

As shown in Fig. 1 above, sonority plateaus unfold in 44 instances out of 493 (9%) that can be categorized into five patterns: 1) nasal + nasal (3 instances; 7%), 2) voiced fricative + voiced fricative (3; 7%), 3) voiceless fricative + voiceless fricative (27; 61%), 4) voiced stop + voiceless stop (6, 14%), and 5) voiceless stop + voiceless stop (5, 11%), as represented in Fig. 16, and identified and exemplified in Fig. 17.

As can be observed in Fig. 16, the pattern of voiceless fricative + voiceless fricative is the largest amongst the sonority plateau patterns and this can be attributed to the existence of eight voiceless fricative consonants in MSA phonemic inventory, in contrast with less members in all other natural classes, as can be seen in Table 1 above.

The foregoing provides an exhaustive answer to the third research question related to sonority plateaus in MSA CC coda. The occurrence of only 9% of plateaus in this coda is consistent with Carlisle (2001) generalization that in languages, sonority plateaus are less frequent and marked. It also lends some support to Watson (2002) findings of some incidence of sonority plateaus in San’ani Arabic, and, though indirectly, to Gishri (2009) similar findings for Modern Hebrew.

6. Conclusions

Based on an exhaustive quantitative evidence, the study provides a thorough account of the different MSA CC coda patterns and subpatterns that either show conformity to the Sonority Sequencing Principle or violate it in the manner of sonority reversals and plateaus. Contrary to what is taken for granted in the literature that MSA CC coda normally complies with SSP, the study reveals compliance in only 42% of the data, and, consequently, breaking in 58%; distributed between sonority reversals (49%) and sonority plateaus (9%).

Although sonority plateaus are “less dangerous” than sonority reversals according to Carlisle (2001): (5), they still form a violation to the principle. The MSA CC coda is thus almost divided between compliance and insurmountable, with some inclination toward the latter status. This state of affairs poses challenge to SSP which has been assumed for long to govern complex onsets and codas in syllables. Accordingly, reconsidering a more relevant theoretical model outside the scope of the sonority theory is called for. Steriade (1995) Perceptibility Theory already advocated by Ohala and Kawasaki (1997), Wright (2004), Moreton et al. (2008) might be thought of as a more relevant alternative. The theory simply suggests that a segment’s compatibility within a given environment depends on how accurately it is likely to be perceived in that environment. Our ongoing research on the acquisition of MSA final consonant clusters by Jordanian children indicates that the perceptive dimension remains a valid option. Further research is recommended, though, to examine the relevance of the perceptibility theory to the phonotactics of MSA complex coda.

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