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Word-Final Consonant Clusters in Najdi Arabic: An Optimality Theory Approach

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Abstract

This study examines word-final consonant clusters in Najdi, an understudied variety of Arabic spoken in central Saudi Arabia. Sixteen participants read words that took into account falling, plateau, and rising sonority consonant clusters containing obstruents, nasals, liquids, and glides. The instrument included various sonority distances for falling and rising sonority clusters. In the results, participants added epenthesis in rising sonority clusters and in plateau sonority clusters containing sonorants but not in falling sonority clusters or in plateau sonority clusters containing obstruents. The study incorporated optimality theory to organize Najdi Arabic's apparent constraints and adds to the literature on how the sonority sequencing principle, minimal sonority distance, and markedness hypothesis can help predict what types of consonant clusters Najdi speakers are likely to modify.

Keywords: *Najdi Arabic, optimality theory, syllable, sonority, consonant cluster.*

Introduction

This study investigated the word-final consonant cluster patterns allowed in Najdi—a less well-documented variety of Arabic in central Saudi Arabia—and to what extent the sonority sequencing principle (SSP) predicted those patterns. Najdi was expected to allow falling sonority coda clusters (typically less marked) but epenthesize rising sonority coda clusters (typically more marked). Furthermore, speakers were expected to allow plateau sonority coda clusters comprising two obstruents, while coda clusters with two sonorants might be epenthesized. This expectation followed Carnie (1994) and Bat-El (2012) and the projected continuum in Figure 1 of most-to-least marked clusters.

Figure 1

Projected Coda Cluster Continuum in Najdi Arabic

Most Marked			Least Marked
Rising	Plateau sonorants	Plateau obstruents	Falling

According to the SSP, every syllable has a segment acting as the peak (typically a vowel), which is preceded and/or followed by falling sonority (Selkirk, 1984). Thus, segments with higher sonority are normally closer to the peak, and those lower on the scale are farther away (Dressler, 1992). Figure 2 illustrates this ordering of segments (Steriade,

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2003). Najdi speakers were expected to add epenthesis only in more marked clusters, meaning /qabl/ “before” would become /gɑbəl/ , but not with less marked clusters, such as /sɪlk/ “wire.”

Figure 2

Segment Ordering in Coda Consonant Clusters

vowel → glide → liquid → nasal → obstruent

Minimal sonority distance (MSD) is the distance in sonority between sounds or the degree of sonority for each sound in a consonant cluster (Selkirk, 1984). This concept helps determine the clusters permitted in syllable onsets and codas in different languages (Eckman & Iverson, 1993). The fewer steps in sonority a language requires to jump in the coda, the more clusters it will have. For example, if a language allows the coda /ln/ to occur, it will often also allow /lk/ and /wk/. A nasal preceded by a liquid (one step) in a coda implies that liquid-obstruent (two steps) and glide-obstruent (three steps) clusters can be found as well. Clements (1990) provided a hierarchical scale for the onset; however, since the concern here was the coda, the scale in Figure 3 is reversed, similar to Greenberg (1978).

Figure 3

The Sonority Hierarchy Scale for the Coda

V > G > L > N > O

0 1 2 3 4 Rank

The assumption was that if Najdi speakers could produce a falling sonority coda cluster with one step in sonority distance, such as the liquid-nasal cluster in /ħelm/ “dream,” they must have produced two and three steps, as in a liquid-obstruent, e.g., /ħɑrf/ “letter,” and a glide-obstruent, e.g., /kejd/ “deception.” If they could produce a rising sonority coda cluster with three steps of sonority distance, such as the obstruent-glide cluster in /qɑbw/ “basement,” this would imply they had produced one and two steps, as in the nasal-liquid cluster in /dʒɑmr/ “firebrands” and the obstruent-liquid cluster in /qɑbl/ “before.” This followed Broselow and Finer’s (1991) evidence in falling sonority clusters, although the reverse of their hypothesis was necessary in this study, where the rising sonority coda was examined.

Optimality theory (OT) evaluates candidates and determines which would be the optimal surface form according to how a language orders a set of constraints (Hancin-Bhatt, 2008). These constraints are divided into two families: markedness (ONSET, NOCODA, *COMPLEX, *VOICED-CODA) and faithfulness (MAX-IO, DEP-IO, IDENT-IO). The winning candidate is the one incurring the least serious violations of the constraints (McCarthy, 2008).

Methods

Participants consisted of 16 native Najdi speakers from central Saudi Arabia who had learned Classical Arabic in school. Two (both men) were assigned to a control group. Half the participants were male and half were female. Ages varied between 18 and 40. Some were studying for a BA, some had a BA, and others had an MA.

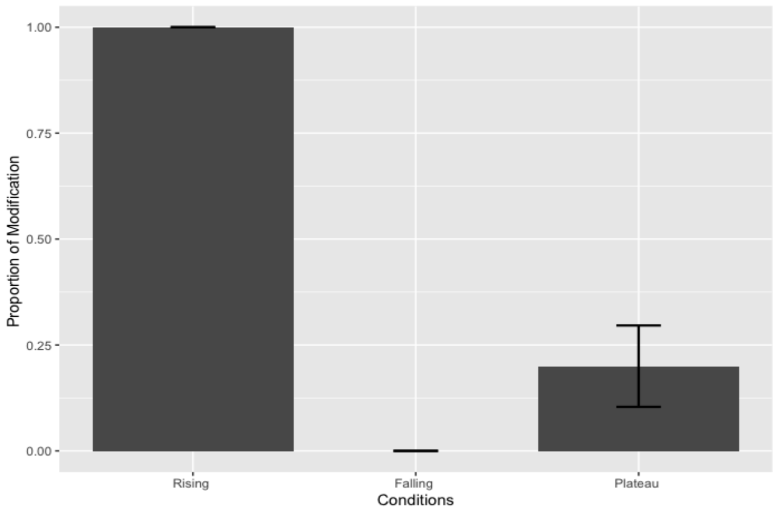
The instrument (see Appendix A) consisted of 31 monosyllabic words participants were recorded reading. These words contained word-final rising, falling, and plateau sonority consonant clusters possible in Classical Arabic. The words containing obstruents included stops and fricatives. The data included the nasals /m/ and/n/, liquids /r/ and /l/, and glides /w/ and /j/ to see if one in a given pair would be treated differently from the other. Orthography should not have affected how speakers produced the data, as all words—with different sonority profiles—were spelled out with two word-final consonants, CC#.

Participants filled out a demographic questionnaire regarding age, gender, education, and city of origin. Then the main instrument was presented in paper format. The instructions were simple; participants were asked to read the words slowly with a brief pause between words, and for practice each participant read 4–5 words not used in the instrument. The control group was asked to read the words in Classical Arabic instead of Najdi. Speech Analyzer was used to determine the pronunciation of the clusters and whether Najdi productions differed from the control group.

Results and Discussion

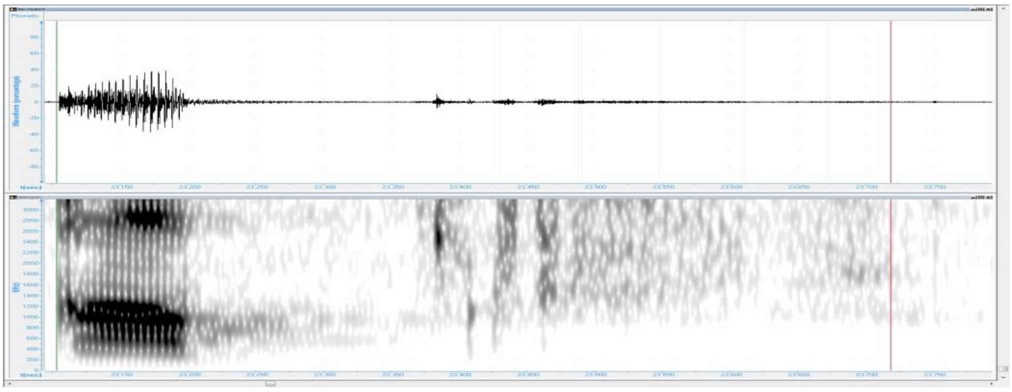
The results supported the study's expectations. When the second consonant in a coda cluster was less sonorous than the first, participants always pronounced the cluster without modification, #CVCC#. In contrast, when the second consonant was more sonorous than the first, participants always inserted a vowel, #CVCvC#. Najdi was predicted to never violate the SSP. However, when coda clusters had two consonants at the same sonority level, all participants pronounced them without modification, except in one cluster. Participants dealt with clusters in nearly the same way, rendering further statistical analysis unnecessary (see Figure 4).

Figure 4 Falling, Rising, and Plateau Sonority Clusters



Falling sonority clusters were all produced without modification (CC#), while epenthesis occurred in rising and plateau sonority clusters. All rising sonority clusters were produced with vowel insertion (CvC#), but only one word (20%) in the plateau sonority group had epenthesis. Spectrograms clearly showed the pronunciation differences between control (see Figure 5) and Najdi (see Figure 6) participants.

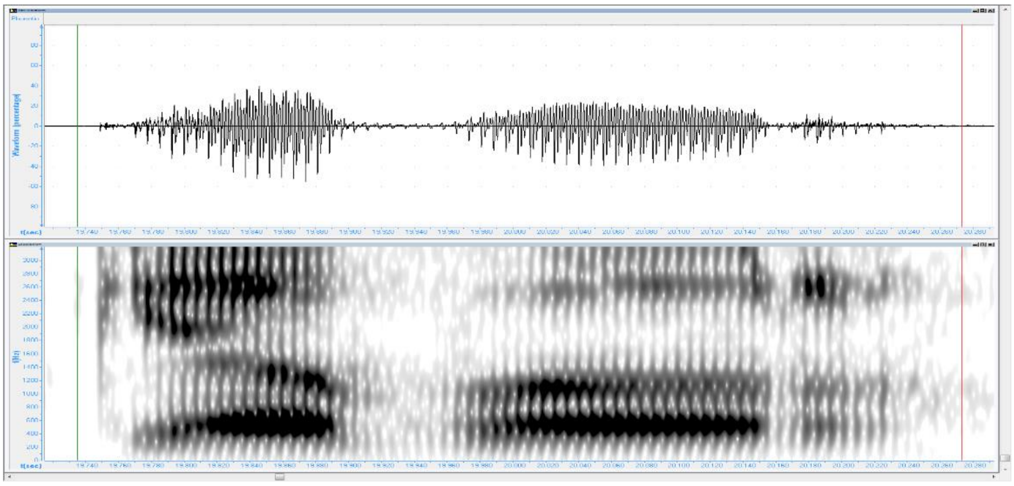
Figure 5 Pronunciation of /qɑbr/ by Participant 15



q ɑ b r

Besides measuring each word's nucleus, the epenthesis in each cluster was measured to determine whether it could be considered a vowel. The results yielded approximately similar lengths between the nucleus and epenthetic vowel, meaning the epenthesis could be considered a new vowel inserted into the word. The /q/ of Classical Arabic was always pronounced [g] by the Najdi participants. Nevertheless, [q] was used in the transcription when discussing Classical Arabic while [g] was used to transcribe the Najdi data. This had no bearing on the results since the focus was on coda clusters.

Figure 6 Pronunciation of /gɑbər/ by Participant 10



g ɑ b ə r

Falling Sonority

All participants pronounced two-consonant clusters without modification when the difference in falling sonority was only one step. Since this type of cluster was allowed in Najdi Arabic, falling sonority clusters with a sonority distance of two or three steps were also allowed (see Broselow & Finer, 1991). Thus, clusters comprising two consonants differing by two sonority steps had the same result as those differing by one step. The words used to test this hypothesis were /bejn/ "between," /ħelf/ "swear," /ħɑrf/ "letter," /sɪlk/ "wire," and /bɑrd/ "cold." These words yielded the anticipated results, as all participants pronounced them without modification. As expected, clusters with three steps (/sejf/ "sword" and /kejd/ "deception") likewise showed no vowel insertion.

OT was implemented to account for the favored order of constraints in Najdi Arabic. Several possible outputs can be obtained from a given input in OT and are ordered according to a constraint hierarchy, which determines which forms are well-formed and which are not (Nathan, 2008). Markedness constraints influence the selection of the output based on rules defining well-formedness, while faithfulness constraints influence the input as well as the output, pressuring the output to avoid deviation from the input (Prince & Smolensky, 2004, p. 106). Since CV is the most unmarked syllable structure (Carlisle, 2001; Prince & Smolensky, 2004), CV and CVC are the main syllables in Classical Arabic (Kiparsky, 2003), and CVC is the main pattern in Najdi Arabic, it appeared obvious that ONSET was obligatory in Najdi Arabic. Thus, the basic constraint ranking was as follows in (1).

(1) ONSET >> NOCODA

Since the proposed methods to produce the coda clusters were either faithful to the Classical Arabic forms or involved vowel insertion, the first OT constraints discussed should be NOCODA and DEP (see Table 1).

Table 1 Tableau of /bɑrd/ Favoring /bɑrd/

Input: bɑrd	DEP	NOCODA
a. bɑrəd	*!	*
b. bɑrədə	*!	
c. → bɑrd		*

DEP clearly outranked NOCODA in Najdi because all participants uttered /bɑrd/ with no epenthesis, leading to the constraint ranking in (2).

(2) ONSET >> DEP >> NOCODA

*COMPLEX was added to determine which constraint would be preserved more often by Najdi speakers. In other words, would they more likely avoid violating *COMPLEX or DEP, even if the latter would require uttering a complex coda? As presented in Table 2, Najdi speakers showed no difficulties producing complex coda clusters and did not epenthesize them.

Table 2 Tableau of /bɑrd/ Favoring /bɑrd/ Involving *COMPLEX

Input: bɑrd	DEP	*COMPLEX	NOCODA
a. bɑrəd	*!		*
b. bɑrədə	*!		
c. → bɑrd		*	*

This choice indicated that the constraint ranking for Najdi would place *COMPLEX at the same level as NOCODA, as shown in (3).

(3) ONSET >> DEP >> *COMPLEX, NOCODA

Rising Sonority

Najdi speakers pronounced rising sonority clusters differently from falling sonority clusters. All participants added epenthetic vowels to this cluster regardless of how many sonority steps there were between the two consonants. More specifically, when the difference in sonority was three steps, they always added epenthesis. Instead of producing the clusters in /sˤɑfw/ “clarity” and /qɑbw/ “basement” as they would be in Classical Arabic (CC#), the participants inserted a vowel inside each cluster, turning these into disyllabic words, /sˤɑ.fəw/ and /gɑ.bəw/.

Eckman (1991) and Carlisle (1998) claimed that no language should have obstruent-liquid as an onset cluster and lack obstruent-glide clusters since the latter is less marked than the former. Since participants in the present study used epenthesis in three-step sonority clusters, it was thus likely that two- and one-step sonority clusters would display epenthesis according to the principles of markedness. For example, /rɑmj/ “throwing,”

/qɪʃr/ “peel,” /tˤɪfl/ “child,” /qɑbl/ “before,” and /qɑbr/ “grave” had clusters differing by two steps, while /telw/ “after,” /dʒɑrw/ “puppy,” /rɑml/ “sand,” /dʒɑmr/ “firebrands,” /dʒefn/ “eyelid,” and /ʔɪbn/ “son” had one step. In the data, these words displayed epenthesis in the same way as words with clusters of three sonority steps. Specifically, Najdi speakers’ productions were transcribed as /rɑ.məj/, /gɪ.ʃər/, /tˤɪ.fəl/, /gɑ.bəl/, /gɑ.bər/, /te.ləw/, /dʒɑ.rəw/, /rɑ.məl/, /dʒɑ.mər/, /dʒe.fən/, and /ʔɪbən/.

The emergence of an epenthetic vowel increased the need to implement OT. As justified before, the constraint ranking for Najdi so far is shown in (4).

(4) ONSET >> DEP >> *COMPLEX, NOCODA

Since the constraint DEP was violated by participants, it was necessary to rearrange this ranking. This called into question what led participants to violate this constraint and whether cluster sonority was the cause. Therefore, the SSP was incorporated as a constraint to determine to what extent it could be violated in Najdi, as exemplified in Table 3.

Table 3 Tableau of /qɑbl/ Favoring /gɑ.bəl/

Input: qɑbl	SSP	DEP	*COMPLEX	NOCODA
a. → gɑ.bəl		*		*
b. gɑ.bə.lə		**!		
c. gɑbl	*!		*	*

This clearly showed how SSP was valuable in Najdi; Najdi speakers added an epenthetic vowel whenever they encountered a cluster violating the SSP. Thus, the constraint ranking was modified to the one in (5).

(5) ONSET >> SSP >> DEP >> *COMPLEX, NOCODA

Plateau Sonority

For plateau sonority clusters, the results indicated two procedures that participants followed. Four words were produced with no modifications, while one was modified with epenthesis. Since the insertion occurred only between sonorants and never between obstruents, obstruents and sonorants are discussed in the next two sections with this in mind.

Obstruents. Obstruents in consonant clusters included stops and fricatives. There was a stop-stop cluster in /ħɪqd/ “spite,” stop-fricative in /sɑqf/ “roof,” fricative-fricative in /nɑfs/ “self,” and fricative-stop in /sɑfk/ “shed.” These words were produced by all participants without modification, CC#. This followed from Carnie (1994), who stated that Modern Irish consonants closer to the syllable nucleus had a sonority the same as or exceeding the adjacent consonant in a given cluster since that consonant had a greater distance from the nucleus.

Participants did not insert vowels into any falling sonority clusters but did insert vowels into all rising sonority clusters. Furthermore, they did not insert vowels into any plateau sonority clusters when their components were obstruents but did apply epenthesis between two sonorants. Therefore, the constraint SSP was explored. At this point, NO RISING SON was ranked higher than DEP since all participants added epenthesis to the rising sonority clusters, but the competition between DEP and NO PLATEAU SON remained unclear since the results showed both insertion and no insertion. One of the words containing a rising sonority cluster is explained in Table 4.

Table 4 Tableau of /rɑml/ Favoring /rɑ.məl/

Input: /rɑml/	NO RISING SON	DEP	*COMPLEX	NOCODA
a. → rɑ.məl		*		*
b. rɑ.mə.lə		**!		
c. rɑml	*!		*	*

At this point, the constraint ranking was as follows in (6).

(6) ONSET >> NO RISING SON >> DEP >> NO FALLING SON, *COMPLEX, NOCODA

Adding NO PLATEAU SON changed this to the ranking in (7), as explained in Table 5.

(7) ONSET >> NO RISING SON >> DEP >> NO PLATEAU SON, NO FALLING SON, *COMPLEX, NOCODA

Table 5 Tableau of /ħɪqd/ Favoring /ħɪgd/

Input: /ħɪqd/	NO RISING SON	DEP	NO PLATEAU SON	*COMPLEX	NOCODA
a. ħɪ.gəd		*!			*
b. ħɪ.gə.də		**!			
c. → ħɪgd			*	*	*

Sonorants. With sonorant clusters, /sɑmn/ “fat” was the only word showing epenthesis, /sɑ.mən/, similar to Modern Irish (Carnie, 1994). Also, Bat-El (2012) indicated that sonorants were not allowed in Hebrew onset clusters, while obstruents were permitted “(lavan-a > levan-a, *lvan-a, katana > ktana)” and that there was a tendency to avoid onsets with sonorants at a plateau sonority (p. 325).

Some plateau sonority clusters contained an epenthetic vowel while others did not, based on the type of consonants in the cluster. To account for this, the NO PLATEAU SON constraint was divided into NO SON + SON and NO OBS + OBS, as shown in Table 6.

Table 6 Tableau of /sɑmn/ Favoring /sɑ.mən/

Input: /sɑmn/	NO RISING SON	NO SON + SON	DEP	NO OBS + OBS	*COMPLEX	NOCODA
a. → sɑ.mən			*			*
b. sɑ.mə.nə			**!			
c. sɑmn		*!			*	*

The constraint ranking was thus revised to the one in (8).

(8) ONSET >> NO RISING SON, NO SON + SON >> DEP >> NO OBS + OBS, NO FALLING SON, *COMPLEX, NOCODA

Considering the preferred ranking of the three possible ways of avoiding clusters violating the SSP (MAX, IDENT, DEP), all participants used only one: inserting a vowel between the two consonants in the cluster. In other words, they ranked MAX and IDENT higher than DEP. An example of this is given in Table 7.

Table 7 Tableau of /qɑbl/ Favoring /gɑ.bəl/

Input: qɑbl	SSP	MAX	IDENT	DEP	COMPLEX	NOCODA
a. gɑbl	*!				*	*
b. gawl			*!		*	*
c. gal		*!				*

d. → gɑ.bəl				*		*

Taking this into account, the final ranking of constraints is given in (9).

(9) ONSET >> NO RISING SON, NO SON + SON >> MAX, IDENT >> DEP >> NO OBS + OBS, NO FALLING SON, *COMPLEX, NOCODA

Conclusion

This is one of the few studies on cluster reduction in Najdi Arabic. It supports the SSP and adds to the discussion on why speakers of different languages use different strategies for reducing consonant clusters. The hypothesis was that Najdi speakers would only modify SSP-violating clusters. Falling sonority clusters (as in /ħɪlf/ "swear") were expected to be produced without modification, whereas rising sonority clusters (as in /qɑbr/ "grave") were expected to be modified. Plateau sonority clusters were included to see how they would be produced. Similar to Zahedi et al.'s (2012) study on Sanandaji Kurdish, the present study found that the SSP was fundamental in explaining Najdi coda clusters.

Unlike studies that found participants used more than one solution to resolve marked clusters (e.g., Flack, 2009; Hansen, 2001; Major, 2008; Zahedi et al., 2012; Zampini, 2008), Najdi speakers in the present study only used epenthesis between the first and second consonant in a coda cluster. This suggested they were concerned with following the SSP first, and when encountering structures violating it, would be more likely to rank DEP (no insertion) below MAX (no deletion) and IDENT (no feature alteration). As a result, they added an epenthetic vowel in the most marked clusters (rising and plateau sonority clusters consisting of two sonorants).

The expectations based on MSD were when a falling cluster with one step of sonority in a coda was allowed, then two and three steps must also be allowed, and if Najdi speakers could produce a rising cluster with three steps of sonority in a coda, this would imply they had acquired one and two steps as well. This was confirmed in the results. In addition, markedness suggests that plateau sonority clusters containing sonorants and rising sonority clusters are more marked than plateau sonority clusters containing obstruents and falling sonority clusters. Participants were thus predicted to modify the more marked clusters but not the less marked.

Based on the results, Najdi Arabic allowed consonant clusters in the coda, but the clusters were organized so that they always followed the SSP. Since not all coda clusters in Classical Arabic obey the SSP, as in /qɪʃr/ "peel," Najdi speakers inserted an epenthetic vowel in such clusters, /gɪʃər/. The interaction of markedness and faithfulness constraints led to the most optimal outputs in different environments. The final ranking for constraints in Najdi was ONSET >> NO RISING SON, NO SON + SON >> MAX, IDENT >> DEP >> NO OBS + OBS, NO FALLING SON, *COMPLEX, NOCODA.

Although each level of sonority was treated identically by speakers, the researcher did not include all of the sounds belonging to each set. Therefore, it would be interesting if the sequences nasal + liquid [nr, nl, rn, ln] and liquid + obstruent [ls, rʃ, sl, ʃl, lq, rt, ql, tr] were considered in future studies. Additionally, since this study was based on monosyllabic words, future work could employ disyllabic or trisyllabic words, which might show that stress plays a role in determining how speakers produce rising, plateau, and falling sonority coda clusters.

Finding Arabic words with clusters containing two glides or liquids as well as [nm] was difficult. Since the study divided the plateau sonority cluster category into sonorants and obstruents, the instrument should have had more items to confirm that the sonorant category would trigger epenthesis while the obstruent category would not. Other Arabic dialects could be investigated to see if they support the results from Najdi. Studies could also test whether words borrowed from other languages would be modified like native Arabic words (cf. Zahedi et al., (2012).

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