ISSN 1799-2591
Theory and Practice in Language Studies, Vol. 14, No. 6, pp. 1688-1696, June 2024
DOI: https://doi.org/10.17507/tpls.1406.09

An Optimality-Theoretic Analysis of Syllable Structure in Najdi Arabic

Mohammed Q. Ruthan
Department of English Language and Literature, Prince Sattam Bin Abdulaziz University, Al-Kharj, Saudi Arabia

***Abstract*—This paper provides a constraint-based analysis of the syllable structure of onset consonant sequences in Najdi Arabic, spoken in central Saudi Arabia. Unlike Classical or Standard Arabic, Najdi is believed to allow consonant clusters in the onset. The study tested two assumptions. The first is that Najdi onset clusters result from a vowel deletion process, leading to different kinds of clusters with distinct sonority hierarchies and that these form complex onsets. The second is that Najdi inputs are different from Classical or Standard Arabic, in which there is no vowel in the underlying representation and hence no deletion occurs, resulting in simplex onsets. The paper adopted optimality theory to analyze the data, considering a phenomenon that occurs in the speech of Najdi speakers. Following this framework, constraints were utilized to demonstrate the syllable structure of the onset clusters in Najdi according to the above assumptions. The results revealed consonant sequences rather than consonant clusters, meaning the consonants were not parsed in the same syllable, agreeing with previous acoustic research.**

***Index Terms*—Arabic, consonant sequence, Najdi, optimality theory, simplex onset**

I. Introduction

Arabic dialects are spoken in regions and countries across the Middle East and North Africa (Albirini, 2016; Bale, 2010). As such, they can be broadly divided into Eastern and Western dialects. The Eastern dialects can be further divided into those of the Arabian Peninsula (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, the United Arab Emirates, and Yemen), the Syro-Lebanese dialects (Jordan, Lebanon, Palestine, and Syria), and the Mesopotamian dialect (spoken in Iraq). The Western dialects are spoken in Morocco, Tunisia, Algeria, Libya, and Mauritania (Kaye & Rosenhouse, 1997; Versteegh, 2013). These dialects differ at the phonological, morphological, syntactic, semantic, and pragmatic levels.

According to Versteegh (2013), there are four main groups of dialects in the Arabian Peninsula: the north-west Arabian dialects, the north-east Arabian (Najdi) dialects, the Hijazi dialects, and the south-west Arabian dialects. According to Ingham (1994), Najdi Arabic can be split into four regions: Mixed Central and Northern Najdi, Central Najdi, Northern Najdi, and Southern Najdi. Even though Ingham pointed out that they are phonologically almost the same, these subgroups may differ linguistically on a number of levels. The current study examined Central Najdi Arabic, the dialect spoken in Riyadh and the surrounding areas.

In Standard and Classical Arabic, consonant clusters are not permitted in the onset position, but they are permitted in some colloquial dialects, including Moroccan, Najdi, and Jazani Arabic. Some researchers have assumed that the onset consonant clusters in Najdi Arabic are the result of the deletion of a vowel in nouns, adjectives, and verbs of the syllable structure CVC.CVC, as shown in (1). These onset consonant sequences show different sonority profiles, including rising (a), plateau (b), and falling (c).

(1)		Standard Arabic	Najdi Arabic	Gloss
a.	Rising sonority	[turab]	[trab]	“soil”
		[ħimar]	[ħmar]	“donkey”
				(Alghmaiz, 2013)
b.	Plateau sonority	[baqarah]	[bgʌrʌh]	“cow”
		[ʃuħum]	[ʃħum]	“fats”
c.	Falling sonority	[rumuʃ]	[rmuʃ]	“eyelashes”
		[lisæn]	[lsæn]	“tongue”
				(Alkhonini, 2021)

Such consonant sequences raise the question of whether they are simplex or complex. Fortunately, this question has been addressed (see Alkhonini, 2021; Alkhonini & Kwon, 2023). In another direction, the present study examined Najdi onset consonant sequences acoustically to show they constitute simplex onsets. Based on these findings, the study provides an optimality theory analysis that complements the acoustic data.

The Significance of the Study

The aim of this study is to present a constraint-based analysis of the syllable structure of word-initial consonant sequences in Najdi Arabic based on optimality theory (Prince & Smolensky, 2004). It demonstrates how the consonant sequences should be represented with optimality theory constraints as simplex rather than complex onsets. By shedding light on the syllable structure of Najdi consonant sequences, the findings suggest that other Arabic varieties considered to allow onset clusters should be revisited based on this approach.

II. Literature Review

A. *Arabic Syllable Structure*

Numerous phonologists (e.g., Carlisle, 2001) consider CV to be the universal syllable structure. The syllable structure of Arabic consists of one peak and does not permit more than one vowel (Angoujard, 1990). Although the consonant cluster is allowed in coda position, the Arabic syllable starts with one consonant and ends with a consonant or a vowel: CV or CV(C) (Kiparsky, 2003). Consequently, according to Abushihab (2010), Classical Arabic does not allow consonant clusters in the onset but does allow them in the coda. In Classical Arabic, the coda cluster can consist of two segments which are equal in sonority or two segments, the first being more sonorous and the second less sonorous, or vice versa. Classical Arabic does not have onset clusters and requires that a syllable not begin with a vowel (Abushihab, 2010).

However, onset clusters can be found in various dialects of Arabic. Due to geographical distribution and political divisions, Arabic has many varieties that are spoken in different countries, which have different syntactic, sociolinguistic, and phonological structures previously explored by linguists such as Fouad (1964), Sieny (1972), Almozainy (1981), Shaw et al. (2009, 2011), and Theodoropoulou and Tyler (2014).

Classical Arabic is not used in everyday speech but can appear in formal situations (Ferguson, 1959). Speakers of Arabic now speak the variety associated with the area they live in. For instance, in Saudi Arabia, there are different dialects with different phonological structures. Dialects like Najdi and Hijazi have been extensively studied, showing syllable structures similar to or diverging from Classical Arabic. For example, Alqahtani (2014) and Al Motairi (2015) discussed Najdi and Qassimi Arabic, respectively.

Abboud (1979) and Ingham (1994) found onset consonant clusters to be a feature of the Najdi dialect. Ammar and Alhumaid (2009) argued that Najdi has a different syllable structure (CVC) from Classical Arabic. Alqahtani (2014) discussed different phonological processes, such as metathesis, epenthesis, vowel shortening, and syncope, affecting Najdi syllable structure. He found that bi-consonantal clusters in Najdi resulted from these processes. Several studies (e.g., Alghmaiz, 2013; Alqahtani, 2014) have directly or indirectly assumed that Najdi Arabic has complex onsets because it allows onset consonant clusters. However, Alkhonini (2021) acoustically demonstrated that Najdi has simplex rather than complex word-initial consonant sequences.

B. *Sonority Sequencing Principle*

The sonority sequencing principle (SSP) restricts clusters to a phonetic hierarchal system (Carlisle, 2001). It requires the syllable to have only one segment to function as the peak of the syllable (the most sonorous segment, usually the vowel), followed and proceeded by a segment that falls in sonority compared to the peak. Therefore, the SSP with the sonority hierarchy determines segment ordering in consonant clusters. Segments that are more sonorous should appear close to the peak, whereas segments that are less sonorous should appear farther from the peak (Dressler, 1992). In other words, the first consonant in the onset cluster should be lower in sonority and the second should be higher in sonority. Therefore, onset clusters that show this pattern are known as “rising sonority” clusters. As for coda clusters, SSP requires the inverse of the pattern described above, showing a decrease in sonority; that is, the first consonant is higher in sonority and the second is lower, i.e., “falling sonority” (Carlisle, 2001). The sonority hierarchy is based on the consonants’ manner of articulation, as proposed by Carlisle (2001), as seen in Figure 1.

Nucleus
Vowels
Glides Glides
Onset Liquids Liquids *Coda*
Nasals Nasals
Fricatives Fricatives
Stops Stops

Figure 1. The Consonant’s Sonority Hierarchy (Carlisle, 2001)

However, conformity to this hierarchy is not absolute. Some languages (e.g., English) conform more to it, while others do not, such as Polish (Rubach & Booij, 1990). Even though the SSP can explain the ordering of segments in a cluster, it cannot tell the difference between a good and a bad consonant cluster. For instance, Duanmu (2002) used /pl/ and /tl/ clusters to demonstrate how the first is accepted in English onset clusters, as in the word “play,” whereas the latter is not accepted, although both combinations have the same sonority slope: stop > liquid.

Many studies have tested the validity of the SSP using the phonological and syllable structures of different languages (Carlisle, 1991). One method is to ask participants to pronounce some words that obey the SSP and other words that do not. Carlisle (1991), for instance, tested Spanish speakers' production of /st-/ and /sl-/ onset clusters. He recruited 11 native Spanish speakers, asking them to read a passage that contained 290 sentences including a word in each sentence with the target combinations. The results showed a significant difference between onset clusters. The participants tended to use epenthesis more (36%) when the cluster did not follow the SSP, namely with /st-/ because it reversed the sonority hierarchy from fricative > stop. With /sl-/, they used epenthesis only 25% of the time since it did not violate the SSP.

However, some consonant combinations obey the SSP but are not allowed in certain languages. For instance, English allows two- and three-consonant onset clusters but not the onset combination /pn-/ or /ps-/, while these are allowed in other languages, such as Greek *pnefmonia* "pneumonia" and *psycholgia* "psychology" (Roca & Johnson, 1999).

C. Word-Initial Consonant Sequences and SSP in Najdi Arabic

Previous researchers have argued that Najdi Arabic onset consonant clusters result from the deletion of short high vowels (e.g., Alghmaiz, 2014). This assumption is based on setting Standard Arabic as a reference point for comparison with colloquial dialects like Najdi. Others have argued that the input or underlying representation for Najdi Arabic is not the same as Standard Arabic, given that Classical or Standard Arabic is not a native language for Arabic speakers acquired from early childhood. Thus, examples and explanations for both accounts are provided when possible.

Based on the first assumption, unstressed vowels tend to be omitted in casual speech in Najdi Arabic (Alghmaiz, 2013) and other varieties, such as Yemeni (Yaari et al., 2012), Ammani (Daana, 2009), and Palestinian (Abu-Salim, 1982) Arabic. This pattern has likewise been observed in other languages, such as English (Glowacka, 2001). For example, in Standard Arabic, the word /bʊður/ "seeds" is pronounced with no consonant clusters, but omitting the short vowel results in a word-initial cluster /bður/ in Najdi Arabic (Alghmaiz, 2013; Alqahtani, 2014). Table 1 shows further examples of this phenomenon, adapted from Alghmaiz (2013).

TABLE 1
WORD-INITIAL CONSONANT CLUSTERS IN NAJDI ARABIC

Consonant Pattern	Consonant Combination	Najdi Arabic	Standard Arabic	Gloss
Stop + Fricative	/ts/	/tsamʊħ/	/tasamʊħ/	forgiveness
Fricative + Nasal	/ðn/	/ðnub/	/ðʊnub/	sins
Liquid + Glide	/rw/	/rwajah/	/rɪwajah/	a novel
Nasal + Glide	/mw/	/mwafɪq/	/muwafɪq/	agreed
Stop + Liquid	/tr/	/trab/	/tʊrab/	soil

According to the second assumption, these word-initial consonant sequences are not the result of vowel deletion and instead represent the underlying form in Najdi Arabic. This is because Arabic is defined by diglossia, where children acquire the colloquial varieties at home and through everyday communication with family and friends, while standard forms are taught in school and restricted to formal situations, such as government documents, mass media, and newspapers (Ferguson, 1959; Haddad, 2005). According to Arabic sociolinguists such as Jasim and Sharhan (2013), these colloquial varieties have different vocabulary, grammar, and phonology from that of Classical and Standard Arabic. Thus, native-speaking children of the Najdi dialect acquire it at home before they go to school, thereby learning Najdi before Standard Arabic (Alkhonini, 2021). Based on this, in this study it is assumed that the input in Najdi would correspond with the output unless shown otherwise.

In optimality theory, one can assume that the input corresponds to the output except when there is a reason to depart from that rule due to lexicon optimization (Kager, 1999). Lexicon optimization assumes that the selected underlying form is the one that corresponds to the surface form with the least violation. Since the inputs in the current study were derived from Najdi Arabic, those inputs were expected to correspond to the outputs in Najdi Arabic. Table 2, adapted from Alkhonini (2021), shows a sample of word-initial consonant sequences in Najdi Arabic with no comparison to standard forms.

TABLE 2
WORD-INITIAL CONSONANT CLUSTERS IN NAJDI ARABIC

Consonant Pattern	Consonant Combination	Najdi Arabic	Gloss
Stop + Fricative	/k+s/	/kfuf/	injuries
Fricative + Liquid	/ʕ+l/	/ʕlædʒ/	cure
Liquid + Stop	/l+b/	/lbæn/	chewing gum
Glide + Liquid	/w+r/	/wrəgəh/	paper
Nasal + Fricative	/n+f/	/nfus/	selves
Fricative + Fricative	/ʃ+ħ/	/ʃħum/	fats

As illustrated by Table 2, Najdi Arabic allows word-initial consonant sequences with rising, plateau, and falling sonority. However, this production does not always occur. According to Alghmaiz (2013) and Alkhonini (2021), epenthesis sometimes appears. For example, Alghmaiz (2013) observed that the words /ħɪmar/ "donkey" and / ðʊnub/

"sins" were produced 80% of the time with a consonant cluster and 20% of the time with prothesis, as /ɪħmar/ and /uǒnub/. Alkhnonini (2021) found that prothesis was used more with word-initial consonant sequences with falling sonority such as /ɪwrəgəh/ "paper." Such patterns were taken into consideration in the current study as they could form possible candidates.

III. DATA

The primary sources of data were the studies by Alkhonini (2021), Alkhonini and Kwon (2023), and Alghmaiz (2013) on word-initial consonant clusters in Najdi Arabic spoken in and around Riyadh, the hub of this dialect, located in the Najd region of central Saudi Arabia.

IV. ANALYSIS AND DISCUSSION

A. Syllabification of Word-Initial Consonant Sequences in Najdi Arabic

The association between the syllabification of word-initial consonant sequences and temporal patterns has been shown by previous research (e.g., Browman & Goldstein, 1988; Byrd, 1995; Goldstein et al., 2009; Hermes et al., 2013; Hermes et al., 2017; Shaw et al., 2009, 2011). That is, the syllabic parsing can be ascertained by timing the speech segments (consonants and vowels). In their pioneering articulatory study of American English, Browman and Goldstein (1988) found that no matter how many consonants were added to the word-initial consonant sequence, the mean of the midpoints of the consonant sequence (the c-center) remained stable to the end of the following vowel (the anchor). Consequently, the time interval between the midpoint of the rightmost consonant (the right edge) and the end of the vowel (the anchor) was reduced as more consonants were added word-initially. Their findings suggested that the English word-initial consonant sequences, which are typically thought to generate complex onsets, may have an observable c-center-to-anchor interval stability in the articulatory domain. This finding has since been replicated in different languages with complex onsets, such as Georgian (Goldstein et al., 2007), Italian (Hermes et al., 2013), Romanian (Marin & Pouplier, 2014), and Polish (Hermes et al., 2017), and languages with simplex onsets, such as Moroccan Arabic (Shaw et al., 2009, 2011). The temporal measurements have likewise been replicated acoustically in languages with complex onsets, such as American English (Ruthan et al., 2021; Selkirk & Durvasula, 2013), and simplex onsets, such as Jazani Arabic (Ruthan et al., 2021; Ruthan, 2020) and Najdi Arabic (Alkhonini, 2021). The bottom line is that languages with complex onsets show a c-center stability pattern with word-initial consonant sequence syllabification being tautosyllabic, #CCVX, whereas languages with simplex onsets show right-edge stability with word-initial consonant sequences being heterosyllabic, #C.CVX. Such findings are important for understanding the syllable structure of Najdi Arabic through an optimality theory analysis.

B. Optimality Theory Analysis of Najdi Arabic Word-Initial Consonant Sequences

(a). Najdi Consonant Sequences as Complex Onsets

Syllable structures have been analyzed using various approaches. However, since its introduction in 1993, optimality theory has grown to be the most significant framework in this area (McCarthy & Prince, 1993, 1995; Prince & Smolensky, 2004). The power of this theory is that it accounts for the relationship between a provided input form and a specific output form. Accordingly, this framework is used to analyze the syllable structure of word-initial consonant sequences in Najdi Arabic and related processes such as prothesis.

According to McCarthy (2008), the optimality theory mechanism can be described as an input-output relationship where each input has a specific output. Both GEN (for GENERATOR), which produces an unlimited number of potential candidates, and EVAL (for EVALUATOR), which evaluates candidates through constraints, are essential parts of any grammar that are required for this mechanism to function (Kager, 1999). In optimality theory, there are two types of constraints, markedness and faithfulness constraints. The former provides broad generalizations about well-formedness, while the latter requires that the input and output match (Prince & Smolensky, 2004).

This section accounts for the analysis of word-initial consonant sequences in Najdi using optimality theory constraints pertaining to sonority and syllabic parsing. To clarify the variations of word-initial consonant sequences in this dialect, it was noticed that the constraint of syllabic parsing needs to be ranked higher to account for different types of these simplex onsets. Thus, a new constraint is proposed.

As mentioned earlier, the cause of word-initial consonant sequences in Arabic is debated. Some argue that vowels are part of the input for such words, while others claim they are not. The most important point here is the input needed to perform the optimality theory analysis. The author followed Alkhonini (2021) in assuming that words with word-initial consonant sequences had an underlying representation of /CCVC/. Thus, the inputs in the optimality theory table would be, for instance, /gsˤur/ "palaces," which is expected to be the optimal candidate for Najdi Arabic, while /gusˤur/ would be the optimal form for Standard Arabic, as demonstrated in Table 3. The ONS and FTBIN constraints are defined below:

ONS: A syllable must start with a consonant. (Prince & Smolensky, 2004)
FTBIN: Feet are binary under moraic or syllabic analysis. (Kager, 1999)

TABLE 3

/gusˤur/	*COMP-ONS	FTBIN	ONS	MAX-IO	CONTIGUITY-IO	DEP-IO
☞ a. (gu).sˤur						
b. (ɪg).sˤur			*!			*
c. (gsˤur)	*!	*				
d. (sˤur)		*!		*		
e. (gɪ.sˤur)					*!	*
f. (gur)		*!		*		

Table 3 picks (a) as the optimal candidate as it satisfies Standard Arabic phonology by avoiding a complex onset and an onsetless syllable structure, thereby not violating highly ranked constraints. The closest candidate to the optimal candidate is (e), which violates CONTIGUITY-IO and is thus eliminated. To eliminate the next closest candidate, candidate (c), Standard Arabic sets *COMP-ONS and FTBIN constraints as highly ranked, which candidates (c), (d), and (f) violate, whereas candidate (b) violates the third highest ranked constraint, ONS.

In order for Najdi Arabic to pick candidate (c), the highest constraint, as the dialect presumably allows complex onsets, *COMP-ONS needs to be ranked low and FTBIN removed from the set of constraints, as illustrated in Table 4.

TABLE 4

/gsˤur/	ONS	MAX-IO	CONTIGUITY-IO	DEP-IO	*COMP-ONS
a. gusˤur			*!	*	
b. ɪgsˤur	*!			*	
☞ c. gsˤur					*
d. sˤur		*!			
e. gɪ.sˤur			*!	*	
f. gur		*!			

As a result, candidate (c) is picked as the optimal candidate since it does not violate any of the constraints. Candidate (a) is the next closest since it violates the least fatal constraint, DEP-IO. Candidate (b) is eliminated because it begins with a vowel, violating the highest ranked constraint, ONS. Candidate (d) deletes the consonant /sˤ/ and candidate (f) deletes /g/, so both violate MAX-IO, while candidate (e) still violates the same constraint CONTIGUITY-IO, because of the epenthesized vowel.

However, if Najdi Arabic allows falling sonority onset sequences, allowing another candidate /sˤgur/ “falcons,” the constraints in Table 4 will not produce the optimal candidate. Instead, there will be two winning candidates, as shown in Table 5.

TABLE 5

/gsˤur/	ONS	MAX-IO	CONTIGUITY-IO	DEP-IO	*COMP-ONS
a. gusˤur			*!	*	
b. ɪgsˤur	*!			*	
☞ c. gsˤur					*
☞ d. sˤgur					*
e. sˤur		*!			
f. gɪ.sˤur			*!	*	
g. gur		*!			

Table 5 shows that both /gsˤur/ and /sˤgur/ win, since they only violate the lowest ranked constraints. However, because the input is /gsˤur/, candidate (c) would be more ideal. Therefore, to get (c) as the optimal candidate, Table 6 adds the SSP constraint, as defined below:

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

TABLE 6

/gsˤur/	ONS	SSP	MAX-IO	CONTIGUITY-IO	DEP-IO	*COMP-ONS
a. gusˤur				*!	*	
b. ɪgsˤur	*!				*	
☞ c. gsˤur						*
d. sˤgur		*!				*
e. sˤur			*!			
f. gɪ.sˤur				*!	*	
g. gur			*!			

In Table 6, candidate (d) is eliminated because it violates the new constraint (SSP). Candidate (d) has a falling sonority onset; that is, /sˤ/ is a fricative and so is more sonorous and followed by /g/, a stop, which is less sonorous, where in onsets the sonority should increase and not decrease, according to the SSP. Thus, the constraint ensures that candidate (c) is the optimal candidate by not violating any constraint.

In addition to being a possible candidate, /sˤgur/ also needs to be considered as an input. In other words, if /sˤgur/ is an input, the winning candidate must have an identical output, /sˤgur/. However, the constraints outlined above might not produce the desired candidate, as demonstrated in Table 7.

TABLE 7

/sˤgur/	ONS	SSP	MAX-IO	CONTIGUITY-IO	DEP-IO	*COMP-ONS
a. sˤugur				*!	*	
b. ɪsˤgur	*!				*	
☞ c. gsˤur						*
d. sˤgur		*!				*
e. gur			*!			
f. sˤɪ.gur				*!	*	
g. sˤur			*!			

Table 7 shows candidate (c) as the optimal candidate, while the desired candidate is eliminated by the SSP constraint. Re-ranking the constraints does not change the results, since candidate (c) does not violate any of the constraints. Thus, to get candidate (d) as the optimal candidate, another constraint is needed, namely LINEAR-IO (see Table 8). This constraint is defined below:

LINEAR-IO: No metathesis, no movement. (McCarthy, 2008)

S1 reflects the precedence structure of S2, and vice versa. (Pater, 1995)

TABLE 8

/sˤgur/	ONS	LINEAR-IO	MAX-IO	CONTIGUITY-IO	DEP-IO	*COMP-ONS
a. sˤugur				*!	*	
b. ɪsˤgur	*!				*	
c. gsˤur		*!				*
☞ d. sˤgur						*
e. gur			*!			
f. sˤɪ.gur				*!	*	
g. sˤur			*!			

The LINEAR-IO constraint eliminates candidate (c), which shows metathesis of the initial consonant sequence in the input. Note that this constraint does not determine whether /sˤg/ is possible or conforms to the SSP. Table 9 re-evaluates the previous word, /gsˤur/ “palaces”.

TABLE 9

/gsˤur/	ONS	LINEAR-IO	MAX-IO	CONTIGUITY-IO	DEP-IO	*COMP-ONS
a. gusˤur				*!	*	
b. ɪgsˤur	*!				*	
☞ c. gsˤur						*
d. sˤgur		*!				*
e. sˤur			*!			
f. gɪ.sˤur				*!	*	
g. gur			*!			

Table 9 shows that the LINEAR-IO constraint solves the previous problem when the SSP constraint was used. The LINEAR-IO constraint eliminates candidate (d), the candidate with metathesis, regardless of whether /sˤg/ is a possible combination in the dialect or conforms to the SSP. What is important to the constraint is to have faithful output that looks like the input. Therefore, the optimal candidate in both cases is not the one that conforms to the SSP but the one that matches the segment sequence.

Candidates with prothesis have been eliminated in all previous analyses, which should not be the case. According to Alghmaiz (2013) and Alkhonini (2021), some words with word-initial consonant sequences, especially those with a falling sonority profile, are broken up by inserting an initial vowel (prothesis). For example, the word /wrəgəh/ “paper” is either produced as [wrəgəh] with a word-initial consonant sequence or /ɪwrəgəh/ with prothesis. This means that a Najdi Arabic speaker can choose to produce either of these outputs and both are correct. This raises the question of what set of constraints can produce two possible surface forms.

To account for these two possible surface forms, it is necessary to introduce the framework of local optionality, specifically partial grammar order (Anttila, 1997, 2006; Anttila & Cho, 1998). Partial grammar order gives the ranking flexibility, allowing a given input to yield two or more outcomes. Put differently, the process of producing optionality involves leaving out the order in which competing constraints should be ranked and then solving that unclear portion of the grammar in a different way depending on the evaluation. Thus, the constraints in Table 10 allow two possible outputs by lowering the constraint ONS and then not ranking the constraints *COMP-ONS and ONS.

TABLE 10

/wrəgəh/	LINEAR-IO	MAX-IO	CONTIGUITY-IO	DEP-IO	*COMP-ONS	ONS
a. wərəgəh			*!	*		
b. ɪwrəgəh				*!		*
☞ c. wrəgəh					*	
d. rwəgəh	*!				*	
e. rəgəh		*!				
f. wɪrəgəh			*!	*		
g. rəgəh		*!				

Candidates (b) and (c) violate the lowest unranked constraints, but candidate (b) still violates a higher ranked constraint, DEP-IO, making candidate (c) the only optimal candidate. Therefore, the partial grammar order needs another step. That is, another constraint DEP-IO should be unranked so it can allow candidate (b) to be picked as an optimal candidate, as demonstrated in Table 11.

TABLE 11

/wrəgəh/	LINEAR-IO	MAX-IO	CONTIGUITY-IO	DEP-IO	*COMP-ONS	ONS
a. wərəgəh			*!	*		
☞ b. ɪwrəgəh				*		*
☞ c. wrəgəh					*	
d. rwəgəh	*!				*	
e. rəgəh		*!				
f. wɪrəgəh			*!	*		
g. rəgəh		*!				

(b). Najdi Consonant Sequences as Simplex Onsets

The above analyses were based on previous assumptions that word-initial consonant sequences form complex onsets (Alghmaiz, 2013; Alqahtani, 2014). Therefore, SSP was used to eliminate some candidates and evaluate others as optimal. However, recent studies such as Alkhonini (2021) and Alkhonini and Kwon (2023) have acoustically shown that word-initial consonant sequences are simplex rather than complex onsets. That is, the syllabification of word-initial consonant sequences in Najdi Arabic is heterosyllabic (#C.CV#) and not tautosyllabic (#CCVX). This means the first consonant of the word-initial sequence does not belong to the same syllable as the prevocalic consonant. In other words, the first consonant of the word-initial sequences forms a prosodic word-level appendix (Kiparsky, 2003). Based on these findings, the inputs in previous analyses should be something like #C.CV#, not #CCV#. Consequently, some constraints (e.g., SSP) are either used incorrectly (since these consonant sequences are simplex onsets, meaning they are not in the same syllable and thus do not violate SSP) or need to be re-evaluated and ranked differently (e.g., *COMP-ONS). In addition, the candidate that is optimal in previous analyses should not be due to the syllabification findings, as demonstrated in Table 12. For the sake of relevance, other possible candidates are not included in Table 12.

TABLE 12

σ μ │ │ /g.sˤur/	R-L/C-L	LINEAR-IO	MAX-IO	CONTIGUITY-IO	DEP-IO	*COMP-ONS	ONS
☞ σ μ │ │ a. /g.sˤur/							
b. gsˤur	*!					*	
μ μ │ │ c. ɪg.sˤur					*!		*
σ μ │ │ d. sˤ.gur		*!					
μ μ │ │ e. gɪ.sˤur				*!	*		
μ μ │ │ f. gu.sˤur				*!	*		

To eliminate the previous optimal candidate /gsˤur/ and account for the actual optimal candidate /g.sˤur/, the input first needs to be different from the abovementioned inputs. Second, the constraints Remote-License-C-Left (R-L/C-L) and *COMP-ONS should outrank other constraints:

*COMP-ONS: Complex onsets are not allowed. (Prince & Smolensky, 2004)

R-L/C-L: Left-edge consonants are remotely licensed. (Mahfoudhi, 2005)

Following Mahfoudhi (2005), who examined consonant clusters in Tunisian Arabic and suggested the constraint R-L/C-L to account for the left-most consonant in the onset cluster by licensing it remotely, the present study proposes using R-L/C-L to account for a similar pattern in Najdi Arabic. For instance, Mahfoudhi (2005) suggested that, for an input such as /qlam/ "a pen," the candidate [qlam] is eliminated by R-L/C-L, whereas the optimal candidate [q.lam] wins. In the present study, to account for /g.sˤur/, the constraints R-L/C-L and *COMP-ONS rule out /gsˤur/, which violates both constraints, as demonstrated in Table 12.

Table 12 shows candidate (a) as the optimal candidate, satisfying all constraints, while candidate (b) is ruled out due to violating R-L/C-L and *COMP-ONS, and candidate (c) violates the third highest inviolable constraint, ONS. Candidate (d) has a different surface form from the input due to metathesis and so is eliminated by LINEAR-IO. CONTIGUITY-IO rules out candidates (e) and (f) due to epenthetic vowels inserted between the first and second consonants.

Thus, the full and final constraints for Najdi word-initial consonant sequences, given that they are simplex onsets, are the following: R-L/C-L >> LINEAR-IO >> MAX-IO >> CONTIGUITY-IO >> DEP-IO, *COMP-ONS, ONS.

V. Conclusion

In this study, optimality theory was used to discuss the syllabification of word-initial consonant clusters in Najdi Arabic. Unlike previous accounts, which considered consonant clusters as complex onsets, in this study Najdi consonant sequences were treated as simplex onsets. Therefore, the study proposed using optimality theory constraints that set apart simplex from complex onsets and suggested a specific constraint ranking for these sequences. Based on this analysis, other varieties of Arabic claimed to have consonant sequences as complex onsets could be revisited.

Acknowledgements

This study was supported by funding from Prince Sattam bin Abdulaziz University project number PSAU/2024/R/1445.

References

[1] Abboud, P. F. (1979). The verb in northern Najdi Arabic. *Bulletin of the School of Oriental and African Studies*, *42*(3), 467–499.
[2] Abu-Salim, I. M. (1982). *A reanalysis of some aspects of Arabic phonology: A metrical approach* [Unpublished doctoral dissertation]. University of Illinois at Urbana-Champaign.
[3] Abushihab, I. (2010). Phonological contrastive analysis of Arabic, Turkish and English. *Journal of Language and Literature, (4)*, 16–24.
[4] Al Motairi, S. (2015). *An optimality-theoretic analysis of syllable structure in Qassimi Arabic* [Master's thesis, Eastern Michigan University, Ypsilanti]. Retrieved February 25, 2024, from https://commons.emich.edu/theses/612/
[5] Albirini, A. (2016). *Modern Arabic sociolinguistics: Diglossia, variation, codeswitching, attitudes and identity*. Routledge.
[6] Alghmaiz, B. A. (2013). *Word-initial consonant cluster patterns in the Arabic Najdi dialect* [Master's thesis, Southern Illinois University]. Retrieved February 25, 2024, from https://core.ac.uk/download/pdf/60559338.pdf
[7] Alkhonini, O. (2021). *Underlying representation and acoustic analyses of two-consonant initial clusters and prothesized vowels in Najdi Arabic* [Unpublished doctoral dissertation]. English Department, George Mason University.
[8] Alkhonini, O. A., & Kwon, H. (2023). Temporal organization of word-initial consonant sequences in Najdi Arabic. In R. Skarnitzl & J. Vol ń (Eds.), *Proceedings of the 20th International Congress of Phonetic Sciences* (pp. 2005–2009). Guarant International.
[9] Almozainy, H. (1981). *Vowel alternations in a Bedouin Hijazi Arabic dialect: Abstractness and stress* [Unpublished doctoral dissertation]. University of Texas, Austin.
[10] Alqahtani, M. S. M. (2014). *Syllable structure and related processes in optimality theory: An examination of Najdi Arabic* [Doctoral dissertation, Newcastle University]. Retrieved February 25, 2024, from http://hdl.handle.net/10443/2757
[11] Ammar, W., & Alhumaid, A. (2009). A phonetic study of Najdi Arabic interference in L2 acquisition of English. *Arab Journal for the Humanities*, *27*, 213–235.
[12] Angoujard, J. P. (1990). *Metrical structure of Arabic*. Walter de Gruyter.
[13] Anttila, A. (1997). Deriving variation from grammar. *Amsterdam Studies in the Theory and History of Linguistic Science Series, 4*, 35–68.
[14] Anttila, A. (2006). Variation and opacity. *Natural Language & Linguistic Theory*, *24*(4), 893–944.
[15] Anttila, A., & Cho, Y. (1998). Variation and change in optimality theory. *Lingua*, *104*(1–2), 31–56.
[16] Bale, J. (2010). Arabic as a heritage language in the United States. *International Multilingual Research Journal*, *4*(2), 125–151. https://doi.org/10.1080/19313152.2010.499041
[17] Browman, C. P., & Goldstein, L. (1988). Some notes on syllable structure in articulatory phonology. *Phonetica*, *45*, 140–155.
[18] Byrd, D. (1995). C-centers revisited. *Phonetica, 52*(4), 285–306. https://doi.org/10.1159/000262183

[19] Carlisle, R. (1991). The influence of syllable structure universals on the variability of interlanguage phonology. In A. D. Volpe (Ed.), *The Seventeenth LACUS Forum 1990* (pp. 135–145). Linguistic Association of Canada and the United States.
[20] Carlisle, R. (2001). Syllable structure universals and second language acquisition. *International Journal of English Studies, 1*(1), 1–19.
[21] Dressler, W. U. (Ed.). (1992). *Phonologica 1988: Proceedings of the 6th International Phonology Meeting*. Cambridge University Press.
[22] Duanmu, S. (2002). Two theories of onset clusters. *Chinese Phonology Journal*, *11*, 97–120.
[23] Ferguson, C. A. (1959). Diglossia. *Word*, *15*(2), 325–340.
[24] Fouad, P. A. (1964). *The syntax of Najdi Arabic* [Unpublished doctoral dissertation]. University of Texas, Austin.
[25] Glowacka, D. (2001). Unstressed vowel deletion and new consonant cluster in English. *Poznan Studies in Contemporary Linguistics*, *37*, 71–94.
[26] Goldstein, L., Chitoran, I., & Selkirk, E. (2007). Syllable structure as coupled oscillator modes: Evidence from Georgian vs. Tashlhiyt Berber. In J. Trouvain & W. J. Barry (Eds.), *Proceedings of the 16th International Congress of Phonetic Sciences* (pp. 241–244). Saarland University.
[27] Goldstein, L., Nam, H., Saltzman, E., & Chitoran, I. (2009). Coupled oscillator planning model of speech timing and syllable structure. In G. Fant, H. Fujisaki, & J. Shen (Eds.), *Frontiers in phonetics and speech science: Festschrift for Wu Zongji* (pp. 239–249). Commercial Press.
[28] Haddad, Y. (2005). *Etymological itineraries in second language phonology: The case of Arabic*. Retrieved February 25, 2024, from https://roa.rutgers.edu/files/784-1105/784-HADDAD-0-0.PDF
[29] Hermes, A., Mücke, D., & Auris, B. (2017). The variability of syllable patterns in Tashlhiyt Berber and Polish. *Journal of Phonetics*, *64*, 127–144.
[30] Hermes, A., Mücke, D., & Grice, M. (2013). Gestural coordination of Italian word-initial clusters: The case of 'impure s.' *Phonology*, *30*, 1–25.
[31] Ingham, B. (1994). *Najdi Arabic: Central Arabian*. John Benjamins.
[32] Jasim, T. A., & Sharhan, K. S. (2013). Phonological metathesis in Iraqi Arabic dialect: A synchronic perspective. *Journal of the College of Languages*, *(26)*, 1–24.
[33] Kager, R. (1999). *Optimality theory*. Cambridge University Press.
[34] Kaye, A. S., & Rosenhouse, J. (1997). Arabic dialects and Maltese. In R. Hetzron (Ed.), *The Semitic languages* (pp. 263–311). Routledge.
[35] Kiparsky, P. (2003). Syllables and moras in Arabic. In C. Fery & R. van de Vijver (Eds.), *The syllable in optimality theory* (pp. 147–182). Cambridge University Press.
[36] Marin, S., & Pouplier, M. (2014). Articulatory synergies in the temporal organization of liquid clusters in Romanian. *Journal of Phonetics*, *42*, 24–36.
[37] McCarthy, J. (2008). *Doing optimality theory: Applying theory to data*. Blackwell.
[38] McCarthy, J., & Prince, A. (1993). *Prosodic morphology: Constraint interaction and satisfaction*. Rutgers University Center for Cognitive Science.
[39] McCarthy, J., & Prince, A. (1995). Faithfulness and reduplicative identity. In J. Beckman, L. W. Dickey, & S. Urbanczyk (Eds.), *University of Massachusetts occasional papers in linguistics* (Vol. 18, pp. 249–384). GLSA Publications.
[40] Pater, J. (1995). *Austronesian nasal substitution and other N Ĩeffects.* Utrecht Prosodic Morphology Workshop.
[41] Prince, A., & Smolensky, P. (2004). *Optimality theory: Constraint interaction in generative grammar*. Blackwell.
[42] Roca, I., & Johnson, W. (1999). *A course in phonology*. Wiley.
[43] Rubach, J., & Booij, G. E. (1990). Edge of constituent effects in Polish. *Natural Language & Linguistic Theory*, *8*(3), 427–463.
[44] Ruthan, M. Q. (2020). *Aspects of Jazani Arabic* [Doctoral dissertation, Michigan State University]. Retrieved February 25, 2024, from https://d.lib.msu.edu/etd/48518
[45] Ruthan, M., Durvasula, K., Lin, Y., & Heidenreich, S. (2021). Probing syllable structure through acoustic measurements: Case-studies on American English and Jazani Arabic. *Phonology*, *38*(2), 173–202.
[46] Selkirk, E. (1984). On the major class features and syllable theory. In M. Aronoff & R. T. Oehrle (Eds.), *Language sound structure: Studies in phonology* (pp. 107–136). MIT Press.
[47] Selkirk, E., & Durvasula, K. (2013). Acoustic correlates of consonant gesture timing in English. *The Journal of the Acoustical Society of America*, *134*(5), 4202–4202.
[48] Shaw, J. A., Gafos, A. I., Hoole, P., & Zeroual, C. (2009). Syllabification in Moroccan Arabic: Evidence from patterns of temporal stability in articulation. *Phonology*, *26*(1), 187–215.
[49] Shaw, J. A., Gafos, A. I., Hoole, P., & Zeroual, C. (2011). Dynamic invariance in the phonetic expression of syllable structure: A case study of Moroccan Arabic consonant clusters. *Phonology*, *28*, 455–490.
[50] Sieny, M. E. (1972). *The syntax of urban Hijazi Arabic* [Unpublished doctoral dissertation]. Georgetown University.
[51] Theodoropoulou, I., & Tyler, J. (2014). Perceptual dialectology of the Arab world: A principal analysis. *Al-ʿArabiyya: Journal of the American Association of Teachers of Arabic*, *47*(1), 21–39.
[52] Versteegh, K. (2013). *Landmarks in linguistic thought Volume III: The Arabic linguistic tradition*. Routledge.
[53] Yaari, S. A. S., Al Hammadi, F. S., & Luwa, A. B. (2012). Vowel deletion in Arabic dialects of Yemen (ADY): A linguistic perspective. *International Journal of Linguistics*, *4*(2), 430–458.

Mohammed Q. Ruthan got his BA in English Language and Literature from Al-Imam Muhammad Ibn Saud Islamic University and graduated with a Second Honor Degree in 2010. He received his MA in Linguistics from Southern Illinois University in 2014. He was awarded his PhD in linguistics from Michigan State University in 2020. His dissertation examined phonological and sociolinguistic aspects of Jazani Arabic.