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Analysis of Stress Assignment Patterns of Standard Arabic within the Optimality Theory Framework

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Abstract
Optimality theory (OT) is the latest model of phonology which views the language acquisition process as a way of reordering universal constraints provided by Universal Grammar (UG) according to the language-specific grammar. It, therefore, presents a more promising model towards language universalities. This study aims to utilize the OT framework to provide a deep comprehensive analysis of syllable types and stress assignment system of Standard Arabic (SA). To achieve the purpose of the study, mono-syllabic, di-syllabic, tri-syllabic and quadri-syllabic words taken from SA were analyzed. Since SA is a variety that is used mainly in education, literature, law and mass media in the Arab World, the authors of the study who are PhD holders of linguistics and native speakers of SA were the informants of the data analyzed in the study. The findings of the study showed that SA involves six types of syllables which are CV, CVV, CVC, CVVC, CVCC, and CVVGG. The foot type of SA is trochaic; hence it is parsed from the left to right. The study also showed that SA involves a default-to-stress system since stress is commonly assigned to the rightmost heaviest syllable, or if a heavy syllable does not exist it will be assigned to the light leftmost one. Stress is, therefore, highly affected by syllable type and location**.** The study revealed that stress assignment system of SA is predictable and could be accounted for by utilizing a limited number of universal constraints. The following constraint hierarchy was developed to explain stress assignment in SA; Culminativity; *δδδδ>>WSP>> EDGEMOST (H; R; Word)>> Nonfinality>> EDGEMOST (L; L; Word). Finally, further studies are recommended to investigate the interaction between stress assignment and other syllable-based phonological processes to provide a full account of the phonological system of SA from an OT perspective.

Keywords: Standard Arabic, Stress Assignment, Optimality Theory.

Introduction

The Arabic language has different varieties, namely, Classical Arabic, Standard Arabic (SA), and Colloquial Arabic. Classical Arabic is an old variety that is used in the holy Quran and old religious writings

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and literature; SA, on the other hand, is the formal variety that is highly used nowadays in formal situations, and in literary work. Colloquial Arabic is the one that is used in everyday conversations. Each country, city, or area might have a different colloquial dialect of its own. SA is the official language of 23 countries most of them are located in the Middle East part of Asia and the Northern parts of Africa in the area which is known as The Arab World. It also serves as a national language in a number of sovereign states or as a minority language in others like Cyprus, Turkey, Niger, Senegal, Mali, and parts of Iran. This cultural as well as geographical diversity leads to variations in terms of word stress assignment.

Though, stress assignment of Arabic language as a whole is highly affected by two major factors; the syllable weight and its position (Kabrah, 2011; Lin, 2019). Arabic dialects and varieties mainly vary in terms of the positions of each of the syllable types, the interaction between stress assignment and other phonological processes, and the impact of lexical issues on stress assignment (Watson, 2011). The investigation of stress in Arabic has a great contribution to the stress theory in general. Opaque cases of stress in the Arabic language posed a great challenge to the phonological theories and led to the development of a number of them (Watson, 2011). This in turn raises the need to conduct this study to figure out whether OT, the latest model in phonology, can better explain the stress assignment patterns of SA.

The development of OT attracted the attention of linguists all over the world. In OT, the variations between language varieties are due to reordering a number of universal violable constraints which are provided by Universal Grammar (UG). Accordingly, the constraints are universal while the ranking is language-specific. A number of researchers have utilized the new promising OT in their analysis of stress related phenomena of different Arabic dialects (Abu-Abbas, 2012; Ahmad, 2022; Al Aboudi, 2022; Alabeeky, 2021; Alfadely & ALhamami, 2018; Alhoody & Aljutaily, 2022; Guba, 2018; Hijazi, 2020; Smirkou, 2023).

However, so far, no studies have investigated syllable types and stress assignment system of Standard Arabic in the context of Optimality theory. Therefore, this study attempts to bridge a gap in the literature and tackle this issue from an Optimality theory perspective. It aims to provide a constraint-based analysis of syllable types and stress assignment patterns of SA. It mainly tests whether the available constraints in the literature are sufficient to derive the attested stress assignment patterns in SA. This investigation also attempts to provide data for future comparative and contrastive phonological studies of SA and other linguistic varieties. It can also be utilized in future studies that investigate the interaction between stress assignment and other syllable-based processes in SA to provide a comprehensive account of the phonological system of SA. The implications of the study include providing data for native and non-native phonologists of Arabic language to conduct comparative and contrastive studies. Furthermore, it will also provide a basis for future studies that investigate syllable-based processes in Standard Arabic since syllable-based processes apply to avoid the existence of impermissible syllable types in the language.

Problem Statement

One of the problems engrossing the researchers is to find out whether stress patterns can be explained by utilizing a constituent larger than a syllable. The notion of foot was therefore adopted, which is a metrical unit which commonly used in poetry. Each foot comprises one or more syllables in which a single syllable bears the stress and it is therefore called the strong syllable or the stressed one. If the word comprises only one foot, the head of the foot will be considered strong and receives stress. If the word comprises more than one foot, one of them will be more prominent and receives the primary stress. While the head of other feet will receive a secondary stress. This in turn enables researchers to identify primary stress, secondary stress, and unstressed syllables in a word.

Footing classification is an important subject to discuss and examine in the light of this study. A foot can be classified based on the size of the foot into bounded and unbounded. Abounded foot is a foot that comprises two syllables, whereas unbounded foot is one that consists of more than two syllables. The existence of bounded feet in bounded stress languages raised an assumption that the foot inventory is composed of binary feet only which consist of two syllables or two moras. Binary feet can be classified in terms of the position of the stressed syllable within a foot into iambic and trochaic. In an iambic foot, the second syllable is stressed, while in a trochaic foot, the first syllable is the stressed one. Languages also vary in terms of the direction of parsing feet. In some languages, feet are parsed from right to left, while in others, they are parsed from the left side to the right one. The foot-type in SA is trochaic. In other words, it is left headed or stressed. It is composed of two consecutive light syllables (LL), a light syllable and a heavy stressed syllable (LH), or a stressed heavy syllable (H). This argument can be justified when we investigate di-syllabic words which are composed of light syllables. Since in di-syllabic words which are composed of two light syllables as [ku'. tub] 'books' the left syllable is more prominent and stressed. Accordingly, identifying the foot type in SA can best explain our choice of [ku'. tub] over [ku.tu'b] on words composed of LL syllables.

Default-to-opposite stress is another classification of language texts that attracted the attention of researchers (Sayed et al., 2019). It assumes the existence of two types of languages based on the position of the stressed syllable. Many languages with default-to-opposite assign stress to the heaviest right syllable, if not to the leftmost one. Other languages of default-to-opposite system assign stress to the heaviest left syllable, if not to the rightmost light one. In the first type of languages, the default side is the left side since

it attracts the syllable if heavy syllables do not exist, whereas the default side is the right in second type of languages since it also attracts stress if a heavy syllable does not exist (Gordon, 2000).

Footing direction of SA is another issue to be investigated, it starts from the left side to the right one since in tri-syllabic words that consist of three consecutive light syllables as [kaˈ.ta.ba] 'he wrote', stress falls on the antepenultimate. Thus, parsing feet from the left side to the right one leads to the actual form in the given language in which stress falls on the right antepenultimate syllable. While parsing feet from the opposite side yields to a wrong output since the penultimate syllable will be the head. Foot type and direction are, therefore, important to explain stress patterns of SA of words composed of consecutive light syllables. In this study, it will be argued that SA has a default-to-left stress system since stress is assigned to the rightmost heavy syllable, otherwise it is assigned to the leftmost light syllable that does not exceed the antepenultimate. It is also necessary to argue and examine why one primary stress is found per word (Altakhaineh, 2017).

To the best of the researcher's knowledge none of the previous studies have reported the existence of a secondary stress in SA. Few studies argued for the existence of a secondary stress in Sudanese Arabic (Ali, 2014). The violation of the bimoraic word minimality condition is an important issue to be discussed in the language under study. The bimoraic word minimality condition states that content words are minimally bimoraic. However, languages vary in terms of their prohibition of monomoraic words, and they show weak, strong, or no prohibition. The degree of prohibition relies mainly on the minimal size of a word in a language and the way it deals with degenerate monomoraic words. Monomoraic words are allowed and not prohibited in SA. Since it allows content words which consist of single mora. For instance, SA involves imperative verbs as [qi] 'protect' and [ʕi] 'understand' which are derived from the doubly weak verbs [waqaa] 'he protected' and [waʕaa] 'he understood', respectively. This proves that monomoraic words are not prohibited in SA.

Literature Review

Standard Arabic (SA) is a variety that is spoken as a second language mainly in the Arab World. It is used in some restricted domains, namely education, literature, law, and mass media. It also serves as a mean of communication between people who speak Arabic dialects which are not mutually intelligible. It is the variety of Arabic language that has developed in the 19th and 20th century in the Arab World (Ryding, 2005). The investigation of syllable structure and stress assignment of SA has attracted the attention of a number of scholars in recent times (Al huneety et al., 2023; Alhuwaykim, 2018; Btoosh, 2019). A few years earlier, Brame (1970) provided one of the most comprehensive accounts of the phonology of SA within generative phonology. His study contained a thorough investigation of the interaction between a number of phonological processes, namely, stress assignment, syncope, and epenthesis. Bamakhramah (2010) provided an analysis of syllable types, and syllable related phenomenon in three Arabic varieties namely, Classical Arabic, Meccan Arabic, and Hadrami Arabic within the Optimality theory approach. The study mainly focused on syllable parsing with a great emphasize on super-heavy syllables, investigating the interaction between syllable parsing, epenthesis, syncope, and metathesis. The study also argued that such phonological processes avoided impermissible syllable types and satisfied high ranked constraints.

In another study Alrajeh (2011), presented a digital phonetic investigation of stress assignment in SA. The main focus of the study was on detecting duration, intensity, and fundamental frequency. The findings of the study show that only duration and intensity have an effective phonetic impact on stress in SA. The study also reveals that there is a crucial interactive correlation between the syllable type and the stress assignment rules of the investigated language. Watson (2011), likewise, provided an account of stress assignment in Arabic. The study involves a thorough analysis of Arabic language and its impact on the development of metrical theory. It also provides an overview of the studies that have investigated stress assignment in Arabic within the generative phonology framework. Furthermore, the study involves an account of stress in a number of Arabic forms, namely Classical Arabic, San'ani, Cairene, and Levant. It mainly made a comparison between the stress systems of the investigated varieties and focused on the aspects that posed a real challenge for Metrical Phonology.

Optimality theory (Prince & Smolensky, 2004) posits three main components of phonology: a set of universal constraints (CON), a generator (GEN), and an evaluator (EVAL). The generator generates an infinite number of candidates for a given input. CON is composed of two types; faithfulness constraints and markedness constraints. Faithfulness constraints ensure the faithfulness of the output to a given input. Markedness constraints, on the other hand, are responsible of ensuring the well-formedness of the input. Based on the language specific constraint hierarchy, EVAL then chooses the optimal candidate of a given input. The optimal candidate is, therefore, the one that satisfies the higher ranked constraints in the language under consideration (Hao, 2019; Smirkou, 2023).

One of the main principles of OT is that Universal Grammar (UG) involves a number of universal constraints which represent the main properties of the human language in general. The ranking of these constraints varies according to language specific rules. These constraints are strictly ranked. Accordingly, a highly ranked constraint cannot be violated at the expense of satisfying a low ranked one. Violability is another important principal of OT which states that the optimal candidate does not necessarily satisfy all the constraints in the constraint hierarchy.

A lot of research has been conducted in various aspects of optimality-theoretic analysis including syllable structure and related processes, aspects of the phonology and Optimality theoretic analysis of stress assignment in Arabic loanwords (Alhuwaykim, 2018; Alqahtani, 2014; Alqarni, 2021; Shafi & Syed, 2021). However, there is a dearth of studies on the observed variations between languages and dialects attributed to the differences in the constraints from optimality theoretic perspective. There is a dire need to discuss the ranking which is more capable of handling problematic issues in phonology. For example, linear generative models assume that the grammar of a given language determines the structural change of rules which are serially arranged. OT proposes that the GEN produces an infinite number of candidates which are evaluated by the EVAL to choose the optimal output based on the language's constraint hierarchy. Another strength of OT is that it asserts that constraints are universal and provided by UG and languages have on restrictions on the input which is called richness of the base.

For these reasons, the current study utilized OT over all previous phonological models. The significance of the study can be attributed to its investigation of syllable types and stress assignment patterns of SA from an OT perspective the latest theory in phonology which assumes that Universal Grammar provides universal constraints that interact with each other. Then the different ranking of the universal constraints can account for variations between languages and dialects. The present study, therefore, attempts to fill a gap in the literature through providing a thorough investigation of syllable types and stress assignment in SA which to the best of my knowledge has not been fully covered in previous studies. It also makes a great contribution to the study of the phonological system of Semitic languages in general.

Methodology

- *Research Design*

This study used a descriptive research design focusing on syllable types and stress assignment patterns of SA. The first part involved the syllable types attested in the investigated variety. The second part explained the stress assignment patterns of SA. The third part investigated the foot type and direction. The fourth part, on the other hand, provided a constraint-based analysis of stress assignment patterns from an OT perspective**.**

- *Sampling and Data Collection*

The sample of the study comprised primary informants who are all highly educated scholars and hold doctorate degrees in linguistics. The sources of data were mainly based on SA, that is a standard language used in literature, education, law, and mass media. The data was collected with the view to providing a constraint – based analysis of stress assignment of SA.

- *Research Procedure*

Table 1*: Phonetic Symbols.*

Arabic Symbols	IPA Symbols	Arabic Symbols	IPA Symbols
أ	ʔ	ص	sˤ
ب	b	ض	dˤ
ت	t	ط	tˤ
ث	θ	ظ	ðˤ
ج	dʒ	ع	ʕ
ح	ħ	غ	ɣ
خ	x	ف	f
د	d	ق	q
ذ	ð	ك	k
ر	r	ل	l
ز	z	م	m
س	s	ن	n
ش	ʃ	ه	h

The study investigated words based on the number of syllables: mono-syllabic, di-syllabic, tri-syllablic and quadri-syllabic. Mono-syllabic words were analyzed based on the weight of the syllable starting with light syllables and ending with super-heavy ones. An English equivalent was provided for each Arabic word as a gloss which was shown in single quotes. Finally, a list of the phonetic Arabic symbols was referred to as shown in Table (1).

Results and Discussion

- *Stress Assignment Types*

Stress assignment rules are highly affected cross-linguistically by two major factors. The first factor is syllable weight which has a direct impact on stress assignment. Heavy syllables are considered as stress attracters in most languages. The second factor is the location of the stressed syllable in a word. Stress tends to fall on a syllable at an edge-most position; leftmost or rightmost (Sa'di, 2022). Then, the language-based rules come into interaction with these factors to explain the stress assignment patterns attested in the world languages and dialects.

Six syllable types are attested in SA which are CV, CVV, CVC, CVVC, CVCC, and CVVGG. The first three freely occur in positions within a word; word-initially, word-medially, or word-finally. Syllables of CVVC type appear in word final position. They also appear in word initial and word-medial positions if the final consonant is part of geminate (e.g., [maad.dun] 'he is stretching' active participle). Syllables of CVCC and CVVGG types occur word-finally, as illustrated in table (2). This reveals that syllables of SA do not start with a vowel or a complex consonant cluster.

Table 2*: Syllable Types in SA.*

Syllable type	Example
CV	**da**.**ra**.**sa** 'he studied'
CVV	**qaa**.la 'he said'
CVC	**mad**.ra.**sah** 'school'
CVVC	**baab** 'door'
CVCC	**dars** 'lesson'
CVVGG	**maadd** 'stretching'

The syllable weight, on the other hand, is mainly affected by the number of moras within the syllable. Light syllables are those that comprise a single mora while heavy syllables are the ones that comprise two moras. Generally speaking, onset consonants are considered weightless, short vowels are assigned one mora, long vowels assigned two moras, consonants in coda position are assigned one mora if they do not occur word-finally, and geminate consonants are assigned one mora.

However, syllable weight differs across linguistically. Languages mainly vary in their treatment of syllables of CVC type that end with one vowel and one consonant. In some languages, this type of syllable is considered as a heavy syllable, while in others it is considered as a light syllable word-finally. This can be explained by the Peripherality condition according to which a constituent can only be extrametrical if it occurs at the leftmost or the rightmost edge. Hence, CVC syllable word-finally is considered light. This type of syllable will also be considered in SA as a light syllable just in word final position. Therefore, in SA, syllables can be divided in terms of weight into three categories; light, heavy, and super-heavy. Light syllables are those of CV and CVC (word-finally). Heavy syllables involve CVC (in non-final position), CVV, CVCC (word-finally), and CVVC (word-finally). While, Super-heavy syllables involve CVVC (in non-final position), and CVVGG.

Additionally, according to the permissible syllable types in SA, each syllable has to start with a consonant. Consequently, an intervocalic consonant serves as an onset of the following syllable. Moreover, onset consonant clusters are highly prohibited. No syllable can begin with two or more than two consonants on syllable onset position regardless of the place of the syllable within a prosodic word. Hence, the first consonant of an intervocalic bi-consonantal cluster is considered as a coda of the preceding syllable and the second consonant is considered as an onset of the following one. This in turn reflects the high position of the markedness constraints ONS and *COMPLEXons. The former constraint prohibits having an onsetless syllable, and the latter prohibits having a consonant cluster in a syllable onset position. Since every syllable has an onset, no more than one C may associate to an onset.

On the other hand, codas are permissible but not obligatory in SA. This reflects the low ranking of the *CODA constraint which prohibits having a coda consonant. The word final syllable may contain a bi-consonantal cluster in pausal forms. A bi-consonantal coda cluster is also allowed word-medially and word-finally if the two consonants of a cluster are geminated consonants. Accordingly, it can be argued that *COMPLEX CODA is ranked lower than *COMPLEXons and no more than one C may associate to a coda. The nucleus of a syllable in SA may involve a short vowel or a long one, but never involve two different vowels or a diphthong.

- *Stress Patterns in SA.*

Stress assignment in SA is crucially affected by syllable weight. Particularly, heavy syllables are stress bearers in SA. Stress is also affected by another important factor which is the position of the syllable in a word since stress is never assigned to any syllables that precedes the antepenultimate. In other words, the stress must fall on one of the last three syllables in SA regardless of the weight of the syllables per word. Furthermore, it will be argued that a single stress is assigned per word in SA. Three principles govern stress assignment of SA: stress can be assigned to the ultimate super-heavy syllable; if not, it is assigned to the penultimate heavy syllable; or, if not, it is assigned to the antepenultimate one. Therefore, stress in SA falls on one of the last three syllables, namely ultimate, penultimate, anti-penultimate.

The ultimate syllable attracts stress if it is super-heavy of CVVC or CVVCC type. The penultimate syllable receives stress if it is heavy and the ultimate syllable is not of CVVC or CVVCC type. On the other hand, the antepenultimate syllable is stressed if the penultimate syllable is not heavy and the ultimate one is not of CVVC or CVVCC type. Accordingly, the antepenultimate syllable is stressed regardless of its weight light or heavy if the penultimate and the ultimate syllables are not heavy. Table (3) presents mono-syllabic, di-syllabic, tri-syllabic, and quadri-syllabic words providing more illustrative examples of stress assignment in SA.

Table 3*: Syllable Types in SA.*

Syllable types	**Mono-syllabic words**	**Gloss**
Ĺ	wa	'and'
Ĺ	min	'from'
H́	fii	'in'
H́	kuub	'cup'
H́	burj	'tower'
H́	shaadd	'tightened, active participle'
Syllable types	**Di-syllabic words**	**Gloss**
ĹL	ku.tub	'books'
H́L	war.dah	'flower'
LH́	ra.suul	'messenger'
H H́	ʔaj.yaal	'generations'
Syllable types	**Tri-syllabic words**	**Gloss**
ĹLL	da.ra.sa	'he studied'
LLH́	da.ra.suu	'they m. studied'
LH́L	wi.laa.dah	'childbirth'
H́LL	saa.fa.ra	'he traveled'
HH́H	suu.daa.niyy	'Sudanese'
LH H́	ja.mii.laat	'Beautiful pl. f.'
HL H́	yad.ru.suun	'they m. study'
H H́L	daa.ʕii.na	'they pray, active participle pl. m.
Syllable types	**Quadri-syllabic words**	**Gloss**
LHĹH	mu.jad.di.duun	'innovators'
H ĹLL	mad.ra.sa.ti	'my school'
L H́LL	mu.saa.ba.qah	'competition'
LL H́L	ta.ta.fat.taħ	' bloom'

- *Analysis of Stress Patterns of SA*

This part mainly provides an analysis of stress assignment rules in SA from an OT perspective. OT enables us to account for the whole previously explained issues concerning the stress assignment phenomenon like syllable weight, syllable location, extrametricality, and others via utilizing a few constraints. The presence of these violable constraints enables researchers to explain the attested stress assignment patterns not only in a single language but also cross-linguistically.

As illustrated earlier, heavy syllables attract stress in SA. This can be accounted for through the adoption of Weight-To-Stress Principle (WSP) constraint according to which heavy syllables are prominent and therefore must be assigned stress (Prince & Smolensky, 2004). The heavy syllables marked by WSP are prominent on the foot structure. First of all, monomoraic or mono-syllabic words of CV type are allowed in SA. Hence, it can be claimed that *PrWd which demands words to be minimally bimoraic is low ranked in SA. Furthermore, stress assignment of monosyllabic words requires the adoption of Culminativity constraint which states that one of the syllables among a word is prominent and is therefore stressed. It can also be argued that this constraint is in a high undominated position in SA. Table (4) shows stress assignment of words of CV type.

Table 4*: Words of CV Type.*

/qi/ 'protect'	**Culminativity**	***PrWd**
☛ a. [qi]		*
b. [qi]	*!	*

Table 4 reveals that the first candidate (a) is the winner as it obeys the higher ranked Culminativity constraint. Candidate (b) loses as it violates all constraints.

In OT, the extra-metricality condition which determines that a consonant in final position is assigned no mora is substituted by *Final-C-μ constraint. The function of this constraint is that it prohibits coda consonants in word final position from receiving a mora (Hayes, 1989). Accordingly, words of CVC type are considered monomoraic and violate the *PrWd constraint as shown in Table (5).

Table (5): *Words of CVC Type are Monomoraic.*

/sin/ 'tooth'	**Culminativity**	***Final-C-μ**	***PrWd**
a. [sμμ]		*!	
☛b. [sμn]			*
c. [sμn]	*!		*

Table (5) reveals that the second candidate (b) is the winner since it is monomoraic and, therefore, violates the lowest ranked constraint *PrWd. While candidate (a) loses since it violates *Final-C-μ. Candidate (c) which is not stressed is also ruled out because it violates the Culminativity and *PrWd constraints. The

analysis above of words of CVC type proves that *Final-C-μ outranks*PrWd in the language under study.

Words of CVV type, on the other hand, are considered as heavy bimoraic syllables. This can be handled through presenting *MORA [v] constraint. This constraint requires vowels to be moraless. To account for the fact that syllables of CVV type are heavy bimoraic in SA and they attract stress in the presence of light syllables, *MORA [v] will be low ranked in SA. Table (6) shows the constraint hierarchy for syllable assignment in words of CVV type.

8.*Mora [v]: No mora is associated with a vowel.

Table (6)*: Culminativity>>*Final-C-μ>>*PrWd>>*MORA [v].*

/fii/ 'in'	Culminativity	*Final-C-μ	*PrWd	*MORA [v]
☛a. [fμμ]				**
b. [fμi]			*!	*
c. [fii]			**!	

Although the first candidate (a) in the above Table (6) incurs a violation of the low ranked constraint *MORA [v], it is the optimal one as it obeys the high ranked constraints Culminativity, *Final-C-μ, and *PrWd, respectively. Candidates (b) and (c) lose since they fatally violate the higher ranked constraint *PrWd.

The developed hierarchy above can successfully explain the attested stress patterns of words of CVVC and CVCC types. Table (7) represents stress assignment of words of CVVC type.

Table (7)*: Stress Assignment of Words of CVVC Type.*

/kuub/ 'a cup'	Culminativity	*Final-C-μ	*PrWd	*MORA [v]
☛a. [kμμb]				**
b. [kμμμ]		*!		***
c. [kμub]			*!	*
d.[kμμb]	*!			**

Table (7) supports our argument concerning the dominance relation that holds between the presented constraints, namely Culminativity,*Final-C-μ,*PrWd, and *MORA [v]. Candidate (a) is the winner since it satisfies the high ranked constraints. Candidate (b), in which the final consonant is assigned a more, is ruled out due to a fatal violation of *Final-C-μ. It also violates *MORA [v]. Candidate (c) loses since it violates the high ranked constraint *PrWd as well as the low ranked constraint *MORA [v]. The last candidate (d) also loses as it violates the high ranked undominated constraint Culminativity which requires having a stressed syllable.

The presented hierarchy can also justify stress assignment of words of CVCC type as shown in Table (8). In such words, candidate (a) is the optimal one since it only violates the lowest ranked constraint *MORA [v].

Table (8)*: Words of CVCC Type in SA.*

/burj/ 'a tower'	Culminativity	*Final-C-μ	*PrWd	*MORA [v]
☛a. [bμμj]				*
b. [bμμμ]		*!		*
c. [bμrj]			*!	*
d.[bμμj]	*!			*

However, the adopted constraints hierarchy is not sufficient to illustrate the analysis of words of CVVCC type which end with a geminate cluster, as presented in Table (9).

Table (9): *Culminativity>>*Final-C- μ>>*PrWd>>*MORA [v].*

/ʃaadd/ 'tightened, active participle'	Culminativity	*Final-C-μ	*PrWd	*MORA [v]
a. [ʃμμdd]				**
b. [ʃμμμd]				**
c. [ʃμadd]			*!	*
d. [ʃμμdd]	*!			**
e. [ʃμμμμ]		*!		**

As shown in Table (9), the first two candidates are equal in terms of incurring two violations of the lowest ranked constraint *MORA[v]. Thus, the proposed hierarchy is not capable of choosing the second candidate in which the first coda is assigned a mora as the optimal one. To solve this problem a Weight-By-Position (WBP) constraint which demands coda consonants to be assigned a mora will be adopted.

WBP should be ranked higher than *MORA [v] to account for the choice of candidate (b) the actual output as the optimal one, as illustrated in Table (10).

Table (10)*: Culminativity>>*Final-C- μ>>WBP, *PrWd>>*MORA [v].*

/ʃaadd/ 'tightened, active participle'	Culminativity	*Final-C-μ	WBP	*PrWd	*MORA [v]
a. [ˈʃμμdd]			**!		**
☛b. [ʃμμμd]			*		**
c. [ʃμadd]			**	*!	*
d. [ʃμμdd]	*!		**		**
e. [ʃμμμμ]		*!			**

Table (10) shows that candidate (b) is the winner since it incurs the least fatal violations. It mainly violates WBP and *MORA [v]. On the contrary, candidate (a) loses since it incurs two violations of WBP and two violations of *MORA [v] constraints.

Though the proposed hierarchy above can clearly account for stress assignment patterns of mono-syllabic words in SA, the analysis of multi-syllabic words necessitates the adoption of Nonfinality constraint which prohibits having a word final stressed syllable. Stress assignment of disyllabic words of LL type is shown in Table (11).

Table (11)*: Stress Assignment of Disyllabic Words of Ll Kind.*

LL /ku.tub/ 'books'	Culminativity	Nonfinality
☛a. [ˈkμ.tμb]		
b. [kμ.ˈtμb]		*!
c. [kμ.tμb]	*!	

Table (11) shows that words of LL type as /ku.tub/ are stressed on the left light syllable [ˈkμ.tμb]. The adoption of Nonfinality is crucial to favor candidate (a) the actual output which vacuously satisfies the Nonfinality constraint over candidate (b). Candidate (c), on the other hand, loses as it fatally violates the higher ranked Culminativity constraint.

The constraint hierarchy is also capable of accounting for stress assignment of di-syllabic words of HL type, as clarified in Table (12).

Table (12)*: Di-Syllabic Words of HL Kind in SA.*

HL /war.dah/ 'a flower'	Culminativity	Nonfinality
☛a. [war.dah]		
b. [war.ˈdah]		*!
c. [war.dah]	*!	

Taking into account that heavy syllables are stress attracters in SA, a new constraint should be added to account for the rest of stress patterns in SA. WSP constraint that demands heavy syllables to receive stress is the best to account for the rest of di-syllabic words of such types.

WSP constraint should be ranked higher than Nonfinality to explain the attested stress assignment of di-syllabic words of LH type, as illustrated in Table (13).

Table (13)*: Stress Assignment of Disyllabic Words of LH Kind.*

LH /ra.suul/ 'a messenger'	Culminativity	WSP	Nonfinality
a. [ra.suul]		*!	
☛b. [ra.ˈsuul]			*
c. [ra.suul]	*!		*

As shown in Table (13), candidate (a) in which stress falls on the light syllable is ruled out since it incurs a violation of WSP. Candidate (c) loses because it violates the undominated constraint Culminativity as well as the lowest ranked constraint Nonfinality. Consequently, the second candidate (b) which violates the lowest ranked constraint Nonfinality is the winner. This analysis proves that Nonfinality must be ranked higher than WSP in SA.

In the same vein, di-syllabic words composed of two consecutive heavy syllables receive stress on the ultimate syllable in SA. The analysis of this type of words is shown in Table (14).

Table (14)*: Stress Assignment of Words of HH Type in SA.*

HH /ʔaj.yaal/ 'generations	Culminativity	WSP	Nonfinality
☛a. [ʔaj.yaal]		*	
b. [ʔaj.ˈyaal]		*	*
c. [ʔaj.yaal]	*!		*

According to the proposed hierarchy, candidate (a) in Table (14) will wrongly surface as the optimal one. To solve this issue and to allow the rightmost heavy syllable to be stressed a new constraint which is called EDGEMOST should be presented here. According to this constraint a stressed syllable should be at one of the

two edges of a word rightmost or leftmost (Prince & Smolensky, 2004). Since in SA the heavy rightmost syllable is commonly stressed in a word, it will be assumed that this constraint is specified to the right edge of a word, as follows. Hence, EDGEMOST (δ; R; Word) requires the stressed syllable lies at the right edge of the word.

EDGEMOST constraint should be ranked higher than Nonfinality to account for stress assignment patterns in SA, see Table (15).

Table (15)*: Culminativity>> WSP, EDGEMOST (δ; R; Word)>>Nonfinality.*

HH /ʔaj.yaal/ 'generations	Culminativity	WSP	EDGEMOST (δ; R; Word)	Nonfinality
a. [ʔaj.yaal]		*	*!	
☛b. [ʔaj.ˈyaal]		*		*
c. [ʔaj.yaal]	*!	**		*

Table (15) clearly shows that candidate (b) which received stress on heavy syllable on the right edge is the winner since it incurs the least fatal violations among others. Obviously, the proposed hierarchy in this pattern can correctly explain stress assignment of di-syllabic words in SA. Now,

Next, the investigation goes deeper to include tri-syllabic words of different syllable types (LLL types) as /da.ra.sa/ 'he studied' as seen in Table (16). In such types of words stress falls on the antepenultimate.

Table (16)*: Stress Assignment of Tri-syllabic Words of LLL Type in SA.*

LLL /da.ra.sa/ 'he studied'	Culminativity	WSP	EDGEMOST (δ; R; Word)	Nonfinality
a. [da.ra.sa]			**!	
b. [da.ˈra.sa]			*!	
☛c. [da.ra.ˈsa]				*
d.[da.ra.sa]	*!		*	

According to the proposed hierarchy in Table (16) candidate (c) wrongly surfaced as the optimal output. To allow candidate (a) the actual output to win, nonfinality constraint should be ranked higher than EDGEMOST (δ; R; Word) constraint. However, the dominance relationship above between the two constraints was necessary to explain stress assignment of words composed of two heavy syllables. To solve a similar problem concerning stress assignment of tri-syllabic words in Jordanian Arabic, Abu-Abbas (2012) suggested that the EDGEMOST constraint can be divided into two; the first one is EDGEMOST (H; R; Word) is specified for stressed heavy syllables while the second one is EDGEMOST (L; R; Word) for stressed light syllables. In this pattern, in the case of EDGEMOST (H; R; Word), the stressed heavy syllable lies at the right edge of a word; whereas, the EDGEMOST (L; R; Word), the stressed heavy syllable lies at the right edge of a word.

Accordingly, EDGEMOST (H; R; Word) constraint can be arranged higher than Nonfinality to justify stress assignment of words of HH type, and EDGEMOST (L; R; Word) is arranged lower than Nonfinality to explain stress assignment of LLL words, look at Table (17),

Table (17): *Culminativity>>WSP; EDGEMOST (H; R; Word)>> Nonfinality>> EDGEMOST (L; R; Word).*

LLL /da.ra.sa/ 'he studied'	Culminativity	WSP	EDGEMOST (H; R; Word)	Nonfinality	EDGEMOST (L; R; Word)
a. [da.ra.sa]					*!
☛b. [da.ˈra.sa]					
c. [da.ra.ˈsa]				*!	
d.[da.ra.sa]	*!				

In Table (17), candidate (d) loses since it violates the Culminativity constraint. On the other hand, candidate (c) loses since it fatally violates the Nonfinality constraint. However, the proposed hierarchy wrongly predicts that candidate (b) which received stress on the penultimate syllable is the optimal output because it satisfies the entire constraints.

Therefore, it can be argued that the adoption of the EDGEMOST constraints proposed by Abu-Abbas (2012) cannot justify the choice of the right actual output of words of LLL type in SA. They cannot also explain the choice of the antepenultimate light syllable in quadri-syllabic words of HLLL type. Hence, it will be proposed that the EDGEMOST constraint can be divided into two constraints each of which is assigned to a different edge side based on the syllable weight; the first one is EDGEMOST (H; R; Word) which assigns stress to the rightmost heavy syllable, whereas the second one is EDGEMOST (L; L; Word) which assigns stress to the leftmost light syllable. Accordingly, it is now known that in the case of EDGEMOST (H; R; Word), a stressed heavy syllable lies at the right edge of a word; whereas, in the case of EDGEMOST (L; L; Word), a stressed light syllable lies at the left edge of a word (Table 18).

Table (18)*: Culminativity>>WSP; EDGEMOST (H; R; Word)>> Nonfinality>> EDGEMOST (L; L; Word).*

LLL/Da.Ra.Sa/ 'He Studied'	Culminativity	WSP	EDGEMOST (H; R; Word)	Nonfinality	EDGEMOST (L; L; Word)
☛a. [da.ra.sa]					
b. [da.ˈra.sa]					*!
c. [da.ra.ˈsa]				*!	*
d.[da.ra.sa]	*!				

The developed constraint hierarchy in Table (18) is now capable of justifying the choice of candidate (a) which is assigned stress on the antepenultimate light syllable over candidate (b) which received stress on the penultimate light syllable. The first candidate (a) is optimal as it fulfills the entire constraints in the constraint hierarchy.

It is worth mentioning that the proposed hierarchy also explains stress assignment of tri-syllabic words of LLH, LHL, HLL, HHH, LHH, HLH, and HHL types.

The next step in the investigation was to include quadri-syllabic words which involved a heavy syllable. The first type to be investigated was words of LHLH type. The proposed constraint hierarchy successfully explained stress assignment of words of this type, as shown in Table (19).

Table (19)*: Quadric-syllabic Words of LHLH Type in SA.*

LHLH/Mu.Jad.Di.Duun/ 'Innovators'	Culminativity	WSP	EDGEMOST (H; R; Word)	Nonfinality	EDGEMOST (L; L; Word)
a. [mu.ˈjad.di.duun]		*	*!		*
b. [mu.jad.ˈdi.duun]		**!	*		
☞ c. [mu.jad.di.ˈduun]		*		*	*

Table (19) shows that candidate (c) in which the ultimate heavy syllable received stress is the optimal one. It violates WSP, Nonfinality, EDGEMOST (L; L; Word), respectively. Candidate (a) is ruled out as it incurs a violation of the high ranked constraints WSP, EDGEMOST (H; R; Word) as well as the low ranked constraint EDGEMOST (L; L; Word). Candidate (b) also loses since it fatally violates WSP and EDGEMOST (H; R; Word) constraints.

Taking into account that stress does not exceed the antepenultimate syllable in SA, words of HLLL will pose a real problem to the constraint hierarchy as illustrated in Table (20).

Table (20)*: Stress Assignment of Quadric-Syllabic Words of HLLL Type In SA.*

H LLL/Mad.Ra.Sa.Ti/ 'My School'	Culminativity	WSP	EDGEMOST (H; R; Word)	Nonfinality	EDGEMOST (L; L; Word)
a. [mad.ˈra.sa.ti]		*	*		
b. [mad.ra.ˈsa.ti]		*	*		*
c. [mad.ra.sa.ˈti]		*	*	*	*
☛d. [mad.ra.sa.ti]					*

According to the developed constraint hierarchy in Table (20), the last candidate (d) in which the pre-antepenultimate heavy syllable is stressed surfaces as the optimal output. However, in such kind of words the antepenultimate light syllable is the one that receive stress in SA. To solve this problematic issue, a new constraint *δδδδ can be adopted. This constraint serves to prohibit stress from exceeding the antepenultimate syllable regardless of the weight of other syllables within the word in SA. This constraint can be given a high undominated position in the hierarchy due to its importance, as in Table (21).

Table (21)*: Culminativity;*δδδδ>>WSP>> EDGEMOST (H; R; Word)>> Nonfinality>> EDGEMOST (L; L; Word).*

H LLL/mad.ra.sa.ti/ 'my school'	Culminativity	*δδδδ	WSP	EDGEMOST (H; R; Word)	Nonfinality	EDGEMOST (L; L; Word)
a. ☞ [mad.ˈra.sa.ti]			*	*		
b. [mad.ra.ˈsa.ti]			*	*		*
c. [mad.ra.sa.ˈti]			*	*	*	*
d. [mad.ra.sa.ti]		*!				*

In Table (21), the last candidate (d) loses since it violates the undominated constraint δδδδ. It also incurs a violation of EDGEMOST (L; L; Word). HLLL type words also prove the importance of the EDGMOST constraints to favor candidate (a) which received stress on the antepenultimate light syllable over candidate (b) which received stress on the penultimate light one.

The constraint hierarchy is also capable of accounting for the rest of word types in SA. It can justify our choice of the actual outputs in SA. Table (22) shows analysis of Quadric-syllabic words of LHLL type as /mu.saa.ba.qah/ 'competition' which are stressed on the heavy antepenultimate syllable.

Table (22)*: Words of Quadric-Syllabic LHLL Kind in SA.*

LHLL/mu.saa.ba.qah/ 'competition'	Culminativity	*δδδδ	WSP	EDGEMOST (H; R; Word)	Nonfinality	EDGEMOST (L; L; Word)
☛a. [mu.ˈsaa.ba.qa]						*
b. [mu.saa.ˈba.qa]			*!	*		*
c. [mu.saa.ba.ˈqa]			*!	*	*	*
d. [mu.saa.ba.qa]		*!	*	*		

In Table (22) candidate (a) wins as it incurs one violation of the lowest ranked constraint EDGEMOST (L; L; Word). Candidates (b) and (c) lose as they violate the high ranked constraints WSP, and EDGEMOST (H; R; Word). Candidate (d) loses as it incurs violations of *δδδδ, WSP, and EDGEMOST (H; R; Word) constraints.

Table (23) shows stress assignment of Quadric-syllabic words of LLHL type proves the validity of the proposed hierarchy of SA.

Table (23)*: Words of Quadric-Syllabic LLHL Type in SA.*

LL HL/ta.ta.fat.taħ/ 'bloom'	Culminativity	*δδδδ	WSP	EDGEMOST (H; R; Word)	Nonfinality	EDGEMOST (L; L; Word)
a. [ta.ˈta.fat.taħ]			*!	*		*
☛b. [ta.ta.ˈfat.taħ]						*
c. [ta.ta.fat.ˈtaħ]			*!	*	*	*
d. [ˈta.ta.fat.taħ]		*!	*	*		

According to Table (23), Quadric-syllabic words of LLHL are stressed on the heavy penultimate syllable. Candidate (b) wins since it violates EDGEMOST (L; L; Word). Candidates (a) and (c) mainly lose as they violate the high ranked constraints WSP, and EDGEMOST (H; R; Word). Candidate (d) loses as it incurs violations of *δδδδ, WSP, and EDGEMOST (H; R; Word), respectively.

Conclusion

This study made evident several facts and principles about stress assignment in SA. Six syllable types were found in SA which are CV, CVV, CVC, CVVC, CVCC, and CVVGG. Stress assignment in SA is predictable and highly governed by stress weight and location. A single primary stress is assigned per word. Particularly, it falls on the ultimate superheavy syllable, if a superheavy syllable does not exist, stress is assigned to the penultimate heavy syllable; if not, it is assigned to the antepenultimate. Hence, stress is restricted and assigned to one of the final three syllables of a word. Foot type in SA is trochaic which is parsed from left to right. In the present study, it has been found that SA has a default-to-left stress system since stress often assigned to the rightmost heavy syllable, if not it will be assigned to the leftmost light syllable that does not exceed the antepenultimate. Foot type and direction are important to explain the attested stress patterns of SA of words composed of consecutive light syllables.

Bimoraic word minimality condition was another important issue that was discussed in the study. It has been found that in SA monomoraic words are allowed and not prohibited since SA allows content words which are composed of one mora. The study also provided an OT analysis of mono-syllabic, di-syllabic, tri-syllabic, and quadric-syllabic words. To account for the attested stress assignment patterns in SA, the following constraint hierarchy was developed: Culminativity;*δδδδ>>WSP>> EDGEMOST (H; R; Word)>> Nonfinality>> EDGEMOST (L; L; Word). WSP and EDGEMOST (H; R; Word) constraints also held high ranking positions. WSP explained the fact that in SA heavy syllables were considered stress bearers and attracted stress. EDGEMOST (H; R; Word) required that the heavy rightmost syllable to be the one that received stress.

According to the permissible syllable types in SA, each syllable has to start with a consonant, onset consonant clusters are highly prohibited, and no syllable can begin with two or more than two consonants on syllable onset position regardless of the syllable position within a word. These facts reflected the high position of the markedness constraints ONS and *COMPLEXons. The former constraint prohibits having an onsetless syllable, and the latter prohibits having a consonant cluster in a syllable onset position. The study found that two constraints held the undominated high position in the constraint hierarchy which are Culminativity, and *δδδδ. Culminativity accounts for the fact that a single syllable should be the most prominent and receive stress; while *δδδδ constraint required a stressed syllable to fall within the last three syllables of a word.

Finally, further studies are needed to analyze the interaction between stress assignment and other syllable-based phonological processes in SA to provide a thorough constraint-based analysis of the phonological system of SA. Comparative and contrastive studies with other varieties are highly recommended to be able to generalize the results of this study.

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