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135 Word Stress in Arabic

JANET C. E. WATSON

1 Introduction

Within phonological theory, Arabic word stress has received arguably more attention than the word stress of any language other than English; and within Arabic linguistics, more work has been devoted to stress-related phenomena than any other single topic. This chapter addresses some of the reasons behind this phenomenon.

The chapter is structured as follows: §2 considers the characteristics of Arabic word stress, discussing general features common to different varieties and basic ways in which modern Arabic dialects differ both from Classical Arabic and from each other. §3 provides a historical overview of the treatment of Arabic word stress within generative paradigms, focusing on major contributions in the analysis of Arabic stress, and cases where data from Arabic has contributed to the development of stress theory. §4 considers stress in Classical Arabic, and then examines in more detail word stress in three modern dialects – Cairene, San’ani (Yemen), and Levantine – focusing particularly on phenomena that pose a challenge for metrical phonology.

2 Characteristics of Arabic word stress

With over 250 million speakers, Arabic is the official language of 18 sovereign states from Mauritania in the west to Iraq in the east. It is also spoken in parts of southern Turkey, by Maronite Christians in northern Cyprus, and in parts of sub-Saharan Africa. Arabic language enclaves are found in the Balkh region of Afghanistan, parts of Iran, and Uzbekistan. All Arabic dialects exhibit word stress; however, the socially and geographically diverse area over which Arabic is spoken leads to differences in the mechanics of word stress assignment. In all cases stress location is a function of both syllable weight and syllable position, but dialects differ in the distribution of syllable types, the leftmost extent of stress (third or fourth syllable from the right), the rhythmic grouping of syllables, the interaction of stress, syncope and epenthesis, and the degree to which lexical information may affect stress.

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Arabic recognizes three weights of syllable: light, heavy, and superheavy. Light syllables are always open, heavy syllables are open or closed, and superheavy syllables are closed or doubly closed. Examples of these syllable types from Classical Arabic are given below:

(1)		<i>open</i>		<i>closed</i>		<i>doubly closed</i>
	light	CV	wa 'and'			
	heavy	CVV	sā.fara 'he traveled'	CVC	min 'from' ka.tab.tu 'I wrote'	
	super- heavy			CVVC	bāb# 'door'	CVCC bint# 'girl' CVVGG ¹ mādd# 'stretching'
				CVVG	mād.dun 'stretching (NOM)'	

CV and CVC are unrestricted, although unstressed short vowels in open syllables are often deleted in modern dialects. CVCC and CVVGG are restricted to word- or utterance-final position.² In the distribution of other syllable types, however, dialects vary. Levantine, Sudanese, some Peninsular, and North African dialects allow CVGG and/or CVVC in derived environments word internally, as in: /māsik-īn/ > [māskīn] 'holding (MASC PL)', /ʃāf-ha/ > [ʃāfha] 'he saw her', /muʿallim-īn/ > [mʿallmīn] 'teachers'. Cairene allows CVVC syllables word finally only, as in: [kitāb kibīr] 'a big book', but /kitāb-na/ > [kitabna] 'our book'; Cairene restricts CVCC to utterance-final position, breaking up word-final non-utterance-final CVCC syllables through epenthesis, as in: /bint ʔawīla/ > [bint[i] ʔawīla] 'a tall girl'; CVV occurs only when stressed in Cairene: initial CVV in ['fāfit] 'she saw' and ['ʕālam] 'world' contrast with initial CV in [ʔa'fitu] 'she saw him' and [ʕa'lamu] 'his world'.

Stress falls on one of the last three syllables, in some dialects one of the last four syllables, with assignment dependent on the weight and position of the stressed syllable. Modern dialects follow the assumed rules of Classical Arabic (§3.1) whereby stress is assigned to a final superheavy (CVVC, CVCC, or CVVGG) syllable, as in Cairene: [fi'luus] 'money', [ma-xa'bazʃ] 'he didn't cook', and Palestinian: [ja'waab] 'answer', [bi-'ħuʔʔ] 'he puts'. In the absence of a final superheavy, stress is assigned to a heavy penult (CVV or CVC), as in Cairene: [ka'tabtu] 'you (PL) wrote', [fiħ'muuha] 'they understood her', and Palestinian: [mus'taʃfa] 'hospital', [mu'naafis] 'competitor'. In the absence of either a final superheavy or a heavy penult, the dialects differ. In words with a heavy antepenult, Cairene stresses the light penult, while most other dialects stress the antepenult: Cairene [mad'rasa] 'school' contrasts with Beirut/Damascene ['madrasa].

Modern Arabic dialects differ in their rhythmic grouping of light syllables. Western and Bedouin-type dialects tend to group light syllables into weak-strong

¹ GG denotes GEMINATE.

² In Classical Arabic, superheavy syllables occur pre-pausally only, resulting from pre-pausal deletion of short final vowels or case endings.

pairs (iambics): Cyrenaican Bedouin stresses the penult in forms such as: *[kitab-at] > [ik'tibat] 'she wrote', [ingital-aw] > [inig'tilaw] 'they were killed', and the final syllable in [ki'tab] 'he wrote', [nu'xal] 'palm-trees' (Mitchell 1960); eastern urban dialects group light syllables into strong-weak pairs (trochees), stressing the antepenult in forms such as Cairene: ['katabit] 'she wrote', [in'kasarit] 'it (FEM) broke', and the penult in ['katab] 'he wrote', ['walad] 'boy' (SEE CHAPTER 46: THE IAMBIC-TROCHAIC LAW).

All modern dialects differ from Classical Arabic in at least optionally deleting short vowels in unstressed open syllables (Birkeland 1954). Some dialects delete short high vowels only, as in Damascene: /fihim-u/ > [fihmu] 'they understood', /fihim-na/ > [f'himna] 'we understood' but /katab-u/ > ['katabu] 'they wrote' (Cowell 1964). Other dialects delete short vowels irrespective of their quality, as in Lebanese Kfar-Şġāb: /ḍarab-ak/ > [ḍarbak] 'he hit you' and /samak-i/ > [samki] 'one fish' (Fleisch 1974).

Several dialects differ from the assumed predictable quantity-based system of Classical Arabic in that certain morphemes affect stress placement. In Cairene and Tunisian the 3rd feminine singular perfect inflectional suffix *-it* attracts stress on suffixation: Cairene [ramit] 'she threw' becomes [ra'mitu] 'she threw it (MASC)', contrasting with other CVCVCV forms, such as 'katabu 'they wrote', where the antepenult is stressed. In Iraqi, the dual suffix *-een* retracts stress, although all other cases of word-final CVVC attract stress: [ʔalbeen] 'two dogs' contrasts with [taʕ'baan] 'tired' (Erwin 1963: 43). In Muslim Mosul Iraqi, stress always falls on the final syllable of a verbal or nominal stem when it takes a suffix, as in: [nəx'ləʔ-u] 'we mix it (MASC)' (Jastrow 2007). In some western dialects and dialects of Oman, word stress is phonemic in disyllabic noun-verb pairs: initial stress in [fihim] 'understanding' contrasts with final stress in [fi'him] 'he understood' (Janssens 1972).

Finally, modern dialects differ as to whether or not epenthetic vowels count for stress purposes. In Cairene, a penultimate post-CVC syllable with an epenthetic vowel is stressed like any other penultimate post-CVC syllable: compare [bin'tina] 'our daughter' with [mad'rasa] 'school' and [fih'mitu] 'she understood him'. In Iraqi and Levantine, by contrast, stress is assigned as if the epenthetic vowel were not there: penultimate stress in Muslim Mosul [ka'tabit] 'I wrote' contrasts with initial stress in ['katabət] 'she wrote' (Jastrow 2007).

3 Theoretical accounts of Arabic word stress

This section provides a historical overview of theoretical accounts of Arabic word stress, focusing on ways in which research on Arabic has contributed both to the development of metrical theory and to a deeper understanding of Arabic prosodic structure and cross-dialectal differences.

3.1 Pre-generative approaches

Concepts upon which generative studies of Arabic word stress draw have their roots in early pre-generative approaches. The older traditional studies of Erpenius (1656), Brockelmann (1907), and Wright (1971) recognized the role of the syllable and syllable weight in stress assignment, distinguishing between light (CV) and

heavy (CVV and CVC) syllables (see CHAPTER 57: QUANTITY-SENSITIVITY). The analyses of stress in Cairene by Harrell (1957) and Cairene and Cyrenaican Bedouin by Mitchell (1956, 1960) are based on the position and relative weight of syllables.

The Prague School (Jakobson 1971) describes stress assignment not in terms of syllables, but in terms of moras. Moraic accounts of stress in Arabic include Cantineau (1960: 240, author's translations), for whom stress in El-Hamme of Gabes (Tunisia) is placed: "on the third mora of the word . . . on the fourth if the third corresponds to a consonant," accounting for penultimate stress in: [k'tibtu] 'you (PL) wrote', and antepenultimate stress in: ['madrasa] 'school'. The mora is referred to in the informal expression of Abdo's (1969) post-SPE (*The sound pattern of English*; Chomsky & Halle 1968) account, where Classical Arabic stress is assigned to the vowel preceding the last two moras (the third or fourth mora from the right-edge). Within metrical theory, it later returns as a full-fledged element of the representation, firmly embedded within the prosodic hierarchy.

3.2 Generative approaches

Generative approaches to stress in Arabic have followed contemporary approaches in generative phonology, with a few landmark changes in orientation. In the SPE segment-based approach adopted by Abdo (1969), Brame (1970, 1973, 1974), Broselow (1976), Johnson (1979), and Weldon (1980), stress is encoded as a phonological distinctive feature, [+stress], assigned to a [+syllabic] segment in a particular segmental context. Essential variables are included in the vocabulary of phonological rules. Take Palestinian as an example, for which the basic stress rules are:

- (2) a. Stress a final superheavy syllable: [ba-'fūf] 'I see', [bi-'ħuṭṭ] 'he puts'.
- b. Otherwise stress the rightmost non-final heavy syllable: [ba-'fūfi] 'I don't see', [ka'tabti] 'you (FEM SG) wrote', ['miktafif] 'discovering'.
- c. Otherwise stress the first syllable (up to the antepenult): ['katab] 'he wrote', ['zalama] 'man'.

Under this approach, stress is assigned by the following rule (Brame 1974), where C_0 indicates an arbitrary number of consonants, including zero, and C_0^1 either zero or one consonant.

- (3) Stress assignment

$$V \rightarrow [+stress] / \text{--- } C_0((VC)VC_0^1)$$

This rule abbreviates three disjunctively ordered sub-rules:

- (4) $V \rightarrow [+stress] / \text{--- } C_0VCVC_0^1$ e.g. ['zalama], ['miktafif]
- $V \rightarrow [+stress] / \text{--- } C_0VC_0^1$ e.g. [ka'tabti], ['katab]
- $V \rightarrow [+stress] / \text{--- } C_0$ e.g. ['ħaṭṭ] 'he put', [ba-'fūf]

3.2.1 The interaction of morphology and word stress

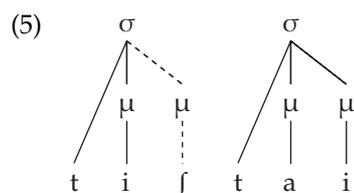
Brame noted that the basic stress rules and their formalism in (2) fail to account for data such as [ka'tabit] 'I/you (MASC SG) wrote' (cf. ['katabit] 'she wrote'),

[ʔabilna] ‘before us’ (cf. [ʔabilna] ‘we accepted’). These forms are derived from underlying /katab-t/ and /ʔabl-na/ through epenthesis (see CHAPTER 41: VOWEL EPENTHESIS), and are explained by Brame as the assignment of stress prior to epenthesis, giving intermediate [ka'tab-t] and [ʔabl-na]. Epenthesis does not undo stress assignment, leading to opaque assignment of stress to a light penult in [ka'tabit], and opaque non-assignment of stress to the heavy penult in [ʔabilna] (§3.2.3; CHAPTER 58: OPACITY DECONSTRUCTED). These cases of opaque assignment, or lack of assignment, of stress were attributed initially by Brame (1970, 1973, 1974) and later by others (e.g. Kenstowicz & Abdul-Karim 1980; Kiparsky 1982, 2000, 2003) to the cycle and the preservation of metrical structure assigned in earlier cycles ((54); CHAPTER 60: CYCLICITY). The SPE-type approach to word assignment has since been superseded, but recognition of the role of the cycle and of the interaction of syncope and epenthesis with word stress assignment has not. As we shall see below (§4.2.3), within the stratal version of Optimality Theory (OT), opaque stress is attributed to inter-level constraint masking: if α is the constraint system of domain Y (e.g. stem), and β is the constraint system of a larger domain Z, then β 's markedness constraints can render α opaque (Kiparsky 2000). Thus, opacity in dialects such as Levantine is attributed to word-level assignment of stress and postlexical epenthesis, which renders stress opaque.

3.2.2 The prosodic hierarchy and representation of the syllable

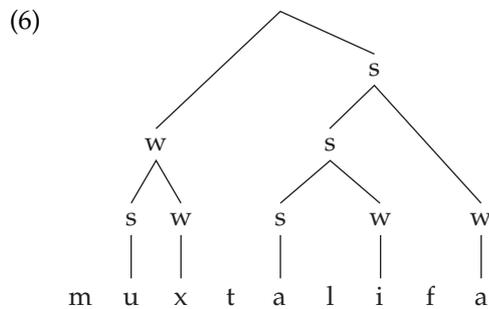
The post-SPE period formed an asyllabic interlude in the analysis of Arabic word stress. Most pre-generative and non-generative accounts made reference to the syllable, and within generative phonology there was increasing recognition that sounds grouped into syllables of differing prosodic weights, and that the syllable formed part of the prosodic hierarchy (Fudge 1969; Kiparsky 1979; McCarthy 1979; Selkirk 1980, 1982; Halle & Vergnaud 1987).

At this time it came to be recognized that the syllable formed a unit within a prosodic hierarchy, a hierarchy that recognized units of prosodic structure above the syllable – the foot (see CHAPTER 42: THE FOOT) and the prosodic word (see CHAPTER 51: THE PHONOLOGICAL WORD) – and a unit of prosodic structure below the syllable: the mora. Weight-based, rather than segment-based, models of the syllable representing the prosodic tier as a series of moras (e.g. McCarthy 1980; Angoujard 1990; McCarthy & Prince 1990) provide a model that reflects the role of prosodic weight in stress assignment by accounting for phonological positions, and by distinguishing between light (monomoraic) and heavy (bimoraic) syllables (Hayes 1989): short vowels contribute one mora, long vowels two moras, geminate consonants one mora, and coda consonants are assigned a mora through Weight-by-Position in languages such as Arabic, where CVC syllables count as heavy (quantity-sensitivity). In San'ani [tiʔtai] ‘you (FEM SG) want’, for example, the vowels contribute moras and /ʔ/ receives a mora through Weight-by-Position (indicated by a dashed line):



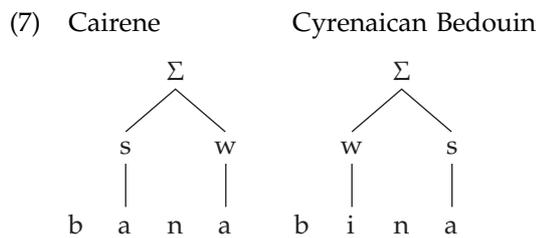
3.2.3 Metrical theory

The prosodic hierarchy plays a pivotal role within metrical theory, which developed from Liberman (1975) and Liberman and Prince (1977) as part of non-linear phonology. It shared with the other main branch of that program, autosegmental phonology, the goal of developing alternatives to the non-local devices of linear theory, such as rule variables and abbreviatory conventions (Kager 1995: 368), and viewed stress as hierarchically organized rhythmic structure. Metrical theory provided representation of the hierarchical nature of stress independently of the segmental tier. This was achieved initially through metrical trees, wherein stress was represented as a hierarchy of binary branching structures, labeled strong–weak (s–w) or weak–strong (w–s) to mark relative prominence at each layer (see CHAPTER 43: REPRESENTATIONS OF WORD STRESS). The metrical tree representation of Cairene [mux'talifa] 'different (FEM SG)' (McCarthy 1979) is:



3.2.4 Rhythmic organization

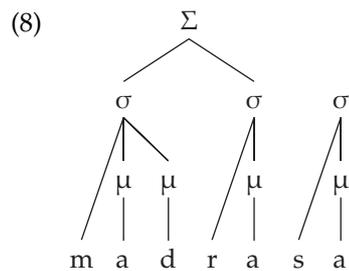
The foot types recognized on the basis of rhythmic organization since Prince (1976) enabled Arabic dialects to be classified in terms of foot shape: dialects such as Cairene, Levantine, and San'ani, which exhibit initial prominence, organize strings of syllables into trochees (s–w pairs); dialects such as Cyrenaican Bedouin, Tunisian, and Moroccan, which exhibit final prominence, organize strings of syllables into iambs (w–s pairs). Compare: Cairene 'bana 'he built' and Cyrenaican Bedouin *bi'na*:³



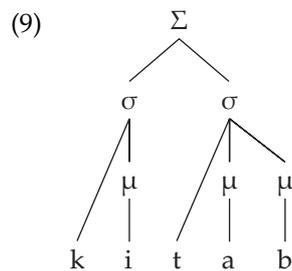
In early metrical accounts, feet which involved counting more than two were permitted: for Halle and Vergnaud (1978), the foot in Damascene, a dialect that exhibits initial prominence, included all syllables (effectively no more than three)

³ All data for Cyrenaican Bedouin are from Mitchell (1960).

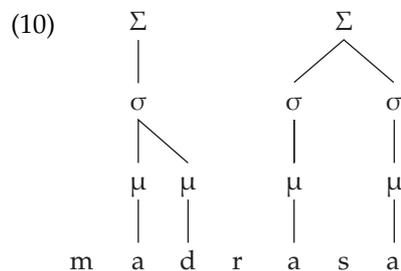
from the stressed syllable to the right-edge of the word, placing a word like ['madrase] 'school' within a single foot. McCarthy (1979, 1980) restricted the foot by measuring it in moras: in Damascene, the stressed mora plus, at most, two following moras. A word comprising three light syllables, such as ['darasu] 'they learnt', exhausts the foot, giving ['(darasu)], but in a word comprising a heavy plus two light syllables, such as ['madrase] 'school', the final light syllable is excluded from the foot: ['(madra)se].



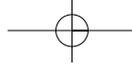
Since these accounts, bounded foot inventories have often excluded feet that require counting higher than two (but cf. e.g. Burzio 1994). Hayes (1989, 1995) argues for absolute binarity: the maximal and canonical iamb consists of a light syllable followed by a heavy syllable, as in Cyrenaican Bedouin [ki'tab] 'he wrote':



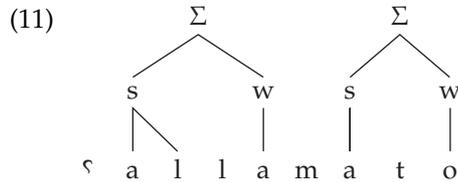
Trochees comprise two equal elements: syllables in the syllabic trochee, moras in the moraic trochee. In a moraic trochee dialect, [madrasa] 'school' comprises two moraic trochees; cf. (8):



The uneven trochee, which comprises a heavy and a light syllable in moraic trochee systems, is ruled out by Hayes. It is, however, invoked by Irshied and Kenstowicz (1984), Angoujard (1990), and Kager (2009) to account for penultimate stress in

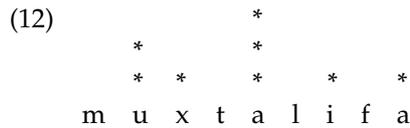


HLLL forms in trochaic Arabic dialects, as in Jordanian Bani-Hassan [ʕalla'mato] 'she taught him':



3.2.5 Constituency and the metrical grid

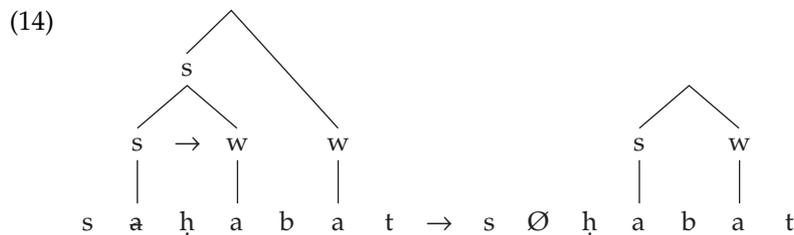
Metrical trees reflect constituency through sister nodes, but fail to represent in any transparent way typical stress characteristics of stress clash or alternating rhythm between strong and weak syllables. Prince (1983) and Selkirk (1984) argued that the metrical grid could better capture the rhythmic characteristics of stress, and that constituency into feet could be eliminated. Compare the pure grid representation of Cairene [mux'talifa] 'different (FEM SG)' below with the metrical tree representation in (6):



In 1985, data from an Arabic dialect appeared to challenge the effectiveness of the pure grid. In an account of Bedouin Hijazi Arabic (BHA), Al-Mozainy *et al.* (1985) analyzed alternations such as those in (13) as resulting from low vowel deletion and stress shift.

- (13) 'saḥab 'he pulled' s'ḥabat 'she pulled'
 'naxal 'palm trees' n'xalah 'a palm tree'
 'salag 'hunting dogs' s'ligah 'a hunting dog'

They argued the direction of shift was governed by constituent structure and that vowel deletion in BHA induces left-to-right stress shift to the sister node within the metrical tree:



Through eliminating constituency, the pure grid provided no explanatory account for the direction of stress shift in data such as these. The introduction of brackets within the grid (Halle & Vergnaud 1987; Halle & Kenstowicz 1991;



- (17) /min-u/ > [minnu] 'from him/it (MASC)'
 /ʕan-kum/ > [ʕannukum] 'about you (PL)'
 /fi-h/ > [fi(h)] 'in it, there is'

Sub-minimal loanwords are typically expanded through vowel lengthening to match the minimal prosodic word, as in: [bār] 'bar' and [bāš] 'bus'. Some dialects, such as San'ani, however, do have stressable monomoraic content words, including [ab] 'father', [ax] 'brother', [yad] 'hand', [dam] 'blood', and a few sub-minimal function words that contrast with comparable bimoraic words in Cairene, and never lengthen, including [kam] 'how many' (cf. Cairene [kām]), [man] 'who' (cf. Cairene [mīn]), and [maʕ] 'with' (cf. Cairene [maʕa]) (Watson 2002: 88–89). Further evidence that degenerate feet are allowed in strong position in San'ani includes the exceptional stressing of peripheral light syllables, giving optional initial stress in forms such as ['tamām] 'good', and optional final stress in forms such as [fik'mih] 'party for parturient' (§4.2.2).

3.2.7 Weak parsing

Many languages stress the third syllable from the word edge. Hayes (1982, 1989, 1995) argues such systems can be accounted for not by expanding the universal inventory to include ternary feet, but by resorting to the independently motivated devices of extrametricality at the edge, destressing in clash, and the non-exhaustivity of foot construction. Non-exhaustivity of foot construction means syllables can be skipped through a device known as weak local parsing, potentially creating ternary alternation in longer strings (Hayes 1995: 308):

- (18) (x .) (x .) (x .)

This device enables Hayes to provide an account of Arabic dialects which dispenses with the uneven trochee. Bani-Hassan [ʕalla'mato], seen above in (11), is analyzed in moraic trochees with weak local parsing (Hayes 1995: 366):

- (19) (x) (x .)
- ʕ a l l a m a t o

3.2.8 Final consonants, syllables, and feet

The right-edge of the word prompts exception in many languages: extra-long syllables are often restricted to the right-edge, and syllables that act as heavy non-finally often fail to attract stress in final position. In Cairene, the sequence [.tab.] is stressed penultimately in [ka.'tab.tu] 'you (PL) wrote', but not finally in ['ka.tab] 'he wrote'. To account for the asymmetric behavior of closed syllables and the invisibility of peripheral elements to stress rules, Liberman and Prince (1977) introduced the notion of extrametricality (see CHAPTER 45: EXTRAMETRICITY AND NON-FINALITY), the rules for which were developed by Hayes (1979, 1982, 1989). Thus, rather than specify for relevant languages that CVC is light finally, but heavy non-finally, and that only CVCC and CVVC syllables are heavy finally, the rightmost consonant is analyzed as invisible to stress rules through extrametricality, making final CVC equivalent in weight to non-final CV (Hayes 1995: 57):

(20)	Final	Non-final
	CV	CV
	CV<C>	CV
	CVC<C>	CVC
	CVV	CVV
	CVV<C>	CVV

In several Arabic dialects, final pairs of light syllables also appear to be invisible to stress rules. In Palestinian, for example, stress is assigned to the rightmost bimoraic sequence in these words:⁵

(21)	'ʔana	'I'
	'katabu	'they wrote'
	bara'kitna	'our cow'
	ka'tabna	'we wrote'

However, in words comprising a heavy syllable followed by two light syllables, or four light syllables, stress is assigned to the initial syllable:

(22)	'barakito > 'bakarto	'his cow' (with High Vowel Deletion)
	'madrasa	'school'
	'fajaratun (Classical)	'tree (NOM)'

Hayes (1995) analyses such patterns as resulting from foot extrametricality, subject to the non-exhaustivity condition. Thus, ['madrasa] is parsed as [(mad)(rasa)], with two bimoraic feet; by not exhausting the word the peripheral foot is eligible for extrametricality, giving [(mad)<(rasa)>]. Stress is assigned to the rightmost visible (non-extrametrical) foot: ['(mad)<(rasa)>]. The characteristic Cairene pattern of stressing a light penult after a heavy antepenult, by contrast, is analyzed as resulting from lack of foot extrametricality: the rightmost visible foot is stressed in all dialects, but only in Cairene is the peripheral foot visible to stress rules: Cairene [(mad)'(rasa)] contrasts with Palestinian ['(mad)<(rasa)>].

3.2.9 CVXC syllables

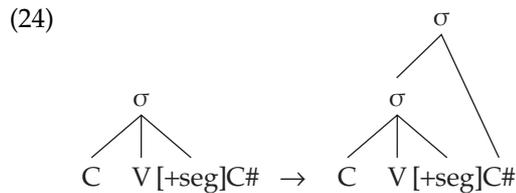
Stress patterns in several languages, including Arabic, indicate that an extrametrical consonant does not deprive the rightmost foot of peripherality: by being contained within the peripheral foot, the peripheral consonant does not intervene between the foot and the right-edge. In San'ani ['katabatih] 'she wrote it (MASC)', for example, extrametrical /h/ falls within the rightmost foot, itself deemed extrametrical. Stress assignment to the rightmost visible foot gives ['(kata)<(bati<h>)>]. An analysis of extrametricality in the case of CVVC and CVCC strings, however, predicts the wrong results: extrametricality would render final C invisible to stress rules; as an extrametrical element it would fall in the adjacent foot, failing to deprive the foot of peripherality; as peripheral feet, CVCC and CVVC syllables would be invisible to stress rules in dialects such as Palestinian for which foot extrametricality holds, but not in dialects where foot extrametricality fails to apply. Such an analysis would predict a stress difference in words of the pattern CVVCVCC

⁵ Data from Brame (1973, 1974), Abu-Salim (1980), and Kenstowicz & Abdul-Karim (1980).

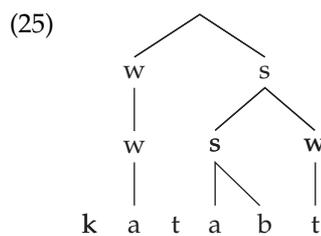
and CVCCVCC between dialects that exhibit foot extrametricality (23a), and dialects such as Cairene, which do not (23b):

- (23) a. Consonant extrametricality: darrast → darras<t>
 Foot extrametricality: (dar)(ras<t>) → (dar)<(ras<t>)>
 Stress rightmost visible foot: *'(dar)<(ras<t>)> (= dar'rast)
- b. Consonant extrametricality: darrast → darras<t>
 Foot extrametricality: *n/a*
 Stress rightmost visible foot: (dar)'(rast)

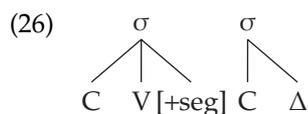
A significant step in research on Arabic stress concerns the analysis of these so-called “superheavy” syllables. Superheavy syllables are exceptional on two counts: they are the only syllable types that are always stressed in final position (although cf. §4.2.2), and they are restricted to domain-final position (at least in morphologically simple forms). Thus, in terms of stress rules, they behave like penultimate CVV or CVC (as do CVVC/CVCC syllables in English; Burzio 1994; Harris & Gussmann 2002). Several analyses of CVVC/CVCC strings have been proposed around the basic analysis of heavy syllable + element. This was expressed initially by McCarthy (1979: 453) through Chomsky-adjointing a word-final consonant to a heavy syllable:



Halle and Vergnaud (1979) analyze final C in CVXC as the weak element in a branching foot:



In later accounts (Aoun 1979; Angoujard 1981, 1990; Selkirk 1981;⁶ Burzio 1994), the rightmost C forms a degenerate syllable, i.e. a syllable with an empty nucleus or null vowel:



⁶ Only for CVCC syllables. See §135.4.2.2.

For Hayes (1995: 126), final C in CVXC is not syllabified at the initial stage: CVXC is analyzed as heavy syllable + stray consonant, while CVC is analyzed as light syllable + extrametrical consonant:

- (27) CVX.C
CV<C>

Within OT, Al-Mohanna (2004) analyses final C of word-final CVXC as attached directly to the prosodic word node. Essentially, then, all accounts show that the rightmost C in CVXC sequences intervenes between the right-edge and the heavy syllable, depriving the foot formed by the heavy syllable of peripherality. Thus, *darrast* (23) in both Cairene- and Palestinian-type dialects is analyzed as [(dar)'(ras).t].

This section has examined key approaches to Arabic stress within the generative paradigm, with particular focus on challenges raised by Arabic data for stress theory. §4 will provide sketches of the stress systems of Classical Arabic and three modern Arabic dialects, focusing on core similarities and differences between the dialects, and examining approaches invoked to account for cross-dialectal differences and apparent exceptions to the stress algorithms.

4 Stress algorithms

4.1 Classical Arabic

The early Arab grammarians provided detailed descriptions of segments and melodic phonological processes characteristic of readings of the Qur'an and certain Peninsula dialects; however, word stress is never mentioned. This led some researchers to believe that Classical Arabic exhibited no word stress (Birkeland 1954; Ferguson 1956; Garbell 1958), and others to assume it to have been similar to the rather fluctuating word-stress system found today in western dialects of the Arabian Peninsula.

The Classical Arabic stress patterns have since been reconstructed through comparison of modern dialect stress patterns (Janssens 1972), versification (Weil 1954; Wright 1971), and observation of the non-dialectal pronunciation of Classical Arabic in some regions (Abu-Fadl 1961; Mitchell 1993). There is now general consensus that Classical Arabic exhibited predictable stress. Disagreement exists, however, as to the leftmost limit of stress. It is agreed that penultimate CVC or CVV bore stress, or, if the penult was light, antepenultimate CVC or CVV. Where both the penult and antepenult were light, as in /mas'alat-un/, researchers differ: Erpenius (1656), Abdo (1969), Brame (1970), Bohas and Kouloughli (1981), and Angoujard (1990) argue that stress did not retract beyond the antepenultimate syllable, giving, in this case, [mas'alat-un] 'problem (NOM)'. Brockelmann (1907), Wright (1971), Janssens (1972), and McCarthy (1979), by contrast, claim stress is assigned to the initial syllable in such cases, giving 'mas'alatun. If this latter holds, this would mean Classical Arabic, in contrast to the modern dialects, exhibited unbounded metrical feet, constructing feet from one heavy syllable up to, but not including, the next heavy syllable. Under both analyses, lexical exceptions exist: dialect comparison and the non-dialectal pronunciation of Classical Arabic suggest stress was not assigned to the initial heavy syllable in derived verb forms VII and VIII, but to the light antepenult, giving: [in'fa'ala] and [if'ta'ala] rather than *[i'nfat'ala]

and *['iftaʕala].⁷ Similarly, most particle prefixes are unstressed irrespective of their relative position (Mitchell 1960: 371, 1975: 77), leading to antepenultimate or penultimate stress in forms such as: [al-'walad-u] 'the boy (NOM)' (cf. Wright's ['madrasat-un] 'school (NOM)'), [al-'yad-u] 'the hand (NOM)', (cf. ['maktab-un] 'office (NOM)'), [wa-'yad-un] 'and a hand (NOM)' (cf. ['katabat] 'she wrote').

The stress algorithm for Classical Arabic is given in (28) (bracketed elements included in case stress retraction is limited to the antepenult):

(28) Classical Arabic stress

- a. Stress a pre-pausal superheavy (CVVC, CVVGG, or CVCC) syllable: [ki'tāb] 'book', [mādd] 'stretching (MASC SG)', [ja'ribt] 'I/you (MASC SG) drank'.
- b. Otherwise, stress the rightmost non-final heavy (CVV, CVC, or CVVG) syllable (up to the antepenult): [da'rasnā] 'we learnt', [ṣā'būnun] 'soap (NOM)', [maktabah] 'library', [māddun] 'stretching (NOM)', [maktabatun] 'library' (non-pause) (or [mak'tabatun]).
- c. Otherwise, stress the leftmost CV syllable (or antepenult): [kataba] 'he wrote', [katabatuhu] 'library' (or [kata'batuhu]).

4.2 Arabic dialects

This section presents the basic stress algorithms for Cairene, San'ani, and Levantine, three dialects analyzed as exhibiting moraic trochaic stress. Each sub-section considers some of the most significant data that has impacted on metrical theory and approaches invoked to handle this data. The section is concluded by a table summarizing the main stress and stress-related typological characteristics of each dialect and of Cyrenaican Bedouin, aspects of which we considered in §3.

4.2.1 Cairene

More generative accounts of word stress have been provided for Cairene than any other Arabic dialect. Cairene attracted attention due to its characteristic avoidance of a heavy antepenult in favor of a light penult, deletion of unstressed high vowels but, with few exceptions (Woidich 2006), not unstressed low vowels, reduction of unstressed long vowels, and its exceptions.⁸ An initial stress algorithm for Cairene was provided by Harrell (1957, cf. also Mitchell 1956):

(29) Cairene stress

- a. Stress-final CVV(C) or CVCC: [ka'tabt] 'I wrote', [ʔa'bū(h)] 'his father', [saka'kīn] 'knives', [ʔala'bāt] 'demands'.
- b. Otherwise, stress the antepenult when the penult and antepenult are light, unless the pre-antepenult is light: [ʔabadan] 'never', [mux'talifa] 'different (FEM SG)'. Cf. [kata'bitu] 'she wrote it (MASC)' with pre-antepenultimate CV.
- c. Otherwise, stress the penult: [yik'tibu] 'they write', [ʕa'malti] 'you (FEM SG) did', [mar'taba] 'mattress', [bētak] 'your (MASC SG) house'.

⁷ An exception for Wright (1971), etc., but not for Angoujard (1990).

⁸ Descriptive accounts of Cairene in the theoretical literature include Mitchell (1952, 1956, 1960, 1975), Harrell (1957, 1960), Tomiche (1964), Behnstedt and Woidich (1985), and Woidich (2006).

Example (29b) predicts penultimate stress whenever the penult, antepenult, and pre-antepenult are light. However, since long strings of light syllables are unattested in Cairene, we cannot evaluate the stress pattern of words that exceed four light syllables by restricting ourselves to dialect data. Mitchell's (1960, 1975) study of Classical Arabic pronunciation as taught in centers in Cairo provided longer strings of light syllables, demonstrating that (29b) held in forms such as [ʃaja'ratuhu] 'his tree', but not in [ʃaja'ratun] 'a tree (NOM)' and [murtabi'tatun] 'connected (FEM NOM)'. Mitchell provides a comprehensive list of canonical patterns, for which Langendoen (1968) formulates an algorithm along the following lines.

(30) Cairene stress

- a. Stress a superheavy ultima.
- b. Otherwise, stress a heavy penult.
- c. Otherwise, stress the penult or antepenult, whichever is separated by an even number of syllables from the rightmost non-final heavy syllable, or, if there is no non-final heavy syllable, from the left boundary of the word.

Seeking a heavy syllable from the word-edge is common, and stressing a light antepenult in the absence of a heavy penult is explicable on the basis of moracounting (stress the third mora from the right-edge); however, the choice of penult or antepenult in (30c) depends not only on the weight of the stressed syllable and that of syllables to its right, but also on the weight of the syllable to its left. McCarthy (1979) viewed the distinction between odd and even sequences of light syllables as a tacit alternating pattern, explaining the apparently complex rules as the grouping of light syllables into left-headed pairs from left to right. Hayes's (1995) bracketed-grid account of the facts and of McCarthy's analysis is below:

- (31) a. Consonant extrametricality: $C \rightarrow \langle C \rangle / \text{_____}]word.$
 b. Foot construction: Form moraic trochees from left to right. Degenerate feet are not permitted.
 c. Word layer construction: Group feet into a right-headed word constituent: End Rule Right (ERR).

Taking [mak'tabak] 'your (MASC SG) office', the rules generate the following metrical structure:

- (32) $\begin{matrix} (. & * &) \\ (*) & (* & .) \\ \mu & \mu & \mu & \mu \\ m & a & k & t & a & b & a & \langle k \rangle \end{matrix}$ word layer construction: ERR
 foot construction: moraic trochees, L>R
 consonant extrametricality

This formalism accounts for most of the data, but fails to account for the following cases:

- (33) a. Penultimate stress in plural nouns of the pattern CiCiCa/CuCuCa: [li'bisa] 'underpants', [gi'riba] 'crows', [si'bita] 'baskets'.

In /ʕālam-u/ > [ʕa'lamu], unstressed CVV is reduced to CV. In /ʔābil-u/ > [ʔablu], the high vowel in the weak position of the foot is deleted, resulting in a CVVC syllable, impermissible in Cairene. The long vowel is subject to Closed Syllable Shortening (CSS) to prevent word-internal CVVC, giving: [ʔablu] 'they met'. Watson (2002), who follows Hayes (1995) in disallowing the uneven trochee, analyses forms such as /sāfir-it/ > [ʕafrit] as assignment of metrical structure prior to syncope with re-assignment of metrical structure after the application of each phonological rule:

- (37) a. Construction of moraic trochees from left to right: (sā)(firit).
 b. Assignment of stress to the head of the rightmost foot: (sā'(firit)).
 c. Reduction of unstressed CVV to CV: (sa'(firit)).
 d. Refooting: ('(safi)rit).
 e. Syncope of the high vowel: '(safrit).

Both these approaches deal with this data, but they miss the generalization that, with the exception of CiCiCa/CuCuCa plurals and the *-it* morpheme, all short high vowels in the position CVCVCV(C) are subject to syncope, even if they would be stressed by the normal stress algorithm (Kenstowicz 1980; Teeple 2009), namely: /kanakit-u/ > [ka'naktu] 'his coffeepot', /kanabit-u/ > [ka'nabtu] 'his sofa'. This data suggests word-internal short high vowels are subject to syncope prior to assignment of metrical structure, as long as the resulting syllable is permissible (cf. Broselow 1992: 36–37): /kanakit-u/ gives [kanaktu], but /mudarris-a/ fails to give *[mudarrsa] because word-internal [.darr.] (CVGG) is impermissible in Cairene.

Syncope is not restricted to the phonological word in Cairene; it also occurs within the phonological phrase: high vowels in word-initial CV syllables are subject to phrasal syncope after a word-final vowel, as in:

- (38) /ʔana fihimt/ > 'ʔana f'himt 'I understood'
 /ʔardi kibīr/ > 'ʔardi k'bīr 'my parcel is big'

Deletion fails to occur in (39), however, even though word-initial CV follows word-final CV:

- (39) /huwwa fihim/ > 'huwwa 'fihim (*fhim) 'he understood'
 /huwwa wiḥif/ > 'huwwa 'wiḥif (*wḥif) 'he is bad'

In (38), the high vowel falls in an unstressed syllable in the citation form ([f'himt] 'I understood', [ki'bīr] 'big'). By contrast, in (39), the high vowel falls in a stressed syllable in the citation form ([f'ihim] 'he understood', [wiḥif] 'bad'). Taken with data such as [ka'naktu] 'his coffeepot', this suggests two types of syncope occur in this dialect: lexical syncope, which targets word-internal CV-flanked high vowels prior to the assignment of metrical structure, and phrasal syncope, which targets unstressed word-initial CV-flanked high vowels after the assignment of metrical structure.

4.2.2 *San'ani*

The main interest in San'ani, the dialect of the old city of San'a, Yemen, lies in its stressing of peripheral light syllables, and the patterning of CVV syllables

with syllables ending in the left-leg of a geminate (CVG), but not with CVC syllables.⁹

The basic stress algorithm for Classical Arabic (28) applies to most word-types:

- (40) a. Stress a final CVCC or CVVC syllable: [gi'rīt] 'I/you (MASC SG) read/learnt', [gam'bart] 'I/you (MASC SG) sat', [ki'tāb] 'book'.
 b. Otherwise, stress the rightmost non-final heavy syllable (CVV or CVC) up to the antepenult: ['madrasah] 'school', [miġ'sālih] 'laundrette', [da'rastih] 'I/you (MASC SG) recited it'.
 c. Otherwise, stress the leftmost CV syllable: ['libisat] 'she put on, wore', [mak'tabatih] 'his library', ['katabatih] 'she wrote it (MASC)'.

(40) fails to apply in San'ani, however, when the penult or antepenult is CVV or CVG. Here the rightmost non-final CVV or CVG syllable attracts stress from final CVCC or CVVC (Watson 2002: 81):

- (41) 'šābūn 'soap'
 'xutṭāf 'clasp'
 mu'darrisīn 'teachers (MASC)'
 'xārijīn 'going out (MASC PL)'

Similarly, while the rightmost non-final CVC syllable is stressed iff in penultimate or antepenultimate position, CVV and CVG are stressable in pre-antepenultimate position:

- (42) mak'tabatī 'my library'
 mu'sajjalatī 'my recorder'
 'hākaḏahā 'like this'

(40) often fails to apply in post-pausal position: San'ani exhibits contextually fluctuating stress (Rossi 1939; Nāim-Sanbar 1994); post-pausally the initial syllable is usually stressed, irrespective of its weight or that of following syllables. Where initial CV is stressed before CVXC, this is analyzed in Watson (2002) as a degenerate syllable (§3.2.6):

- (43) 'tamām 'okay'
 'katabt 'I/you (MASC SG) wrote'
 '?usbūʿ 'week'
 'baladīyāt 'municipality'

The following revised algorithm accounts for the data:

- (44) San'ani stress
 a. Stress the rightmost non-final CVV or CVG syllable: [ma'kātib] 'offices', [ba'sātīn] 'gardens', ['xārijīn] 'going out (MASC PL)', [mit'?axxirāt] 'late (FEM PL)', ['hākaḏahā] 'like this', ['sāfart] 'I/you (MASC SG) traveled', ['dawwart] 'I/you (MASC SG) looked for'.

⁹ Data cited in the theoretical literature include Rossi (1939), Goitein (1970), Nāim-Sanbar (1994), and Watson (2002).

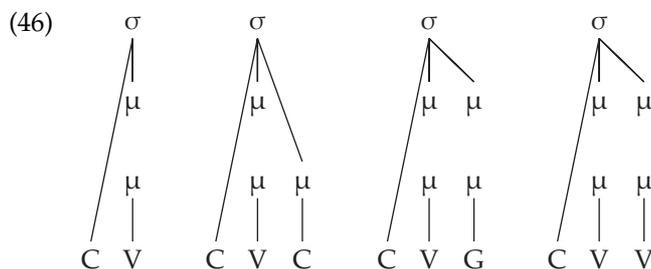
- b. Otherwise, stress final CVVC or CVCC: [ʔab'sart] 'I/you (MASC SG) saw', [laf'laft] 'I/you (MASC SG) collected', [diʃ'mān] 'rebel', [ba'nāt] 'girls'.
- c. Otherwise, stress the rightmost non-final CVC syllable up to the antepenultimate: [laflaf] 'he collected', [maklaf] 'woman', [maklafih] 'his woman'.
- d. Otherwise, stress the leftmost CV syllable: [katab] 'he wrote', [darasat] 'she learnt', [ragabatih] 'his neck', [mak'tabatī] 'my library'.

Adopting Hayes' (1995) bracketed-grid approach, Watson accounts for the facts as follows:

- (45) a. Consonant extrametricality $C \rightarrow \langle C \rangle / _ \text{]word}$
 b. Foot construction Form moraic trochees from left to right. Degenerate feet are permitted in strong position.
 c. Foot extrametricality $\text{Foot} \rightarrow \langle \text{Foot} \rangle / _ \text{]word}$
 d. Word layer construction ERR

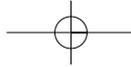
The permitting of degenerate feet in strong position (45b) accounts for post-pausal stressing of CV in words of the structure CVCVXC ([ʔamām], [katabt]), while (45c) accounts for initial stress in [maktabih] 'library' (cf. Cairene [mak'taba]). (45) does not, however, account for the most striking characteristic of San'ani: failure of final CVXC to attract stress when a CVV or CVG syllable occurs in the word, and stress assignment in words ending in CVVC.

Geminates are analyzed as underlyingly moraic (see CHAPTER 3: GEMINATES). Although non-geminate consonants in the rhyme are assigned a mora through Weight-by-Position, geminates are moraicly distinct from non-geminate consonants at some stage in the derivation.¹⁰ This underlying moraic distinctness accounts for the asymmetry in San'ani between CVC syllables, on the one hand, and CVG and CVV syllables, on the other. The distinctness is captured by adopting a two-layered grid within the syllable, where the height of a column depends on the sonority of the segment associated with it (Hayes 1995: 300, drawing on Prince 1983).¹¹ Underlyingly moraic segments have a mora on each layer, while segments assigned a mora by Weight-by-Position have a mora on the lower layer only:



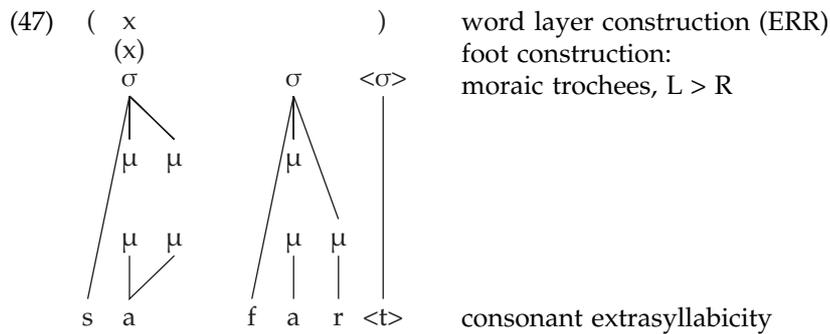
¹⁰ Unstressed vowel shortening in Rural Palestinian also implies a distinction in this dialect between CVC syllables and CVV and CVG syllables (Younes 1995).

¹¹ A similar two-levelled grid developed by Hyde (2006) distinguishes between prosodic and metrical weight. Under this approach, CVC, CVV, and CVG in San'ani are bimoraic, but only in the case of CVV and CVG are both moras projected on the metrical tier.



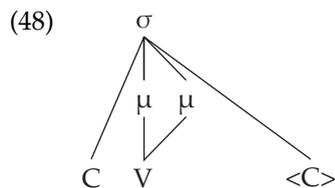
Processes that treat CVC as heavy refer to the lower moraic layer, while processes that treat CVC as light refer to the upper moraic layer. In San'ani, the weight of CVC syllables is relative and entirely dependent on the prosodic environment. Footing is enforced on the upper moraic layer iff underlyingly bimoraic (i.e. CVV or CVG) syllables occur in the word; elsewhere, footing is enforced on the lower moraic layer.

This analysis accounts for the failure of CVCC syllables to attract stress, iff a non-final CVV or CVG syllable falls within the word. Stress is assigned in ['sāfart] 'I/you (MASC SG) traveled' as below:



Penultimate and antepenultimate stress in words such as 'jazzār 'butcher', 'šābūn 'soap' and 'xārijīn 'going out (MASC PL)' is attributed to a prosodic difference in Arabic between CVVC and CVCC syllables. In several Arabic dialects, CVVC occurs in positions from which CVCC is excluded. In Levantine, Sudanese, and Iraqi, CVVC cannot occur morpheme internally but, unlike CVCC, is attested word internally on suffixation of inflectional affixes, as in Lebanese: /kitāb-na/ > [kitābna] 'our book' and Sudanese: /māsik-īn/ > [māskīn] 'holding (PL)' (Broselow *et al.* 1995, 1997). In Classical Arabic, word-internal CVVG syllables are the regular outcome of active participle formation, as in [farra] 'to flee' > [fārr-un] 'fleeing (NOM)' (Wright 1971: 26). And in Cairene, CVVC may occur word finally within the utterance, while words ending in CVCC prompt epenthesis in all but utterance-final position: compare [banāt ʔawīlāt] 'tall girls' with [binti ʔawīla] 'a tall girl' (Selkirk 1981).

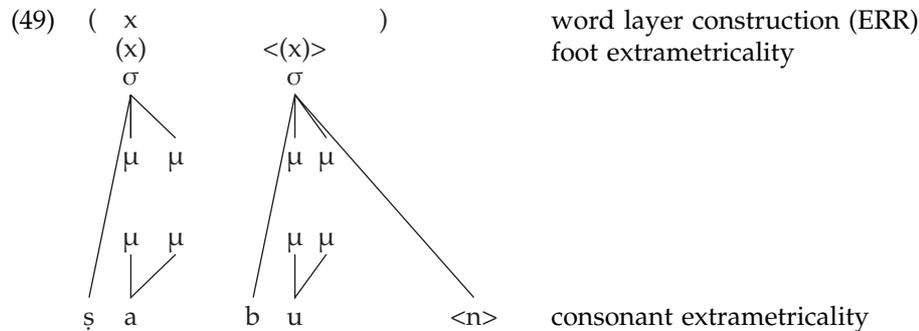
While CVCC is analyzed as a canonical syllable plus an extra element – (24)–(27) – final CVVC is analyzed as a single superheavy syllable (Selkirk 1981: 215), which Watson (1999, 2002) interprets as a bimoraic syllable with an extrametrical consonant:



Under this analysis, final CVVC forms a single bimoraic foot in San'ani. Combined with the moraic grid, the foot formed by word-final CVVC is eligible for extrametricality subject to the Non-exhaustivity Condition, i.e. iff other bimoraic syllables on the upper moraic layer occur in the word. In assignment of stress in ['šābūn]



'soap', two bimoraic feet are constructed on the upper moraic layer; the peripheral foot is extrametrical, and stress is assigned to the rightmost visible foot:



4.2.3 Levantine

Levantine has attracted a great deal of attention within generative phonology due principally to its complex interactions between the morphology and stress assignment.¹² The dialects basically exhibit the Latin stress rule (McCarthy 1980: 79), with the exception of (50a), which Latin lacks:

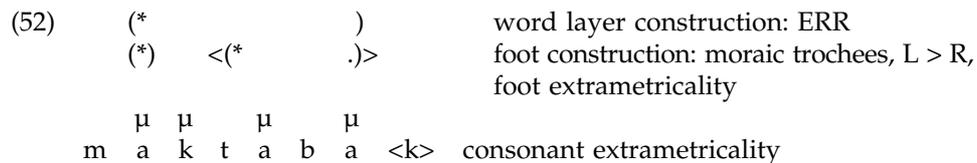
(50) Levantine stress

- Stress final CVCC or CVVC: [bi-t-'ħuʦt] 'she/you (MASC SG) put', [ja'wāb] 'answer'.
- Otherwise, stress a heavy penult: [ka'tabt] 'you (FEM SG) wrote', [bā'arak] 'he blessed'.
- In disyllables ending in CV or CVC, stress the initial syllable: [dā'arab] 'he hit', [bana] 'he built', [ʔana] 'I'.
- Otherwise, stress the antepenult: [darasu] 'they learnt', [mut'taħida] 'united', [ʕallamat] 'she taught', [madrasa] 'school'.

Hayes (1995: 128) accounts for Palestinian stress as follows:

- Consonant extrametricality C → <C> /__]word
- Foot construction Form moraic trochees from left to right. Degenerate feet are forbidden absolutely.
- Foot extrametricality Foot → <Foot> /__]word
- Word layer construction ERR

These rules generate the following metrical structure:



¹² The many traditional descriptive-analytical accounts of Levantine include Feghali (1919), Bauer (1926), Cantineau (1939, 1946, 1960), El-Hajjé (1954), Cowell (1964), Jiha (1964), Grotzfeld (1965), Blanc (1970), Fleisch (1974), and Naïm-Sanbar (1986).

Levantine dialects show a few internal differences. Palestinian stresses the fourth mora from the right-edge in Classical Arabic words such as [ʃajaratun] ‘a tree (NOM)’, giving [ʃajaratun] *vs.* Beirut/Damascene [ʃaʃaratun] (Halle & Kenstowicz 1991). This is analyzed by Halle and Kenstowicz (1991) as a difference in parsing direction and extrametricality: left-to-right in Palestinian (as in (51b), with foot extrametricality), right-to-left in Beirut/Damascene (with syllable extrametricality). Since Cantineau (1939), Levantine dialects have been classified into “differential” and “non-differential” dialects, depending on whether only unstressed high vowels or all unstressed vowels are subject to syncope; cf. (1). Dialects also vary according to whether or not long vowels are shortened in open unstressed syllables, as in Palestinian /makātib-na/ > [makaʔtibna] (Younes 1995) *vs.* Damascene /kātābət-o/ > [kātāʔbətə] ‘she wrote it’ (McCarthy 1980).

4.2.4 The interaction of syncope, epenthesis, and stress

The main interest in Levantine stress data is in the treatment of morphologically complex forms, where stress is assigned opaquely in some cases to a light penult (skipping a heavy antepenult or pre-antepenult), in other cases to a light antepenult (skipping a heavy penult). Consider the Palestinian data below (Brame 1974; Abu-Salim 1980; Younes 1995):

(53)	<i>Penultimate</i>		<i>Antepenultimate</i>	
	kaʔtabit	ʔI/you wroteʔ	ʔxubizha	ʔher breadʔ
	fʔhimit	ʔI/you understoodʔ	ʔbinitha	ʔher daughterʔ
			ʔyikitbu	ʔthey writeʔ
			ʔjabilha	ʔhe gave herʔ

The traditional explanation of opaque stress assignment to the penult in words such as [kaʔtabit] and [fʔhimit], and to the antepenult in [ʔbinitha] and [ʔyikitbu] is that the epenthetic vowel fails to count for stress. Since Brame (1970, 1973, 1974) this explanation has been translated in rule-based approaches into the relative ordering of stress, syncope and epenthesis. Stress is assigned in the lexicon, and within the postlexical component syncope is ordered before epenthesis. This accounts for opaque stress in Palestinian [kaʔtabit] ‘I/you (MASC SG) wrote’ and [ʔyikitbu] ‘they (MASC) write’, where syncope and/or epenthesis take place, and for transparent stress in [ʔkatabin] ‘they (FEM) wrote’, where neither syncope nor epenthesis occurs:

(54)		[[fihm]na]	[katab-t]	[yi-ktib-u]	[katab-in]
	first cycle				
	stress	ʔfihm	kaʔtab-t	ʔyiktib-u	ʔkatab-in
	second cycle	ʔfihm-na			
	post-cyclic				
	syncope	NA	NA	ʔyiktbu	NA
	epenthesis	ʔfihimna	kaʔtabit	ʔyikitbu	NA
	output	ʔfihimna	kaʔtabit	ʔyikitbu	ʔkatabin
		ʔour under-	ʔI/you (MASC	ʔthey (MASC)	ʔthey (FEM)
		standingʔ	SG) wroteʔ	writeʔ	wroteʔ

Levantine-like opacity has continued to attract considerable interest within constraint-based models. Optimality-theoretic approaches towards opacity include: invoking constraints on the stressing of epenthetic vowels, maximizing paradigmatic contrasts,¹³ and translating the notion of the cycle into lexical and post-lexical strata. Within parallel OT, Kager (1999) accounts for Levantine opacity by invoking the constraint HEAD-DEP(O/I) ('every vowel in the output prosodic head has its correspondent in the input'), which prohibits stress on epenthetic vowels. By dominating constraints responsible for stress, HEAD-DEP(O/I) rules out penultimate stressed *[fi'himna] (input [fi'hm-na]) and *[yi'kitbu] (input [yiktib-u]), and other constraints select [fihimna] and [yikitbu]. Kiparsky, however, raises two objections to this constraint: first, its only remit is to prevent epenthetic vowels from being stressed, but epenthetic vowels are not simply unstressable, they are *invisible* to stress: words of the form CVCVCV(C) receive antepenultimate stress unless the final vowel is epenthetic, in which case the penult is stressed, acting as if the epenthetic vowel were not there, as in: [ka'tabit] 'I/you (MASC SG) wrote'. Second, HEAD-DEP(O/I) fails to relate the opacity of stress to other word-level prosodic processes, thus missing the generalization "that *all* processes of word phonology ignore epenthetic vowels" (Kiparsky 2000: 353). For example, word-level closed CVVC syllables are shortened even though they are opened by postlexical epenthesis:

- (55) /ʃāf-it/ > ʃāfit 'she saw'
 /ʃāf-t/ > 'ʃifit (*ʃāfit) 'I saw'

Brame's insight (§3.2.1) that syncope is ordered before epenthesis in dialects such as Levantine is captured in stratal OT by allowing different constraint rankings in the lexical and postlexical strata (Kiparsky 2000, 2003). The relevant constraints here are the faithfulness constraint MAX-V, requiring the stressed vowel of the input to have a correspondent in the output, and the markedness constraints REDUCE, which minimizes the number of non-final light syllables, and LICENSE-μ, which requires all moras to be licensed by syllables. Syncope takes place at the word level because REDUCE outranks LICENSE-μ. At the postlexical level, epenthesis is prompted by the promotion of LICENSE-μ, and MAX-V rules out candidates in which stress is assigned to the epenthetic vowel. Kiparsky's stratal OT analysis of /yiktib-u/ > [yikitbu] is given in (56) and (57):

- (56) VC dialects: Word level

Input: ['(yik).(ti.bu)]	REDUCE	LICENSE-μ	...
a. '(yik).t̪u.bu	*	*	
b. '(yik).(ti.bu)	**!		

¹³ Broselow (2008), for example, argues that the invisibility of epenthetic vowels in Iraqi Arabic is motivated by maximization of contrast between stems of different grammatical types.

Table 135.1 The main stress and stress-related typological characteristics of four Arabic dialects

	Cairene	San'ani	Palestinian	Cyrenaican Bedouin
Syllable structure	CVVC] _{pw} CVCC] _{UTT} CVV CVV: *word-final	CVVC] _{pw} CVVC: In morphologically complex environments CVCC] _{pw}	CVVC] _{pw} CVVC: In morphologically complex environments CVCC] _{pw} CVV: *word-final	CVVC] _{pw} CVVC: In morphologically complex environments CVCC] _{pw}
Stress	Foot type: Moraic trochees Direction: L > R Extrametricality: <C>: Yes <Foot>: No Degenerate feet: No Weak parsing: No Stress shift: No Exceptions: Yes	Foot type: Moraic trochees Direction: L > R Extrametricality: <C>: Yes <Foot>: Yes Degenerate feet: Yes Weak parsing: No Stress shift: Yes Exceptions: No	Foot type: Moraic trochees Direction: L > R Extrametricality: <C>: Yes <Foot>: Yes Degenerate feet: No Weak parsing: No Stress shift: No Exceptions: No	Foot type: Iamb Direction: L > R Extrametricality: <C>: No <Foot>: Yes Degenerate feet: No Weak parsing: No Stress shift: Yes Exceptions: No
Stress-related phenomena	Syncope: High vowels Unstressed long vowel reduction: Yes CSS: Yes Opaque stress: Due to unstressed long vowel reduction	Syncope: All vowels Unstressed long vowel reduction: No CSS: No Opaque stress: No	Syncope: High vowels Unstressed long vowel reduction: To left of stressed syllable only CSS: No Opaque stress: Due to syncope and/or epenthesis	Syncope: All vowels Unstressed long vowel reduction: No CSS: No Opaque stress: Due to syncope and/or epenthesis

(57) VC dialects: Post-lexical level

Input: ['yik.tu.bu]	LICENSE- μ	MAX-'V	REDUCE
a. 'yik.tu.bu	*!		*
b. yi.'kit.bu		*!	**
☞ c. 'yi.kit.bu			**

The main stress and stress-related typological characteristics of Cairene, San'ani, and Palestinian are summarized in Table 135.1. A column is added for Cyrenaican Bedouin, a dialect analyzed as exhibiting iambic stress. The syllable structure row shows the distribution of CVV, CVVC, and CVCC syllables in the dialects:]PW = restricted to phonological word-final,]UTT = restricted to utterance-final position, and 'CVV = only when stressed. The stress row summarizes foot type, direction of foot construction, extrametrical elements (<C> consonant, <Foot> foot), the permissibility of degenerate feet or weak parsing, and the occurrence of stress shift or morphologically induced exceptions. The final row summarizes for each dialect stress-related phenomenon, showing syncope restrictions, and the occurrence or non-occurrence of long vowel reduction, closed syllable shortening (CSS) and opaque stress.

4 Conclusion

This chapter has examined firstly how Arabic has contributed to the development of metrical theory, with its particular contributions in the areas of rhythmic organization, stress shift, right-edge effects, and the interaction of syncope, epenthesis, and stress. Second, it has provided sketches of the stress systems of four Arabic varieties – Classical Arabic, Cairene, San'ani, and Levantine – focusing on core similarities and differences between dialects, and key approaches invoked to deal with these. Due to space restrictions I have focused on a selection of phenomena and data. I have not examined, for instance, notions of secondary stress – attested in San'ani, for instance, but not in Cairene – stress conflation, and the more drastic alterations in morpheme shape exhibited by iambic dialects such as Cyrenaican Bedouin.

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