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2 Phonology

2.1 Introduction

Phonology is the study of systematic patterning in the distribution and realisation of speech sounds, within, and across, language varieties. The phonology of Arabic features heavily in the work of the Arab grammarians, most notably in the *Kitab* of Al-Sībawayh (Harun 1983). Sībawayh provides phonetic descriptions of the articulation of individual speech sounds (see chapter 1), which are accompanied by an analysis of the patterning of sounds in Arabic which is indisputably phonological in nature. Sībawayh was thus among the first in a long line of phonologists to work on the phonology of Arabic, and in this chapter we set out some of the key strands in that research, highlighting the contribution made by the study of Arabic to our understanding of phonology itself.

In what sense was Sībawayh doing phonology, as it is understood today? For one thing, Sībawayh took pains to carefully identify which consonants and vowels made up the phonological inventory of Arabic, classifying individual sounds ([ħuruuf] 'letters') as either basic or 'derived' (Al-Nassir 1993:17-20). Some recent research in this area is discussed in chapter 1 (section 1.2.1).

Sībawayh quite clearly uses the concept of underlying forms, from which positional variants are derived in an orderly and predictable fashion, and carefully describes the operation of a number of named phonological processes. For example, in the case of *imaalah* 'inclination' (raising/fronting of [a:]/[a]), he describes in detail the range of contexts which do or do not trigger the process, and formulates it explicitly as derivational and iterative: a long vowel [a:] will raise/front (to [ie], Owens 2006) when the preceding syllable contains a short front high vowel [i] *kasrah*, and the raised/fronted long vowel will itself then trigger *imaalah* in a following syllable (Al-Nassir 1993:91-103).

The notion of markedness is applied indirectly in the work of the grammarians in all areas of the grammar (Owens 1988), and, in phonology, Sībawayh identifies *saħiiħ* 'strong' and *muʕtall* 'weak' elements in many of the phonological oppositions that he proposes. For example, he distinguishes sounds as either *mutaħarrik* (CV, followed by a short vowel) or *saakin* (C, closing a syllable), and argues that the *mutaħarrik* is the strong member of the pair. Identification of syllable-initial (onset) position as strong, and syllable-final (coda) position as weak, is argued to account for the differing range of phenomena observed in each position (Al-Nassir 1993:111), mirroring contemporary approaches to onset-coda asymmetries in general (e.g. Lombardi 1999), and directly matching claims made about the underlying syllabic structure of Arabic (Lowenstamm 1996, see 2.2.3 below).

Other phonological phenomena discussed by Sībawayh range from the optimal size of the verbal root (3-5 *ħuruuf*) (Al-Nassir 1993:26) to variation in the realisation of particular sounds or lexical items across definable groups of speakers (Al-Nassir 1993:116-7, cf. Owens 2006 ch.7). We even find discussion of the potential phonological effects of word frequency ("they dare change what occurs more frequently in their speech" Al-Nassir 1993:117) which prefigure exemplar-based approaches to phonology (see 2.2.3 below).

A pattern we see in Sībawayh, and which is repeated throughout phonological work on Arabic, is that there are two ways in which Arabic proves to be an interesting object of study: firstly, because the language has phonological features which are themselves typologically relatively unusual, and secondly, because its phonological features vary, minimally but systematically, across different varieties of the language. The Arab grammarians would not have sought to compare the particular properties of Arabic with those of other languages; in the context of modern linguistics however, the typologically unusual properties of Arabic present a genuine challenge to theories which have often been shaped for the most part by work on Indo-European languages. In turn, the fine-grained variation observed among spoken Arabic dialects has proved a rich seam of research, in particular in generative phonology, which seeks to model surface variation in terms of a limited set of underlying structural differences, whether parameters or ranked constraints. In Broselow's (1992:7) words: "the dialects of Arabic provide an ideal testing ground […], since most of the dialects are similar enough to provide a basis for meaningful comparison, but taken as a whole they exhibit a wide range of variation".

In the main body of this chapter, we set out five important strands of phonological research on Arabic, taking in work on the language-particular phonological properties of Arabic as well as research which exploits fine-grained variation among spoken varieties of Arabic for theoretical gain. The discussion is structured so as to move from segmental phonology (the properties of individual speech sounds) to suprasegmental phonology (the properties of larger domains such as the syllable, word or phrase).

2.2 State of the art

2.2.1 Phonotactic restrictions on consonant co-occurrence in Arabic verbal roots

The Arabic lexicon displays non-concatenative (that is, discontinuous) morphology. This has led some authors to analyse Arabic words in terms of a triliteral (three term) consonantal root, with words generated from the lexical root by internal re-arranging of the sequence of consonants and vowels (see chapter 3 for competing views of Arabic morphology):

(1)	katab	kutib	kitaːb	kutub
	'he wrote'	'it was written'	'book'	'books'

In McCarthy's (1979) root + template analysis of Arabic morpho-phonology, consonantal features are represented on a separate tier (or plane) from vocalic features, and different grammatical classes are generated using fixed templates which define the sequence of consonantal and vocalic positions:

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(2)   vowel tier          u   i
                          |   |
      skeletal tier     C V C V C
                        |   |   |
      consonant tier    k   t   b        [kutib] 'it was written'
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Since the majority of Arabic roots are composed of three consonants, one might expect the consonants in any particular lexical root to be selected at random from the consonantal inventory of Arabic, and freely combined. This is not the case however, and, apart from some mention by the Arab grammarians of which consonants resist co-occurrence[1], Cantineau (1946:133-136) was first to note that not all possible combinations of consonants seem in fact to be observed. Building on this, Greenberg (1950) subjected the possible combinations of consonants appearing in initial (C1), medial (C2) and final (C3) position to a systematic quantitative survey, in a corpus of 3775 Arabic verbal roots. The data were taken from two 19th century Arabic dictionaries (by Western authors), with qualitative comparison to the facts of other languages within the Semitic family.

For Arabic (and for Semitic in general) Greenberg establishes two key patterns:

[1] Greenberg (1950 fn2) notes that lists of "incompatible consonants" are provided by Jalāl ad-Dīn Suyūṭī and Ibn Jinni.

(3) complete absence of roots with adjacent identical consonants in C1–C2 position *<*mmd*>, contrasting with no restriction on adjacent identical consonants in C2–C3 position <*mdd*>[2];

(4) varying degrees of restriction on the occurrence of homorganic consonants (that is, which share place of articulation) within a root (C1-C2, C2-C3, or C1-C3).

Working from the generalisations observed in (4), Greenberg motivates a grouping of the Arabic consonantal inventory into four 'sections', or natural classes, shown in (5) below[3]. Within a single verbal root, Arabic consonants are seen to freely occur with those in other sections, which have a different place of articulation, but are subject to restrictions on co-occurrence with members of the same section. Although examples of verbal roots containing two consonants from the same section can be found, the number of such roots is relatively small[4].

(5)	*back*	*liquids*	*front*	*labial*
	x ɣ ħ ʕ h ʔ k g q	l r n	θ ð t d ṭ ḍ s z ṣ ẓ ʃ	b f m

The generalisations expressed in (3) and (4) above have each inspired a large body of research, which has proven significant not only for an accurate understanding of the phonology of Arabic, but of the phonology of human language in general.

McCarthy (1979, 1981) proposes an explanation of the asymmetry inherent in (3) which combines a root + template morphological analysis of Arabic with the insights of Autosegmental Phonology (Goldsmith 1976, 1981). In Autosegmental Phonology, individual speech sounds are represented as (bundles of) features which are associated to syllabic structure. The surface realisation of an underlying feature is determined by how it is linked in to the prosodic structure. For example, a set of vocalic features will be realised as a short vs. long vowel, depending on whether they are linked to one syllabic position only or allowed to 'spread' to two syllabic positions.

For McCarthy (1979, 1981), the ill-formedness of identical consonants in C1-C2 position versus the well-formedness of identical consonants in C2-C3 is due to two facts: i) the strict observance in Arabic of the Obligatory Contour Principle (OCP), which places a ban on adjacent identical segments, and ii) a requirement in Arabic that features only spread autosegmentally from left-to-right[5]. Underlyingly, a verbal root such as <mdd> thus comprises two feature bundles only, representing <m> and <d>. The features of <d> spread left-to-right, filling the third syllabic consonantal position in the template, and yielding surface forms analyseable as triliteral <mdd>. Since spreading only proceeds left-to-right, an empty syllabic position cannot be filled by leftward spreading of <m>, resulting in an absence of verbal roots such as *<mmd>. The analysis is illustrated in (6):

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[2] Identical consonants in C1-C3 position are relatively rare but nonetheless observed e.g. <*qlq*>.

[3] The table shows only consonants in the inventory of Arabic (Greenberg also includes consonants found in other Semitic languages, such as [p]).

[4] In (5), and throughout this paper, the emphatic coronals are represented using non-IPA symbols: [tˤ dˤ sˤ ðˤ] appear as [ṭ ḍ ṣ ẓ] respectively. Although current practice is to represent 'emphasis' using the IPA uvularisation diacritic [ˤ], the phonetic realisation of emphasis varies more widely across dialects than this representation implies (see section 2.2.2 and Chapter 1).

[5] Directionality of autosegmental spreading is usually argued to vary, by rule and by language (see discussion in McCarthy 2004).

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(6)                              C  V  C  V  C          * C  V  C  V  C
                                 |     |  /                  \  |     |
          [madd] “he spread”     m     d                        m     d
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An analysis in terms of underlying forms is warranted because there is no ban on adjacent identical consonants in derived, morphologically complex, forms; compare the lack of a verbal root *<ttk> with permitted forms such as [tatakallam] “you conversed” (McCarthy 1986:209). Bohas (1997) proposes a more radical approach (cf. earlier work by Voigt 1988, Ehret 1989), suggesting that a biliteral root morpheme, called the ‘etymon’, underlies all triliteral roots, not only those with identical C2-C3; each proposed etymon captures a regular form-meaning correspondence between a consonant pair and a semantic field. Other proposals that extend from the templatic nature of Arabic morphology include the claim that Arabic is a language in which all syllables are comprised of sequences of CV pairs (see 2.2.3).

The analysis in (6) has been challenged due to a non-trivial assumption that it makes about the nature of phonology: namely, that some aspects of phonological knowledge are encoded as restrictions on possible underlying lexical representations (that is, as ‘Morpheme Structure Constraints’). McCarthy (1998, 2005) argues against his own earlier analysis, for this reason. A core assumption of Optimality Theory (OT, Prince & Smolensky 2004) is that all grammar, including phonology, determines surface realisations (‘outputs’) only. This claim is formulated in OT as the ‘Richness of the Base’: the phonological grammar must generate all and only those forms observed on the surface of the language, without stipulating restrictions on possible inputs to the grammar (that is, on the properties of the lexicon). Greenberg’s asymmetry (in 3) represents a serious challenge to theories of this kind.

Solutions to this problem, in the OT literature, mostly appeal to the notion of paradigm uniformity, whereby surface forms are preferred if they bear structural resemblance to other surface forms in the same morphological paradigm (McCarthy 1998, 2005, Gafos 1998, 2001, 2003, Rose 2000). In some of these analyses (Gafos 1998, Rose 2000), the doubled final consonant in the surface form of a root like [madda] “he stretched” results from reduplication, and is permitted because, in the OT framework, the OCP constraint can be outranked by other competing constraints. In another approach (Gafos 2001, 2003), the idea of separation of consonants and vowels onto different tiers is rejected, and the underlying form of all Arabic verbs is proposed to be a CVCC ‘stem’, such as /madd/[6].

What about Greenberg’s other generalisation – in (4) – that, although there is no complete ban on adjacent homorganic consonants in C2-C3 position, their occurrence is highly restricted? In a series of papers McCarthy (1986, 1988, 1994) extends an OCP analysis to these facts also. In contrast to the categorical nature of the asymmetry in (3), the restrictions described in (4) are gradient in nature: the key fact to explain is why there are *some* roots containing homorganic consonants rather than none. McCarthy adopts Feature Geometry (Clements 1985, McCarthy 1988), in which the bundle of features which map onto an individual speech sound is represented as a hierarchically grouped tree structure, rather than as an unordered matrix. For example, Laryngeal features (such as [voice] or [spread glottis]) appear under a different node from Place features (such as [labial], [coronal] or [dorsal]). McCarthy (1988) extends this idea by representing individual Place features on separate tiers, as in (7) below. If the OCP (which bans adjacent identical elements) operates on individual tiers then the Place restrictions are explained.

[6] See chapter 3 for discussion of root- vs. stem/word-based approaches to Arabic morphology.

(7)				
	labial tier	[lab]	[lab]	
		|	|	
	skeletal tier	* C	C	C
				|
	coronal tier			[cor]

This analysis predicts a complete ban on homorganic consonants within a single verbal root, but cannot account for the small but non-trivial number of verbal roots that do contain homorganic consonants, and which are too numerous to be treated as exceptions. An additional complication is that within the larger classes of consonants, such as the coronals (Greenberg's 'front' section), consonants are observed to co-occur somewhat more freely than those within the smaller natural classes (Padgett 1995).

A competing approach (Pierrehumbert 1993, Frisch *et al.* 2004) addresses this problem by taking the gradient tendency in (4) as its starting point. The approach is based on a quantitative, probabilistic model of phonology, contrasting fundamentally with the categorical models of generative grammar embodied in the work of McCarthy and Gafos. The analysis in Frisch et al. (2004) is based on a corpus of 2674 verbal roots from a contemporary dictionary of Modern Standard Arabic (Cowan 1979). The distribution of roots is analysed in terms of the ratio of *observed* consonant combinations to those that would be *expected* if consonants were allowed to occur freely in particular positions of the root (Pierrehumbert 1993). For example, given the frequency of occurrence of [d] in C1 position and of [t] in C2 position, Frisch et al expect there to be 2.3 roots of the form < d t X> (where X is any consonant); in fact there are no such roots, and the observed/expected (O/E) ratio is thus '0' which the authors describe as "the strongest degree of under-representation" Frisch et al (2004:185). In contrast there are 4 roots of the form <d g X> where only 3.3 such roots are expected to occur, giving an O/E score of 1.21, a case of over-representation.

Frisch et al (2004) argue that an adequate analysis of the gradient generalisation described in (4) must capture both under- and over-representation of particular consonant co-occurrences. They propose that a principle of 'similarity avoidance' operates productively in the Arabic lexicon. To model this principle they calculate the degree of similarity between two consonants in the Arabic inventory in terms of the number of natural classes in which the two consonants share/do not share membership[7]. The metric thus encodes not only raw phonetic similarity (number of shared features) but also the relative size of the consonantal inventory at each place of articulation (cf. Padgett 1995). The analysis represents a hybrid approach in which the phonological knowledge of native speakers is claimed to combine traditional phonological factors (here, natural classes defined by place of articulation) with frequency effects: "the native speaker knows an abstract but gradient OCP-Place constraint…based on generalization over the statistical patterns found in the lexicon" (Frisch *et al.* 2004:216). Frisch et al. suggest that a general cross-linguistic tendency to avoid repetition of similar sounds, based on a preference for maximally salient adjacent sounds (Boersma 1998), is heightened in Arabic since consonants are adjacent in lexical representations, if a root-based analysis of Arabic morphology is assumed.

To prevent gradient similarity avoidance from applying in the case of roots with identical consonants in C2-C3 – in the case of the generalisation in (3) – Frisch et al (2004) acknowledge that they must

[7] Similarity is calculated as the number of shared natural classes divided by the sum of the number of shared and unshared natural classes (Frisch *et al.* 2004:198).

adopt some form of 'categorical override'. They note that prior approaches to (3), whether autosegmental (McCarthy 1979 et seq.) or paradigm-based (Gafos 2003), both treat the double consonant in a root like <mdd> as licensed by the appearance of a singleton consonant in a related form: the related form in the autosegmental approach is the underlying form (/md/); in a paradigm-based approach the related form is another surface realisation of the same root ([madda] "he stretched"~[madadtu] "I stretched"). Frisch et al (2004) thus propose that some kind of 'related form override' must account for C2-C3 identical roots.

Although Frisch et al. (2004) are formally agnostic about how related forms licence geminate roots in Arabic, they cite a range of behavioural data which they suggest supports an analysis in terms of roots rather than stems. Frisch & Zawaydeh (2001) asked native speakers of Arabic to judge the relative well-formedness of nonsense words; roots with identical C1-C2 such as [tatafa] were universally rejected, but roots containing homorganic consonants in other positions and combinations, such as in C1-C2 in the nonsense word [tasafa], display the same variant restrictions as observed in the general Arabic lexicon. For Frisch et al (2004), this confirms that similarity avoidance is a productive part of the phonological grammar for Arabic. Similarly, Davis & Zawaydeh (2001) argue that truncation patterns in Arabic hypocoristics (nicknames) display effects that can only be explained by appeal to the consonantal root in lexical representation. Finally, evidence from the speech errors of an aphasia patient who is bilingual in French and Arabic (Prunet *et al.* 2000, Idrissi *et al.* 2008), shows different patterns of errors in the two languages, consistent with vowels being present in lexical representations in French but absent from lexical representations in Arabic. In contrast to Frisch et al (2004), Gafos (2001) argues that psycholinguistic data of this kind provide evidence of root-based language *processing* (only), but maintains the claim that the *grammar* of Arabic is stem-based (cf. chapter 3).

In conclusion then, the patterning of consonants in Arabic verbal roots show both categorical and gradient effects (in the generalisations set out above in (3) and (4), respectively) and theories of phonological knowledge need to be able to account for both types of effect. Arguably therefore, a hybrid approach of some kind is to be favoured (such as Pierrehumbert 2006). It is worth noting however that almost all of the analyses discussed above treat the distribution of consonants in verbal roots only, and in Modern Standard Arabic. Studies of patterning of consonants in the nominal system (Faust & Hever 2010) or in spoken dialects are even more rare. An exception is Herzallah's (1990) study of phonetically velar sounds [k x ɣ] in Palestinian Arabic, which behave phonologically as uvular in their co-occurrence restrictions (cited in Davis 1995). Further and broader empirical work in this area may yet reveal a more complete picture for which phonological theory must account.

2.2.2 Post-velar consonants and emphasis

All varieties of Arabic share the property of having a small vowel inventory and a relatively large consonantal inventory (cf. Maddieson 2011). In particular, the consonant inventory has a large proportion of 'guttural' consonants with post-velar place of articulation [q χ ʁ ħ ʕ h ʔ], and a set of 'emphatic' coronal consonants which display post-velar secondary articulation [ṭ ḍ ṣ ẓ] and contrast with plain counterparts [t d s ð][8]. The post-velar(-ised) segments influence the phonetic realisation of neighbouring segments, both vowels and consonants. The most salient effect is backing (F2 lowering) of immediately adjacent vowels: compare [ta:b] 'he repented' ~ [ṭɑ:b] 'he recovered'. In some dialects other consonants, such as [r l m b], can also trigger the same effect in certain contexts. The domain of this 'emphasis spread' is non-local in character, reaching the entire word in some spoken dialects, and

[8] Few varieties display the full set of emphatics, see chapter 1 for discussion.

even beyond it into adjacent words in some cases. Emphasis spread is typologically unusual and is shared with only a few other language families[9].

Work on emphasis represents a large proportion of both past and current research in Arabic phonology, and although the phonetics and phonology of emphatics are inextricably linked, the discussion here focuses on phonological issues[10]. The key phonological issues that have exercised the research community with regard to emphasis include what the nature – and name – of the phonological feature used to represent emphasis should be, whether this feature is a property of individual segments or larger domains, and how to explain the differing domain and directionality of emphasis spread observed in different dialects of Arabic (see Bellem 2007:26-33 for a summary).

The Arab grammarians used a range of terms to describe the properties and effects of the emphatic and guttural consonants. Sībawayh described the emphatic coronals [ṭ ḍ ṣ ẓ] as *muṭbaq* 'covered, enclosed', contrasting with plain coronals such as [t d s], which are *munfatiħ* 'open' (Al-Nassir 1993). The *muṭbaq* consonants are characterised by raising of the tongue dorsum towards *al-ħanak al-aʕla* 'the roof of the mouth' with no mention of a role for the pharynx in the articulation (Al-Nassir 1993). Sībawayh also describes a class of seven consonants - the four *muṭbaq* emphatic coronals plus the three uvulars [q χ ʁ] - which share the feature of being *mustaʕli* 'elevated', and are identified as a natural class because they all block *imaalah* (see 2.1). Ibn Jinnī contrasts the seven *mustaʕli* consonants with all other consonants, which are *munxafiḍ* 'lowered' (Al-Nassir 1993). Sībawayh used the term *mufaxxam* 'made grand' to describe a raised and backed realisation of /a:/ *alif* and /a/ *fatha* , as [ɑː] and [ɑ] respectively, in the context of a *mustaʕli* consonant (Al-Nassir 1993:103)[11]. Sībawayh thus does not categorise the pharyngeals [ħ ʕ] as eliciting *tafxiim.*

Watson (2002) analyses 'pharyngeal' gutturals and 'pharyngealised' emphatics, in Cairene and San'aani, as a single group (cf. Broselow 1976), characterised phonologically by the feature [guttural][12] in a non-primary position in the feature geometry. She sees the gutturals as pharyngealised counterparts of non-pharyngealised sounds, just as emphatic coronals are pharyngealised counterparts of plain coronals, as illustrated in (8) below (Watson 2002:42-44). She describes emphasis spread as 'pharyngealisation', and notes that it is accompanied in some dialects by varying degrees of labialisation.

(8)

------------------------	------------------------*'pharyngeal'*	------------------------		------- *'pharyngealised'*	-------
velars	*uvulars*	*laryngeals*	*pharyngeals*	*coronals*	*emphatic coronals*
[k g]	[q χ ʁ]	[h ʔ]	[ħ ʕ]	[t d s ð]	[ṭ ḍ ṣ ẓ]
|	|	|	|	|	|
[dorsal]	[dorsal]	[guttural]	[guttural]	[coronal]	[coronal]
	|		|		|
	[guttural]		[guttural]		[guttural]

[9] Also found in some other Semitic languages, Caucasian and languages of the Pacific North West (McCarthy 1994, Shahin 2003); the phonetic realisation of the effect varies greatly across languages and dialects.
[10] See chapter 1 for an overview of research on the articulatory and acoustic properties of Arabic emphatics.
[11] Sibawayh also notes that *alif* is realised as [ɑː] in the Hijazi dialect (Al-Nassir 1993:103).
[12] This is a monovalent feature in Watson's analysis; monovalent features are either present or absent from the phonological representation of speech sound, with no binary ± settings.

Watson analyses pharyngeal and pharyngealised sounds with the same feature specification (non-primary [guttural]), but argues that both the phonetic realisation and the extent of pharyngealisation will differ in each sub-group, due to the difference in the relationship between the primary and non-primary features in each case. In pharyngealised coronals, the tongue dorsum realises non-primary [guttural] at the same time as the tongue tip/blade realises primary [coronal]; the tongue is thus under tension and it takes time for the articulators to move back to non-emphatic settings. This results in greater, more non-local spread of pharyngealisation from the emphatic coronals, than from the gutturals (Watson 2002: 273). Watson's featural representation can also explain the realisation of Classical Arabic /q/ in spoken dialects: in Cairene, */q/ lost primary [dorsal] and non-primary [guttural] was promoted, yielding /ʔ/ (Watson 2002: 45 fn18).

In contrast, McCarthy (1994:202-218) argues that the gutturals (Watson's *pharyngeal*) must receive a different featural analysis to the emphatic coronals (Watson's *pharyngealised*), because even though there is evidence for grouping gutturals and emphatic coronals together, in that they both block *imaalah* (McCarthy 1994:218-220), there is also ample evidence that the gutturals form a natural class to the exclusion of the emphatic coronals. Key evidence in Arabic for the natural class of gutturals comes from co-occurrence restrictions within lexical roots (see 2.2.1 above) and from vowel lowering and metathesis (*gahawah* syndrome) in the vicinity of gutturals (McCarthy 1994:202-218).

McCarthy (1994:221) thus proposes a distinct feature representation for the various relevant classes of sound, as in (9) below. He uses the feature [pharyngeal] which is in most respects parallel to Watson's (2002) [guttural][13].

(9)

	uvular gutturals	*low gutturals*	*emphatic coronals*
	[χ ʁ]	[h ʔ ħ ʕ]	[ṭ ḍ ṣ ẓ]
	Place	Place	Place
	[pharyngeal] [dorsal]	[pharyngeal]	[coronal] [pharyngeal] ([dorsal])

Other featural analyses of emphasis include Davis' (1995) treatment of two varieties of Palestinian Arabic, in which a Pharyngeal node is argued to host two features: [RTR] ' retracted tongue root' and [CP] 'constricted pharynx'. Davis argues on articulatory grounds that [RTR] is active in the uvular gutturals [χ ʁ], whereas [CP] is active in the pharyngeals [ħ ʕ]; the emphatic coronals have non-primary [RTR]. In a study that compares data in Palestinian Arabic (PA) and St'àt'imcets Salish, Shahin (2003) argues for a cross-linguistic distinction between uvularisation (spreading of non-primary RTR, in PA from emphatic coronals) and pharyngealisation (spreading of primary RTR, in PA from gutturals). In contrast to the articulatorily defined features described thus far, Bellem (2007) analyses emphasis using a system of psycho-acoustically defined features (after Harris & Lindsey 1995) which includes just three resonance features: A, I and U. For Bellem, A-spreading (emphasis spread) competes in the phonology with I-spreading (*imaalah*) and U-spreading (labialisation).

[13] Both authors ascribe their use of [guttural]/[pharyngeal] to the proposal made in Hayward & Hayward (1989) for a feature [guttural], which is there argued to be more broadly defined, in terms of 'zone of constriction'. Note that McCarthy (1994) treats /q/ separately from the uvular fricatives.

A key area of variation across different varieties of Arabic is in the domain of emphasis spread. All of the spoken dialects studied thus far appear to share the asymmetry that leftward spreading is less restricted than rightward spreading, and that spreading is greater from emphatic coronals than from gutturals. Spreading may be blocked by intervening palatal vowels or consonants in some dialects in one or both directions. Davis (1995) analyses blocking of RTR-spreading by high vowels and palatal consonants by means of a rule grounded in the natural antagonism between [RTR] (retracted) and a [+high] (advanced) tongue positions. Bellem (2007) suggests that variation in the domain of emphasis spread is better analysed as blocking by intervening emphatics/gutturals of an active *imaalah* (palatalisation) process, than as blocking of *tafxiim* (emphasis) by intervening palatals.

For most authors (e.g. McCarthy 1994, Watson 2002) emphasis spread is viewed as autosegmental spreading of a feature from a consonant to adjacent vowels and consonants. However, if separate V/C tiers are assumed, as in 2) above, the exact mechanism by which a spreading feature is able to spread not only to adjacent consonants but also to vowels is not fully spelled out. Working in OT, Shahin (2003) analyses spreading using Alignment constraints on surface (output) realisations. To a limited extent this echoes Beeston's (1970:19) view that *iṭbaaq* is a prosody (in the Firthian sense[14]), rather than a "component of the four velarised alveolar consonants", and thus a property of domains rather than of segments.

This brief summary includes only the most influential and/or innovative work on emphasis in Arabic phonology. A large number of studies of emphasis in individual spoken dialects exist (Bellem 2007 provides a recent survey), and only a few studies have attempted to analyse the patterns of emphasis across dialects or across Semitic in general (Hayward & Hayward 1989, McCarthy 1994, Bellem 2007). In particular Bellem (2007) offers an analysis which links the relative strength of features in different dialects, and thus their capacity to participate in active feature spreading processes such as emphasis, with more general phonological properties of each dialect such as the number of laryngeal contrasts in the phonological inventory. It is comparative work of this kind which is most likely to reveal the full range of phonological representation(s) which underlie the surface phenomena collectively known as emphasis.

2.2.3 Syllabification and syllable structure

Cross-dialectal variation in syllabification across Arabic dialects is perhaps most clearly exemplified by the differing realisation of sequences of three consonants (CCC). Such sequences commonly occur when a consonant-initial suffix, such as [lu] 'to him' is added to a –CC final word, such as [qult] 'I said'[15]. Although a small number of dialects tolerate a surface CCC cluster (e.g. Moroccan [qultlu]), most dialects insert an epenthetic vowel to break up the CCC sequence, and dialects vary as to where the vowel is placed, CvCC vs. CCvC: Iraqi [gəlitlu], but Cairene [ʔultilu]. The pattern is robust, and is also reflected in the realisation of CC-initial loanwords: 'Fred' is [fi.rɛd] in Iraqi but [if.rɛd] in Cairene (Broselow 1983). The basic two-way distinction gives rise to an informal nomenclature of 'gəlit' vs. 'qəltu' dialects (Blanc 1964), or, more recently, of VC vs. CV dialects (Kiparsky 2003).

Two competing explanations of the VC~CV epenthesis facts emerged in the 1980-90s. Ito (1989) proposed a directional difference between the dialects: Iraqi syllabifies from right-to-left, while

[14] See Firth (1948), or Lass (1984:163-66) for a brief overview of Firthian Prosodic Analysis.

[15] Compare Classical Arabic [qult] 'I said', with [qult] in Morocco, [gult] in Baghdad and [ʔult] in Cairo.

Cairene syllabifies from left-to-right. Mester & Padgett (1994) offer an OT implementation of this directional approach, but also note its limitations, not least in explaining different syllabification patterns in word-initial CC clusters (as in the realisations of 'Fred' noted above).

In contrast, Broselow (1992) proposed that a structural parameter determines the syllabic affiliation of stray consonants in different dialects, building on an earlier suggestion by Selkirk (1981) that 'stray' consonants can be syllabified as 'degenerate' (vowel-less) syllables. Broselow suggests that Arabic dialects vary how they treat the 'stray' third consonant in a CCC sequence: in Iraqi a stray consonant is syllabified into a (temporarily) vowel-less rhyme, in Cairene a vowel-less rhyme is not permitted, so the stray consonant is syllabified as an onset. Epenthesis fills in the empty vowel positions, inserting a vowel before a rhymal consonant and after an onset consonant. Broselow further argues that parallel variation across CV~VC dialects in the treatment of word-internal CVVC syllables, is due to a similar structural parameter. In VC dialects, word-internal CVVC syllables are tolerated ([baab-ha] 'her door'), despite breaching a more general preference in Arabic for bimoraic syllables[16]; in CV dialects, a word-internal CVVC sequence is not permitted at all, and is instead repaired by Closed Syllable Shortening (CSS, [bab-ha] 'her door'). Broselow proposed that in VC dialects, the final consonant in a CVVC word-internal syllable is incorporated into the preceding rhyme (satisfying the general preference for bimoraicity), by a process of Adjunction-to-Mora. This process applies in exactly those dialects (the VC dialects) which permit syllabification of the stray consonant in a CCC sequence into the rhyme.

Kiparsky (2003) reframes Broselow's structural analysis as mora licensing. Dialects vary in whether or not they permit semisyllables, which contain a mora that is unlicensed (i.e. unaffiliated to any syllabic position, neither onset nor rhyme), and if so, at what level of representation the unlicensed material is permitted. Kiparsky maintains a basic two-way divide, grouping C (Moroccan) dialects with VC (Iraqi) and contrasting them to CV dialects (e.g. Cairene)[17]. The broad distinction is that VC dialects permit unlicensed moras, whereas CV dialects do not; the distinction between VC and C dialects is that VC dialects permit unlicensed moras at the lexical level but forbid them at postlexical level, whereas in C dialects unlicensed moras are permitted at all levels of representation, both lexical and postlexical. Kiparsky's (2003) account is formulated within OT in terms of ranked constraints: in VC dialects the constraint LICENSEμ (which requires a mora to be affiliated to syllabic structure) is low-ranked, whereas in CV dialects it is highly ranked. Kiparsky assumes a stratified model of Optimality Theory, allowing the VC~C dialects distinction to be modelled as promotion of the constraint LICENSEμ to a higher ranked position at the postlexical level in VC dialects (only).

Kiparsky suggests that variation in the position of the epenthetic vowel in CCC sequences co-varies not just with availability of CSS (found in CV but not in VC, as argued by Broselow) but also with variation in a range of other syllabification phenomena, including metathesis (found in VC but not CV dialects) and the distribution of CC clusters (which occur only word-finally in CV dialects, and only word-initially in VC dialects). Working from a typologically enlarged dataset, Watson (2007) argues that the co-variance between epenthesis and other syllabification patterns is not so clear cut. The match is quite good for VC dialects, but a significant subset of CV dialects (as classified by epenthesis in CCC sequences) turn out to behave rather more like VC dialects, for example by

[16] Broselow (1992) adopts a fairly standard moraic view of syllable structure, in which a mora, a unit of syllable weight, is assigned to rhymal constituents (vowels and coda consonants), but not to onset consonants. Arabic dialects display a general preference for bimoraic syllables, that is, with a heavy rhyme, either VC or VV.
[17] 'C dialects' are those which, like Moroccan, allow surface CCC clusters.

tolerating word-internal CVVC syllables. Watson thus argues for a further dialect group, the 'Cv' dialects[18], and incorporates Broselow's Adjunction-by-Mora parameter into Kiparsky's (2003) OT account as a NOSHAREDMORA constraint. The constraint is low-ranked in VC and in Cv dialects, explaining shared patterns of behaviour across the two groups.

A completely different approach to syllabification in Arabic, which happens to share the notion of vowel-less syllables with Selkirk (1981), developed out of attempts during the 1990s to capture all and only the observed range of template shapes in Arabic verbal and nominal forms (Guerssel & Lowenstamm 1990, Idrissi 1997). In the resulting 'CV-only' analysis (Lowenstamm 1996, 2003)[19], no consonants are syllabified as codas in Arabic at all, instead every syllable-final consonant is analysed as the onset of a vowel-less syllable (cf. also Yoshida 1993, Bellem 2007).

The somewhat atypical syllabification patterns observed in Moroccan Arabic (MA) have inspired their own strand of research. Along with other Maghreb dialects, MA permits a wider range of word-initial onset clusters than observed in other Arabic dialects, such as [kteb] 'he wrote', [glih] 'he grilled', [qleb] 'he knocked over' (Gafos *et al.* 2011:30). These are analysed as branching (complex) onsets by some authors (e.g. Benkirane 1998), but, more commonly, as sequences of simplex onsets separated by empty vocalic positions, in both 'standard' moraic syllable theory (Kiparsky 2003) and CV-only approaches (Boudlal 2001). Recent work by Shaw et al (2009) and Gafos et al (2010, 2011), working within the broad model of Articulatory Phonology (Browman & Goldstein 1986), proposes a model of the mapping between syllabic structure and articulatory evidence (the fine-grained temporal alignment of the articulatory gestures of the two consonants) which favours analysis of MA word-initial clusters as sequences of simplex onsets. The authors remain agnostic as to which phonological representation of such sequences best matches the articulatory facts (though a formal analysis is proposed by Gafos 2002, 2006), but future work of this kind in MA and in other dialects may shed further light on the typology of syllabification in Arabic.

Finally, recent work on variation in the rhythmic properties of different Arabic dialects suggests that the typology of variation in syllabification across all dialects may prove to be even more fine-grained. Work on cross-linguistic rhythmic typology has shown that a two-way divide between 'stress-timed' and 'syllable-timed' languages over simplifies (Roach 1982, Nolan & Asu 2009). Instead there appears to be a continuum of rhythmic variation across languages, arising from independent variables affecting syllabification, including incidence of vowel reduction and the syllabification phenomena discussed in the VC~CV literature outlined above. This rhythmic continuum is observed cross-dialectally in Arabic: although all dialects are stress-timed, a comparison across six dialects displays that they from more- to less-stress-timed as one travels west to east from Morocco to the Levant (Ghazali *et al.* 2002, 2007). This surface variation correlates with the permitted syllabification patterns and syllable types observed in different dialects (Hamdi *et al.* 2005). Further investigation of the rhythmic properties of a wider range of dialects, employing the most stable rhythm metrics (Wiget *et al.* 2010), and perhaps also incorporating a survey of the incidence of vowel reduction (cf.

[18] The Cv dialects are mostly found in Yemen, but also include Meccan

[19] Lowenstamm's CV-only analysis for Arabic has its roots in Government Phonology, in which word-final codas are analysed as the onset of a vowel-less CV syllable (Kaye 1990), and has itself inspired Strict-CV Phonology, which extends the CV-only analysis to all languages (Scheer 2004).

Cantineau's differential vs. non-differential parameter[20]) may reveal new avenues of research on Arabic syllabic structure and syllabification.

2.2.4 Word stress and metrical theory

Arguably the most important contribution made by the study of Arabic dialectal variation to the advance of phonological theory has been in the area of metrical phonology, which seeks to account for the position of word stress in words of different syllabic structures. The position of stress is predictable in all Arabic dialects, and can usually be reduced to a simple stress assignment algorithm.

Although word stress received no attention in the work of the Arabic grammarians, probably because stress assignment is largely predictable (Watson 2011), there is a very rich body of research on Arabic word stress in contemporary linguistics. This has been fuelled by an ample supply of data, in the form of good descriptions of the word stress patterns of a wide range of dialects (dating from the early 20th century onwards), and by theoretical advances, which have led to continual reanalysis in the field, with some of the advances prompted by the facts of particular Arabic dialects. A thorough survey of this literature is provided by Watson (2011), who points out that much of the interest in the study of Arabic word stress lies in the fact that the surface stress patterns of Arabic dialects share many key properties, but vary non-trivially in others (see also Kager 2009).

Stress assignment in all Arabic dialects is sensitive to syllable weight (quantity-sensitive). The basic stress algorithm for all Arabic dialects assigns stress to a final superheavy syllable (CVVC or CVCC), else to a non-final (usually penultimate) heavy syllable (usually CVC or CVV)[21]. A heavy syllable in word-final position does not attract stress however. This pattern makes sense if we adopt the notion of consonant extrametricality, whereby a word-final consonant is excluded from calculations of syllable weight. The disjunction that a final superheavy syllable attracts stress, whereas a final heavy syllable does not, has been observed in all Arabic dialects described to date, and most authors agree that some form of extrametricality holds in all dialects. A rare exception to the 'stress a final superheavy syllable' generalisation is found in Sanaani Arabic in which a non-final heavy syllable (CVV or CVG) may attract stress away from a word-final superheavy syllable (Watson 2002).

For the most part then, cross-dialectal variation in stress assignment is seen in words without either a final superheavy or a penult heavy. Table 1 below gives data from Standard Arabic and four spoken dialects illustrating in a)-b) the shared properties observed in words containing a final superheavy or penult heavy, and in c)-d) the variation observed in two examples of words of other prosodic shapes.

Table 1: Stress assignment in words with varying syllabic structure, as realised in different dialects[22]

	Standard Arabic[23]	*Palestinian Arabic*	*Lebanese Arabic*	*Cairene Arabic*	*Negev Bedouin*	*gloss*
a)	kaˈtabt	kaˈtabt	kaˈtabt	kaˈtabt	kiˈtabt	I wrote
	kiˈtaːb	kiˈtaːb	kiˈtaːb	kiˈtaːb	kiˈtaːb	book
b)	ˈmaktab	ˈmaktab	ˈmaktab	ˈmaktab	ˈmaktab	office

[20] In differential dialects unstressed vowel deletion (syncope) targets only high vowels [i u], whereas in non-differential dialects syncope affects all short vowels, including [a] (Cantineau 1939).
[21] In Sanaani Arabic only CVG (closed by geminate) and CVV count as heavy (Watson 2002).
[22] The algorithms for each dialect, as described in Hayes (1995), are applied to derive a parallel set of examples.
[23] These are 'pausal' forms of the words; that is, as produced utterance-finally, without case-marking vowels.

	ˈka:tib	ˈka:tib	ˈka:tib	ˈka:tib	ˈka:tib	writer
c)	ˈʒamal	ˈʒamal	ˈʒamal	ˈgamal	ʒiˈmal	camel
d)	ˈmaktaba	ˈmaktaba	ˈmaktabi	makˈtaba	ˈmaktabah	library

The examples in a) contain a final superheavy (CVCC or CVVC), which attracts stress in all of the dialects shown. In b) stress falls on a heavy syllable (CVC or CVV) in penult position, even if it is followed by a heavy syllable, in all dialects. Dialectal differences are seen in c)-d). The examples in c) show stress assignment in a disyllable with a light penult, with Negev Bedouin Arabic the odd one out (stress on the final syllable rather than the first). In d) we see stress assignment in a word with a heavy antepenultimate syllable followed by two light syllables (‘HLL’), with Cairene Arabic the odd one out (stress on the light penult, rather than the heavy antepenult).

The surface variation in cases like c)-d) can be ascribed to underlying structural variation, and different theoretical approaches propose different potential parameters of variation. A widely adopted approach is Metrical Stress Theory (Hayes 1995) which reduces surface variation in Arabic to underlying variation in foot type, in the direction of foot construction within the word, in the size of the prosodic constituent targeted by extrametricality (segment vs. syllable vs. foot) and in treatment of syllables which cannot be grouped into a foot of the preferred type (known as ‘degenerate feet’, and linked to restrictions on the size of the minimal word, see 2.2.3 above). A summary of Hayes’ (1995) analysis of a range of Arabic dialects is provided in Table 2.

Table 2: Summary of Hayes’ (1995) Metrical Stress Theory analysis of Arabic dialects.

dialect	*foot type*	*foot construction*	*extrametricality*	*degenerate feet*
Classical	unbounded	left-headed	consonant	N/A
Bani Hassan[24]	moraic trochee	left-to-right	foot	permitted
Palestinian	moraic trochee	left-to-right	foot[25]	absolute ban
Cairene	moraic trochee	left-to-right	consonant	absolute ban
Lebanese	moraic trochee	right-to-left	syllable	absolute ban
Bedouin Hijazi	moraic trochee[26]	right-to-left[27]	syllable	absolute ban
Negev Bedouin	iamb	left-to-right	foot	permitted
Cyrenaican Bedouin	iamb	left-to-right	foot	absolute ban

A metrical foot is a grouping of one or more syllables in which one syllable is designated as the head. Classical Arabic has an unbounded foot (containing any number of unstressed syllables along with the head). The majority of dialects in Hayes’ survey showed a trochaic (left-headed) foot[28], with just a few dialects of Bedouin origin displaying an iambic (right-headed) foot. The difference in foot type is seen clearly in disyllables (Table 1c): moraic dialects have initial stress [ˈʒamal], iambic dialects final

[24] Bani Hassan Arabic is a Bedouin dialect spoken in northern Jordan (Irshied & Kenstowicz 1984).
[25] Jacobs (1990) analyses Palestinian Arabic with syllable extrametricality, rather than foot extrametricality.
[26] McCarthy (2003) re-analyses Bedouin Hijazi as having iambic feet, in parallel with other Bedouin varieties.
[27] Hayes (1995: 181) suggests that Bedouin Hijazi could also be analysed with left-to-right foot construction.
[28] Hayes (1995) distinguishes two types of trochaic foot: the moraic trochee (comprising two mora) vs. the syllabic trochee (comprising two syllables). All the trochaic Arabic dialects use moraic trochees.

stress [ʒiˈmal]. In fact, the iambic pattern is probably equally widely distributed, at least in geographic terms, as it is found in dialects in Chad, Cameroon and Nigeria also (p.c. Jonathan Owens).

All dialects of Arabic show extrametricality, but some of the surface variation can be ascribed to differences in the size of prosodic constituent which the stress algorithm treats as extrametrical. Both Cairene and Palestinian Arabic are analysed by Hayes as building trochaic feet left-to-right through the word, but they differ in how stress is assigned in a word that contains a heavy syllable followed by two light syllables, as in Table 1d) above. Hayes analyses this difference as due to the operation of foot extrametricality in Palestinian Arabic [ˈmaktaba] (the final foot comprising two light syllables is ignored for the purposes of stress) vs. consonant extrametricality only in Cairene Arabic [makˈtaba] (with no effect in this case). In a similar fashion, differences observed in words of different syllable structures are analysed as evidence of variation in the direction of foot construction and in the treatment of degenerate feet (see Hayes 1995 for details).

Van der Hulst & Hellmuth (2010) point out that the minimal stress pairs which crucially distinguish one dialect from another are relatively infrequent, occurring only in words of certain prosodic shapes. This in turn means that, for the bulk of words, more than one set of parameters could account for the data, allowing for variation in which parameter settings language learners infer from them. These apparently minor surface differences between dialects have on occasion been instrumental in the development of metrical theory. For example, Watson (2011) describes how the particular patterns observed in morphologically complex words in Bedouin Hijazi Arabic (Al-Mozainy *et al.* 1985) led to the proposal of the bracketed metrical grid (Halle & Vergnaud 1987, Hayes 1995), a representation which encodes prosodic constituency at different levels. In a similar way, Arabic dialects show variation in the sensitivity of stress assignment to morphological structure (Brame 1973, 1974), and these facts were instrumental in the development of theories such as Lexical Phonology (Kiparsky 1982) and Stratal OT (Kiparsky 2000). Equally, the interaction of stress assignment with segmental processes is well-known in Arabic for giving rise to cases of opacity, in which the triggering context for a phonological process is not apparent in the surface form of the word. Such cases present a particular challenge to non-derivational theories of phonology, such as classic OT, and a sizeable body of literature has sought ways to analyse such cases of opacity (McCarthy 2003, Elfner 2009).

Finally, the literature includes one or two interesting cases of dialects in which citation form word stress assignment patterns are subject to variation in connected speech. In Sanaani Arabic for example, stress may be attracted to the initial syllable of a word when it occurs in post-pausal (phrase-initial) position (Watson 2002). Similarly, in the Casablanca dialect of Moroccan Arabic, the word-stress algorithm observed in words in citation form appears to disappear in connected speech, to be replaced by word-final stress on all words (Boudlal 2001). The interaction of word stress with phrasal stress and other suprasegmental phenomena is probably the least well-documented aspect of the metrical phonology of Arabic dialects, and as such is likely to yield important results in future.

2.2.5 Intonation

Work on intonation in spoken Arabic dialects is an emerging field of research, and the body of literature discussed here is much smaller than that discussed in earlier sections of this chapter.

We define intonation here as comprising the following phenomena (Halliday 1967): the chunking of utterances into prosodic phrases (tonality), the distribution of prosodic prominences (tonicity) and the shape of the pitch contour observed on and around those prominences (tone). A range of competing theoretical positions exist to account for each of these (Gussenhoven 2004, Ladd 2008). For example, for some authors prosodic phrasing (tonality) is derived directly from syntactic structure, whereas for others it reflects an intervening level of representation, the Prosodic Hierarchy (Inkelas & Zec 1995). The Autosegmental-Metrical (AM) theory of intonation offers a formal phonological representation of intonation, in which the pitch contour is modelled as a series of high (H) or low (L) pitch targets, associated autosegmentally with either the heads or edges of prosodic ('metrical') constituents (Gussenhoven 2007).

As for all less widely researched languages, there is a descriptive gap in work on intonation in Arabic, since standard grammars generally lack detailed discussion of intonational properties. As a result, there are relatively few descriptions of the intonational phonology of individual Arabic dialects, and even fewer studies make comparison across dialects. Chahal (2009) provides a secondary analysis of a number of descriptions of individual dialects, and concludes that all of the dialects studied to date display post-lexical use of pitch only (no dialects of Arabic have lexical tone), and that in all cases the observed intonational patterns require analysis in terms of both prominence-lending and demarcative pitch events (pitch accents on stressed syllables, and boundary tones at phrase edges, in AM terms). Chahal's survey found that dialects do vary in the inventory of possible nuclear tones observed (the nuclear tone being the last and most prominent pitch accent in an intonational phrase, together with any following tonal configuration, such as a final rise or final fall) (Chahal 2009). As in other areas of phonology however we might expect to find greater variation across dialects, once more finely-grained parameters of variation are identified. Cross-linguistic prosodic typology is as yet in its infancy, but already suggests that the scope of cross-linguistic intonational variation is not limited to variation in the inventory of possible nuclear tone configurations (Jun 2005).

Ghazali et al (2007) offer a very preliminary overview of intonational variation in Arabic, based on qualitative analysis of a small sample of parallel data in 6 dialects.[29] More data, and analysis informed by known cross-linguistic parameters of variation, is likely to yield further insights. For example, it is known that intonational languages vary in the distributional density of pitch accents (Vigario & Frota 2003, Jun 2005, Ladd 2008). This cross-linguistic variation is also observed cross-dialectally in Arabic: Lebanese Arabic shows at least one intonational pitch accent in every 'intermediate' prosodic phrase whereas Egyptian Arabic displays an intonational pitch accent on every prosodic word, and these two dialects also vary in whether or not they permit deaccentuation (Hellmuth 2007, Chahal & Hellmuth 2012). This parameter would match with the generalisation observed by Ghazali et al (2007) that 'flat hat' patterns, with relatively sparse modulations in pitch across the utterance, were observed only in Eastern (Levantine) dialects, and not in Western dialects (which included Egyptian Arabic).

In another potential parameter of prosodic variation, languages are known to vary in whether their intonational system makes use of both prominence-lending and demarcative pitch events (pitch accents and boundary tones), or of demarcative (boundary tones) only (Jun 2005). Although Chahal's (2009) survey suggested that all Arabic dialects studies up to that point displayed both pitch accents and boundary tones, further descriptive work may reveal that the generalisation is not correct. For example, the stress migration facts of Moroccan Arabic (Mitchell 1993, Boudlal 2001) are open to re-analysis as an intonational system which makes use of boundary tones only. Again, this is consistent with Ghazali et al's (2007) observation that North African dialects displayed a single rise + fall across each utterance (assuming partition of their utterances into two prosodic phrases each).

[29] They also present the results of a larger, and more methodologically robust, quantitative study of rhythmic variation in Arabic dialects, which is discussed above in section 2.2.3.

In intonational phonology, as in other areas of phonological investigation that we have seen in this chapter, there are a range of competing theoretical frameworks available, so that similar surface facts are open to reanalysis. Rifaat (2005) argues, from analysis of Modern Standard Arabic used in Egyptian broadcast media, that the intonational phonology of Standard Arabic is typologically unusual in its simplicity, in comparison to other languages. El Zarka (2011) develops Rifaat's analysis, for colloquial Egyptian Arabic, and suggests that different intonational configurations map directly to pragmatic functions such as focus and topic. Other work on the prosodic realisation of pragmatic functions in Arabic includes work in functional grammar (Brustad 2000) and laboratory phonology (Hellmuth 2009, Hellmuth 2011a). There is little work on the syntax-phonology interface in Arabic, with work on Egyptian Arabic being an exception (Hellmuth 2004, 2010, 2011b).

As in all areas of Arabic phonology, then, good theoretical modelling is dependent on continuing availability of good descriptions of the empirical facts of a range of Arabic dialects. Unlike word stress, these suprasegmental issues did not escape the attention of the Arab grammarians, with discussion of both pre- and post-pausal phenomena (Cantineau 1946), as well as the role of prosody in disambiguation (Al-Harbi 1991), and thus can be expected to yield further theoretical gains in the years to come, once descriptive data is available in a sufficiently wide range of varieties of Arabic.

2.3 Conclusion

In the main body of this chapter we have outlined some of the most influential, or in our view important, areas of Arabic phonological research, and in all of these areas work is ongoing. Other aspects of Arabic phonology, have received only limited attention to date and yet promise to be equally fruitful. One clear example is work on vowels, perhaps due in part to the small size of the vowel inventory of Arabic. This contrasts with Sībawayh who treated the "*alifs* of *imaalah* and *tafkhiim*" with primary focus on *imaalah*; further research on the phonology of vowel fronting/raising in Arabic, within and across dialects, might serve to contextualise the extensive body of work that exists on emphasis (cf. Bellem 2007). Similarly, work on establishing the true size of the phonological vowel inventory of spoken varieties of Arabic is needed (cf. Youssef 2010).

The motivation for continued research in all areas of Arabic phonology is partly theoretical, with reanalysis of existing data triggered as new theories of phonology are proposed and developed. In other cases as we have seen, new data in Arabic has motivated theoretical innovation in the past, and can be expected to do so again. The contribution made to Arabic phonological research by the availability of detailed descriptions of the phonetics and phonology of a range of Arabic varieties cannot be underestimated (Rosenhouse 2011), and yet the facts of many aspects of the phonology of many varieties of Arabic are still unknown. Our understanding of Arabic phonology, and of phonology itself, will continue to benefit from fieldwork which adds descriptions of further dialects and registers of Arabic to the dataset for which phonological theory must account.

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