

Instrumental Studies in Arabic Phonetics

EDITED BY

Zeki Majeed Hassan

Barry Heselwood

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INSTRUMENTAL STUDIES IN ARABIC PHONETICS

Edited by

ZEKI MAJEED HASSAN

University of Gothenburg

BARRY HESELWOOD

University of Leeds



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Zeki Majeed Hassan and Barry Heselwood

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List of contributors

Sallal Al-Maqtari	University of Sanā, Yemen
Feda Al-Tamimi	Jordan University of Science & Technology, Irbid, Jordan; University of Qatar
Alex Bellem	University of Salford, UK
Mohamed Embarki	University of Franche-Comté, Besançon, France
John H. Esling	University of Victoria, Canada
Adamantios I. Gafos	Haskins Laboratories, USA; University of Potsdam, Germany
Christian Guilleminot	University of Franche-Comté, Besançon, France
Zeki Majeed Hassan	University of Gothenburg, Sweden
Sam Hellmuth	University of York, UK
Barry Heselwood	University of Leeds, UK
Philip Hoole	Institut für Phonetik & Sprachverarbeitung, Ludwig Maximilians University, Munich, Germany
Sara Howard	University of Sheffield, UK
Kenneth de Jong	Indiana University, Bloomington, Indiana, USA
Ghada Khattab	University of Newcastle, UK
Shinji Maeda	CNRS-LTCl, TELECOM ParisTech, France
Slim Ouni	University of Nancy 2, France
Rawya Ranjous	Tishreen University, Latakia, Syria
Kimary Shahin	Simon Fraser University, Burnaby, Canada
Janet C. E. Watson	University of Salford, UK
Mohamed Yeou	Chouaib Doukkali University, Morocco
Bushra Adnan Zawaydeh	Basis Technology Corp., One Alewife Center, Cambridge, Massachusetts, USA
Chakir Zeroual	Faculté Polydisciplinaire de Taza, Taza, Morocco; University Sidi Mohamed Ben Abdellah, Morocco; Laboratoire de Phonétique et Phonologie, UMR 7018 CNRS, Sorbonne-Nouvelle, Paris, France

Transliteration and transcription symbols for Arabic

Consonants		
Arabic letter	Transliteration Upper and lower case	Corresponding Phoneme symbol with alternatives
ب	B, b	/b/
ت	T, t	/t/
ث	Th, th	/θ/
ج	J, j	/dʒ/
ح	H, ḥ	/h/
خ	Kh, kh	/x, χ/
د	D, d	/d/
ذ	Dh, dh	/ð/
ر	R, r	/r/
ز	Z, z	/z/
س	S, s	/s/
ش	Š, š	/ʃ/
ص	Ṣ, ṣ	/sˤ, ʂ, S/
ض	Ḍ, ḍ	/dˤ, ɖ, D/
ط	Ṭ, ṭ	/tˤ, ʈ, T/
ظ	Ẓ, ẓ	/ðˤ, ʈ̞, Ð/
ع	‘	/ʕ/
غ	Gh, gh	/ɣ, ʁ/
ف	F, f	/f/
ق	Q, q	/q/
ك	K, k	/k/
ل	L, l	/l/
م	M, m	/m/
ن	N, n	/n/
ه	H, h	/h/
و	W, w	/w/
ي	Y, y	/j/
ء	’	/ɾ/

Vowels		
Arabic letter/ vowel mark	Transliteration Upper and lower case	Corresponding Phoneme symbol
اَ اِ	A, a; Ā, ā	/a/; /aː/
يَ يِ	I, i; Ī, ī	/i/; /iː/
وَ وِ	U, u; Ū, ū	/u/; /uː/
Diphthongs are transliterated ⟨ay, aw⟩ and transcribed /aj, aw/		

Transliteration symbols are used for spelling Arabic lexical items and proper names using roman letters. Phonemic transcription symbols are used for representing phonological forms. The phonemes corresponding to ⟨خ⟩ and ⟨غ⟩ vary according to dialect; symbols for the emphatics vary according to authors' usage. Allophonic and narrow phonetic transcriptions follow the conventions of the International Phonetic Alphabet unless otherwise stated. Transcription for other languages is described where relevant.

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Introduction

Barry Heselwood & Zeki Majeed Hassan

University of Leeds / University of Gothenburg

1. Introduction

In Section 2 of the introductory chapter presents a historical synopsis of the study of Arabic phonetics from the earliest surviving texts up to the modern era of instrumental phonetics. It shows that questions identified by scholars such as Sībawayh over a millenium ago are still live areas of phonetic research today, and argues that, rather than supplanting all the concepts and methods of the past, modern studies add to them and refine them. In Section 3 we discuss the contributions made by the studies in this volume in providing new phonetic and phonological perspectives on longstanding issues and in helping to open up new areas of research in which instrumental methods can play a crucial role.

2. Historical perspective

2.1 Historical background to Arabic phonetics

The phonetics of Arabic has been an object of scholarly study for well over a thousand years. It grew from its beginnings in the Arab world out of the work of grammarians, orthoepists and physiologists (Bohas, Guillaume & Kouloughli 1990) into a distinct tradition which is not only of interest to modern phoneticians keen to know something of the history of the discipline, but which also continues to provide points of reference for the phonetic and phonological analysis and description of Arabic today. Modern concepts and methods in phonetics, rather than completely supplanting those of the Arab grammarians of the Middle Ages, can be seen to re-interpret and augment them. The contributions to the present volume, in showing how modern instrumental phonetics can shed light on the structure of Arabic speech, are the latest in a long line of studies reaching back to the intellectual and scientific achievements of many centuries ago.

The earliest surviving treatises – the *Kitāb al-ʿAyn* attributed to Al-Khalīl (b.718 A.D./100 A.H., d.c.786/170), and Sībawayh's (b.mid-8th century A.D./mid-2nd century A.H., d.c.796/180) *Al-Kitāb* – date from the latter part of the eighth century A.D./mid-second century A.H., but the acuity of their phonetic writings,

the conceptual sophistication of their descriptive categories, and their systematic use of terminology (important differences in their approach to language notwithstanding (Carter 1972:494)) suggest that they had inherited the fruits of a tradition that had already made significant advances in phonetics.¹ Little is known about who contributed what to this 'Old Iraqi School of Grammar' (Talmon 1997:278–283) before the time of Al-Khalil but we do have a list of names supposedly forming a teacher-pupil chain linking Sibawayh back over a century to Al-Du'ali (b.603/16 B.H, d.688/69), the legendary 'inventor' of Arabic linguistics, although Fleisch (1994:171) identifies Ishaq (b. unknown, d.735/117) as the first known Arab grammarian and creator of Arabic linguistic science some decades later than Al-Du'ali. Nevertheless, by the end of the first century of Islam, well before Al-Khalil, the system of diacritical pointing (*naqt*) in use today for differentiating homographic letters inherited from Nabatean, e.g. ح ج and خ, had already been almost completely developed (Revell 1975:179). According to Revell, the criteria for the distribution of dots above and below the letter-shapes show there was an appreciation at that time of phonetic analysis into places of articulation. Dots are placed above letters corresponding to sounds produced further back in the vocal tract, and placed below for those further forward, e.g. uvular خ and palatal ج.

There is considerable difference of view about possible outside influences on the phonetic and wider linguistic thinking of the Arab grammarians. Bakalla (1983:49) is of the opinion that "Arabic phonetics grew up largely independently of the general scientific tradition of the pre-Muslim world". Influences from India have often been suspected (Wild 1965; Danecki 1985) but the similarities giving rise to these suspicions, e.g. starting the description of sounds at the laryngeal end of the vocal tract rather than the labial end, have been dismissed by some as mere coincidence (Law 1990). It might be unwise to completely rule them out given that the flourishing of artistic and intellectual activities during the Abbasid dynasty happened at a time when scientific writings from India were available (Hitti 1970:306–308). But if there were influences from previous Indian phonetic scholarship, it is puzzling that the Arab writers, in common with the Greeks and Romans (Matthews 1994:13–14), did not correctly identify the source of voicing in speech which was certainly known to the Indians many centuries earlier (Allen 1953:33–37).² In his *Risālah*, for example, Ibn Sinā (b. 980/370, d.1037/428) seems

1. For historical Arab scholars, B.C. and A.D. dates are given followed by the equivalent 'before Hijrah' (B.H.) or 'after Hijrah' (A.H.) date. If a date is not specified as B.C. or B.H, then it is A.D. or A.H.

2. Allen (1953:36) claims that Aristotle seems to have appreciated the role of the larynx when he said in Book 4 Chapter 9 of the *Historia Animalium* that "vowel sounds are produced

to attribute voicing to vibrations emanating from across the width of the tongue (Semaan 1963: 42).³ While Sībawayh implies a sound source somewhere behind the places of articulation (Al-Nassir 1993: 36), he never identifies anything that could be interpreted as the vocal folds. Bakalla (1982: 137–8) puts forward a case for believing that the Arab anatomists Al-Rāzi (Rhazes) and Al-Majūsī of the ninth and tenth centuries A.D./second and third centuries A.H. knew about the role of the vocal folds in speech and that therefore grammarians such as Ibn Jinnī (b.c.933/322, d.1002/392) may also have known about this, although it seems that Ibn Sīnā did not, and the evidence that Ibn Jinnī actually appreciated the role of the vocal folds is rather thin. In comparing the vocal tract to a lute string, he likens the sound of an open string to an *‘alif* and the modifications brought about by stopping the string at different points along its length he likens to the differences in sounds produced at the various places of articulation (Mehiri 1973: 166). This does not seem to support an interpretation that he understood phonation as a separate component in speech production. Rather, it presents *‘alif* as lacking a supra-glottal place-of-articulation obstruction, which is of course an accurate enough observation.

Also available to scholars of that period were Greek scientific and philosophical texts translated into Arabic, often via Syriac (Hitti 1970: 309–310). Influences from Greek thinking are discussed by Versteegh who claims that the Arabic linguistic ideas at the time of Al-Khalil and Sībawayh were directly influenced by Greek grammatical theorising, including about consonants and vowels, and only later indirectly through translated works (Versteegh 1977: 10–11, 21–25). Semaan (1963: 10) goes as far as to say that Al-Khalil and Sībawayh were “carrying on and developing the linguistic tradition of the Greeks”. Greek influence on early Arabic linguistics is, by contrast, roundly rejected by Carter (2007) who notes that no such influences were acknowledged at the time despite the widespread practice among Arab scholars in other areas of scientific inquiry of acknowledging outside influences. Carter also argues that the kind of linguistic thinking evident in Sībawayh is qualitatively different from the Greek grammatical tradition, having more in common with Islamic jurisprudence than Hellenistic philosophies of grammar: it is oriented towards language as an observable form of human behaviour rather than showing concern with logical relations and the essence of formal linguistic

by the voice and the larynx”. However, he does not appear to have understood how this happens: in his *De Anima* (II.8.420^b7) he says that “we cannot use voice when breathing in or out, but only when holding the breath”.

3. It is interesting that such vibrations do occur in speech (Ladefoged & Maddieson 1996: 230) though not of course as a phonatory source.

categories. Fleisch (1994: 179–180) also argues against Greek influences, accusing Versteegh of ignoring the system of grammar started by Iṣḥāq.

After Sibawayh, a number of commentators, most prominent among them Al-Mubarrad (b.826/212, d.898/285), Ibn Jinnī, Al-Zamakhshari (b.1074/467, d.1143/538) and Ibn Ya'ish (b.1159/553, d.1245/643), added clarifications and interpretations to Sibawayh's account of phonetics, introducing occasional terminological differences (Danecki 1990:97), but probably not contributing much that was substantially original (see e.g. Owen's (2006:281–282) comparison of Sibawayh's and Al-Zamakhshari's analyses of *imālah*) with the possible exception of Ibn Jinnī. One should, however, acknowledge Ibn Sīnā's appreciation of speech acoustics, and his discoveries concerning the physiology of speech, as original contributions to the phonetics of that period.

It has sometimes been assumed that the impetus for the phonetic and linguistic study of Arabic by Sibawayh and his successors was mainly religious (Gairdner 1935:242), that the prevailing attitude was prescriptive in order to fix 'correct' pronunciations and usages as part of the project to codify the Qur'an. This is clearly true of the *tajwīd*, the orthoepic tradition on Qur'anic recitation started by the Abbasid scholar Al-Khāqānī in the tenth century A.D./third century A.H. (Abu Bakr 1974:52), and religion is said to have motivated the study of the phonetics of Arabic by Al-Du'ali some three centuries earlier (Al-Nassir 1993:3), but there seems to have been a genuine desire to discover for its own sake what the phonetics of Arabic was really like and to develop an observational approach to finding out. Mehiri (1973:76) makes a point of noting that while the title of Ibn Jinnī's *Sirr ṣinā'at al-ʿirab* promises a prescriptive work, in fact what we find in its pages is "un véritable traité de phonétique". A work of purely prescriptive intent would be unlikely to develop the imaginative and phonetically insightful analogy between speech and the playing of a lute alluded to above, or between the workings of the vocal tract and the playing of a flute in which Ibn Jinnī likened the places of articulation to the finger-holes of an instrument powered by the force of the breath (Mehiri 1973:166).

2.2 Methodological issues

Of particular interest to us in the context of modern instrumental phonetic investigations are the methods employed by the early Arab phoneticians and the philosophy underpinning them. Versteegh (1977:96) describes their attitude as empirical, tracing it back to the rejection of rationalism in favour of careful observation in the writings of the Greek physicians. He identifies this as an important methodological influence on the early Arab sciences, including grammar, via the translations made into Syriac and Arabic of Greek medical treatises (Versteegh 1977:90–106). Regarding observational procedures, we know, for example, that

Al-Khalil determined the place of articulation of consonants by examining them in a postvocalic prepausal position in a [ʔa___#] phonetic frame (El-Saaran 1951:204; Sara 2009:2), thereby controlling for context. Ibn Jinnī followed the same method but used the [i] vowel (Mehiri 1973:167). In a warning that shows an appreciation of anticipatory coarticulation, Ibn Jinnī cautioned against placing a vowel after the consonant because it would influence the consonant and displace its articulation (see Embarki et al. this volume for quantification of this phenomenon using locus equations).

Levin (1994) tells us how Sībawayh paid close attention to the everyday conversational speech of the Bedouin, observing variant forms and accepting examples that contradicted some of the rules he had formulated. He would then try to resolve the problem by modifying his theories rather than by dismissing the data. Owens (2006:227) characterises Sībawayh's fieldwork approach by saying that "a basic precept of Sībawayh's methodology is that no observation should go unexplained". According to Bernards (1997:91) "Sībawayh more than once reproached his colleagues for overemphasising the importance of grammatical, theoretical rules, without verifying these rules with the living Bedouin speech." Sībawayh also described how different contexts bring about changes in the realisation of sounds, developing an impressively comprehensive theory of assimilation (*idghām*) to account for them (see Al-Nassir 1993:56–80, and Heselwood et al. this volume for an instrumental and phonological analysis of /r/-to-/l/ assimilation in modern Syrian Arabic).

Procedures for eliciting speech from informants were not so unlike those we use today, and the importance of knowing something about one's informants' social background was appreciated, particularly distinguishing between those from sedentary communities on the one hand and the nomadic desert bedouin on the other. Something of the ethnographic approach can be detected in the practice of listening to speech in its natural social settings, a method known as *al-wifāda* (Suleiman 1999:24, n.19, see also Khattab this volume in relation to acquisition of pronunciation in monolingual and bilingual family settings), and in taking care not to influence informants' pronunciations in the direction of one's own (Alhawary 2003:11–16). A more experimental procedure is seen in the elicitation of targeted data through the asking of specific questions and on-the-spot noting of responses (Alhawary 2003:17), the procedure used, for example, by Labov in his famous and seminal study of New York speech (Labov 1966). As Suleiman (1999:24) points out, both approaches were hampered in the amount of phonetic detail the Arab linguists could record by the lack of an adequate means of transcription much beyond the resources afforded by Arabic orthography. However, some resources for transcription, in addition to orthographic conventions, were developed. Bakalla (1983:54–55) details techniques used by early phoneticians for measuring the duration of nasality in different contexts, such as comparing it to

the time taken to fold and unfold the fingers of one hand or to write the word *ʿalif*. He also tells us how a system was developed to represent nasal assimilation and the coarticulatory spread of nasality using dots, circles and superscript letter-shapes (Bakalla 1983: 55–57).

Further evidence of a commitment to accurate phonetic observation and description comes from the considerable body of literature on speech errors in Arabic which accrued over several centuries from the time of Sibawayh. These studies also show awareness of social factors as determinants of pronunciation (Anwar 1983).

Physiological examinations of the speech organs, including the larynx and the tongue, were made by Ibn Sīnā and written up with descriptions of the structures and functions of the various muscles and ligaments in his treatise on the phonetics of Arabic (Semaan 1963), although as we have noted, he did not understand the role of the larynx in phonation. He did, however, identify and name the muscles responsible for moving the tongue forwards, backwards and up and down (Sara 2004: 39), and described the intrinsic and extrinsic laryngeal muscles and their actions, including some of the muscles composing the vocal folds (Sara 2004: 36–39). He also placed speech in the context of sound in general, attending to the acoustic nature of speech and the central importance of the vibration of air, leading Semaan (1963: 12–14) to regard him as the first true speech scientist, although Ibn Sīnā's familiarity with Aristotle makes it likely that he encountered the notion of vibrating air in Aristotle's *De Anima* (II.8.420^b5) where it is said that "sound is a particular movement of air". It has even been suggested that Ibn Sīnā was the first to consider how one might produce synthetic speech (Bohas, Guillaume & Kouloughli 1990: 98) when he provided experimental advice on imitating speech sounds by clapping the hands, rustling leaves and exploring other non-vocal means of generating sounds which possess features resembling certain features of the sounds of spoken language (Semaan 1963: 57–60).

In addition to attempts to represent phonetic features in a written form, the Arab tradition also produced the first known vocal tract diagram with a visual representation of the organs of speech and the marking of the places of articulation for Arabic speech sounds by appropriate placing of the Arabic letters (see Figure 1). This was produced in the late 12th or early 13th century A.D./sixth century A.H. by Al-Sakkāki (b.1159/555, d.1228/626) (Bakalla 1982: 87). It shows in superior view the lips at the righthand end, the teeth in a horseshoe shape, and the tongue extending rightward into the mouth from the throat. The passage through the nose is represented by the dotted line above the mouth. The placing of the letter ض along the sides of the tongue provides evidence that the lateral articulation of Arabic *ḍād* as described by Sibawayh was still current some four centuries later, contrary to Garbell (1958: 308–310); it still survives in some isolated locations (Al-Azraqi 2010). For comparison, Figure 2 shows a modern mid-sagittal vocal

tract diagram with the major speech organs labelled. Allowing for the different planes of orientation, the reader may observe the overall compatibility of the two diagrams.

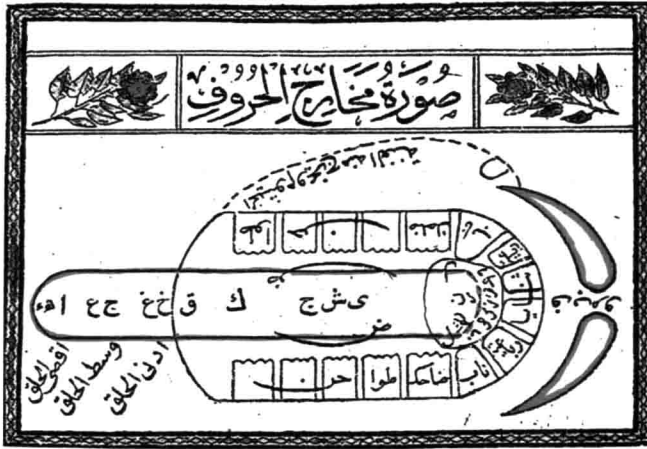


Figure 1. Vocal tract diagram entitled *Šurat makhārij al-ḥurūf* 'Picture of the outlets of the letters' from *Miftāḥ al-'Ulūm* 'The Key to the Sciences' by Al-Sakkāki. Dotted line indicates the nasal passage with a nostril above the lip

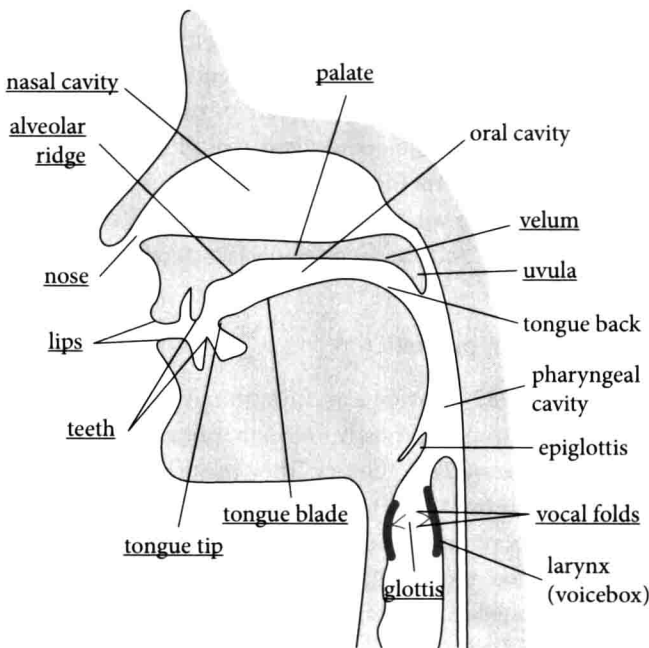


Figure 2. Modern vocal tract diagram with main speech organs labelled anatomically

These methods of observation show that, in an age with no technology for preserving, analysing and measuring speech, investigators nonetheless adopted an empirical approach to try to discover more about the phonetics of Arabic and turned their thoughts to how their discoveries could be represented in writing in ways that show similar preoccupations to modern phonetic transcription practices.

After the destruction of Abbasid society by the Mongols little further development in Arabic phonetics, or in Arab science generally, took place in the Arab world. Apart from a few Orientalists, most Western linguists and phoneticians were largely unaware of the Arab tradition until the 19th and 20th centuries and even then some were dismissive of it (Semaan 1968: 3–5). Until quite recently, histories of phonetics have not been appreciative of the medieval Arab contributions. Panconcelli-Calzia (1957: 11) dismisses the period between the third and 15th centuries A.D. as a barren time for phonetics, saying of the Arabs that they “hardly refer to voice and speech”; this grossly negligent assertion is repeated by Moses (1964: 2). That there has been, and continues in some quarters to be, a general reluctance in the West to acknowledge scientific achievements in Arab culture is argued by Rashed (1980) who shows that significant advances were made in Arab scholarship concerning the value of experimentation for quantifying observations as well as for verifying assertions, and in understanding the importance of creating controlled conditions for experiments. A key figure in this was the physicist Ibn Al-Haytham (Alhazen) who was active in the late tenth and early eleventh centuries A.D./fourth century A.H. When Arab learning reached Europe, this emphasis on the value of experimentation was perhaps the most important and lasting influence not only on the thinking of philosophers of the time such as Roger Bacon (Hackett 1997) but on the whole subsequent rise of scientific investigation and the development of scientific method as the Aristotelian modes of thought of the European Middle Ages gave way to the more humanist Renaissance followed by the ‘Age of Enlightenment’ and modern secularist science.

2.3 Arabic and modern phonetics

Giannini & Pettorino (1982) provide a useful summary of the rising interest in Arabic phonetics among European, mostly German, phoneticians from the mid 19th century through to the early 20th century. They relate how descriptive articulatory accounts were published by Wallin (1855, 1858), Brücke (1860) and Haupt (1890) followed by studies incorporating more detailed references to, and commenting on, the work of the early Arab phoneticians, e.g. Vollers (1892) and Schaade (1911).

As experimental phonetics became established from the turn of the century, its techniques were applied to many languages including Arabic. In 1914 Worrel