The Faculty of Arts

Annals of the Faculty of Arts Volume 50 (October-December 2022)
http://www.aafu.journals.ekb.eg
(A Refereed Scientific periodica)

Ain shams university

Phonetic Properties of Lafz Al-Jalalah

Mariam Almihmadi*

Assistant Professor at the Department of English, College of Social Sciences, Umm Al-Qura University, Makkah, Saudi Arabia
mmmihmadi@uqu.edu.sa

Abstract:

This paper documents the phonetic properties of the Arabic word for God, Lafz Al-Jalalah ‘Allah’. Analysis parameters include stationary and dynamic effects pertaining to the sound composition and sound sequencing of the word. Acoustic analysis reveals that Lafz Al-Jalalah constitutes an unbroken band of acoustic energy, which is auditorily converted into a single prolonged stretch of speech prominence. Implications of this are discussed in relation to the notion of acoustic salience and perceptibility.

Keywords: Lafz Al-Jalalah; Phonetics; Acoustic Salience; Perceptibility

Received: 5/1/2022
Accepted: 10/2/2022
Available online: 29/12/2022

1 Introduction

In the phonetic literature, intrinsic acoustic salience is sometimes defined with reference to the amount of acoustic energy that an acoustic event has. The more acoustic energy a speech event has, the more acoustic salience is ascribed to it. Acoustic salience is usually a good indication of the perceptibility of the acoustic event in question. Put differently, a speech event that is acoustically salient is perceptually robust. When we investigate the acoustic and perceptual salience of words as acoustic events, we need to look into both the sound composition and sound sequencing of the word in question, in terms of both stationary and dynamic properties.

In this paper, I examine the acoustic profile of Lafz Al-Jalalah ‘Allah’ (the Arabic word for God) against the above-mentioned criterion of acoustic salience. In Arabic, Lafz Al-Jalalah ‘Allah’ is unique in its denotation (see e.g., Ibn Al-Qayyim, 1997). For example, the word ‘Allah’ is exclusively applicable to God. The word is also unique in its linguistic properties (e.g., Wateed, 2010). For example, it is the only word in Arabic that has pharyngelised [lˤ] as a phoneme (see below for more on this). Also, the word has no morphological relatives or derivatives. For example, Lafz Al-Jalalah is unpluralised.

This paper surveys the acoustic and perceptual features of Lafz Al-Jalalah and concludes that the word actually has a very salient acoustic signature with a very robust perceptibility profile. Illustrations in the shape of spectrograms and waveform displays are given throughout the paper.

The rest of the paper proceeds as follows. Section 2 provides background information about Arabic including its sound system and paints an overall picture of the research on Arabic phonetics. In section 3, I give an overview of the sound composition and sequencing of Lafz Al-Jalalah, outlining the basic phonetic properties of its sounds and the way they are combined in the word. In section 4, I present a detailed description of the acoustic and perceptual properties of each of the sound components of the word. I also highlight the dynamic and stationary properties of the sounds, where appropriate. Finally, I summarise the arguments and conclude in section 5.

2 Background

Arabic is classified as a south-west Semitic language in the Afro-Asaitic family (Versteegh, 2014, pp. 11–12). It is the fifth most widely spoken language in the world, with more than 360 million speakers (Procházka, 2021, p. 214). The consonant inventory of Arabic consists of 29 phonemes[1] (Thelwall and Sa’adeddin, 1990, p. 37).[2] In terms of its vowels, Arabic is categorised as a three-vowel system with length contrasts (Kotby et al., 2010). These are /i/-/i:/, /a/-/a:/, and /u/-/u:/. These vowels are subject to co-articulatory effects from neighbouring sounds, resulting in several allophonic[3] realsiations. For example, as will be shown in this paper, the vowel /a/ is realsied as /ɑ/ in the vicinty of pharyngelised /lˤ/.

Table 1 presents the consonant inventory of Arabic based on Thelwall and Sa’adeddin (1990, p. 37). This version of the Arabic Consonant Inventory by Thelwall and Sa’adeddin (1990) has been selected for three reasons. Firstly, it appears as an illustration of the IPA in the Journal of the International Phonetic Association. This journal is the flagship of the International Phonetic Association. Secondly, This inventory accurately represnts emphatic consonants (e.g., /sˤ/, /tˤ/, and /lˤ/) as pharyngealised rather than uvualrised. The pharyngealisation component in the production of these consonants has been confirmed by instrumental studies using imaging-based evidence. For example, Al-Tamimi et al. (2009) provides videofluoroscopic images that show that the articulation of Arabic emphatics involves pharyngealisation, rather than uvularisation (e.g., Zawaydeh 1999). More recently, Hermes et al. (2021) provide real-time magnetic resonance imaging (rtMRI) that shows the involvement of the pharynx in the production of the pharyngealised consonants. Thirdly, Thelwall and Sa’adeddin (1990) recognise the phonemic satus of /lˤ/ in their inventory, which is in total agreement with the position taken in this paper. See section 3 for more on the phonemic status of /lˤ/.

Table 1: Arabic Consonant Inventory (based on Thelwall and Sa’adeddin (1990, p. 37). *Across*: places of articulation; *down*: manners of articulation.

	Bilabial	Labio-dental	Dental	Alveolar	Post-alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal
Stop	b		t d				k	q		ʔ
			tˤ dˤ							
Fricative		f	θ ð	s z	ʃ ʒ		x ɣ		ħ ʕ	h
			ðˤ	sˤ						
Nasal	m		n							
Liquid				r						
				l lˤ						
Glide						j	w			

The study of Arabic phonetics goes back to the seventh century (Rosenhouse, 2007). Historiclly, the study of phonetics has been relevant to a variety of research pursuits, including dictionary compliations, grammar descriptions, Tajweed (Quran recitation rules), philosophy, and rhetoric (Mohammad, 2006). In modern times, however, interest in the study of Arabic phonetics has substanially grown and earned it a place as a field of inquiry in its own right and with wide-ranging inter-disciplinary applications. These include dialectology, language disorders, sociolinguistics, language acquisition, natural language processing and automation, forensic linguistics, and cognitive sciences, among many others.

Perhaps the one aspect of Arabic phonetics that has attracted most scholary attention is the issue of pharyngealisation. The phonetics of pharyngeals and their associated phenomena has been extensively studied from diverse experimnetal perspectives, including their articualtion and co-articulation, acoustics, perception, and processing. For an overview, see Shosted et al. (2018). Examples of recent instrumental studies include Hermes et al. (2021), Ahmed and Grosvald (2019), and Altairi et al. (2017). Conversely, it seems that the prosodic aspects of Arabic phonetics are still underinvestigated. Research in this area is still limited. Examples of recent studies on Arabic prosody include Hellmuth (2020) and Alzaidi et al. (2018).

In contrast, the phonetics of vowels has long been a subject of ongoing exploration. Their acoustic, articulatory, and perceptual properties contiue to feature in the literature on Arabic phonetics. Examples of recent work in this area include Aissiou (2020), Farchi et al. (2019), and Kalaldeh (2018). However, to the best of my knowledge, no study has been devoted to the characterisation of the phonetic properties of Lafz Al-Jalalah. The current study is an attempt to fill this gap in the literature.

3 Sound composition and sequencing of Lafz Al-Jalalah

The word 'Allah' is composed of three distinct sounds[4]. These are (1) the low unrounded vowel /a/, which is realised as [ɑ] in the pre-lateral position, and as a long [ɑ:], following the lateral sound, (2) the pharyngealised alveolar lateral [lˤ], and the glottal approximant [h]. The low vowel /a/ is the only low vowel in Arabic (Ladefoged & Maddieson, 1996). It occurs phonemically as short or long. Cross-linguistically, /a/ is attested in may languages. A look at Phoible 2.0 (Moran & McCloy, 2019), the largest repository of cross-linguistic inventories, confirms that. Phoible 2.0 includes 3020 inventories with a total of 3183 segments. /a/ is attested in 2600 inventories of the 3020 registered inventories in the database, constituting an impressive 86% of all inventories. In contrast /a:/ is only found in 893 inventories, with an occurrence percentage of 30%. Interestingly, /ɑ/ is attested in 225 inventories with a percentage of (7%), whereas /ɑ:/ is found in 104 inventories, with a percentage of 3%.

In Lafz Al-Jalalah, the vowel is subject to anticipatory and carry-over pharyngealisation effects due its adjacency to the pharyngealised lateral liquid. This is commonly known in the literature as emphasis spread (Davis, 1995; Watson, 1999). Emphasis spead is known to affect vowels preceding and following emphatic consonants (Norlin, 1987). According to Almasri and Jongman (2004), the vowel most susceptible to pharyngelaisation in Arabic is /a/. This is partly due to its being itself low and non-front. Pharyngealisation is a secondary articulation excuted in addition to (but separately from) the primary articulation. During the production of a pharyngealised sound, the epiglottis tilts backwards and the root of the tongue is lowered, so a constriction is formed between the walls of the pharynx and the epiglottis (Laufer & Baer, 1988).

In terms of distribution, /lˁ/ is attested in only eight inventories, with an exceedingly vanishing proportion compared to the 3020 inventory pool. Even more diminshing is the proportion of the inventories that have /lˁ:/ as a phoneme. Only two languages in Phoible 2.0 (Arabic and Tadaksahak) have this long consonant. In Arabic, /lˁ:/ has a very limited distribution, and it is said that the only native Arabic word with /lˁ:/ as a phoneme is actually Lafz Al-Jalalah ‘Allah’. Ferguson presents arguments in favour of the conclusion that /lˁ/ “must be regarded as an independent phoneme in Classical Arabic and in most if not all the modern dialects” (1956, p. 107). He gave the following contrastive pairs from Classical Arabic Ferguson (1956, p. 108):

(1)	walˁlˁaahu “and God”	versus	wallaahu “he appointed him”
	walˁlˁaahi “by God”	versus	wallaahii “and the one who amuses”

Other occurrences of /lˁ:/ are phonological and/or stylistic allophonic variants with no distinctive power in the language (e.g., Ferguson, 1956). These allophones are recognised as instances of emphasis spread in the phonology of Arabic (for more, see Davis, 1995; Watson, 1999; Younes, 1993). Importantly, /lˁ:/ occurs intervocalically in the word ‘Allah’, with dynamic transitions from and into the adjacent vocalic segments. See the next section for details.

Lafz Al-Jalalah terminates in /h/. The phonetic status of this sound is still open to debate. For example, in the 1990s, the question of whether /h/ is a glottal fricative or not was a contentious point among contemporary phoneticians. The Phonetic Alphabet Association classifies /h/ and /ɦ/ as fricatives. Laufer (1991) defends this position and presents supporting arguemnets. Catford (1990) is also in favour of this classification. On the other hand, several other phoneticians including Pike (1943), O’Connor (1980), Kloster-Jensen (1991), Ladefoged (1990), and Iivonen and Hunt (1992) do not agree. The alternatives suggested in the literature are ‘a voiceless vowel’ (e.g., Heffner, 1969; Chomskey & Halle, 1968), an approximant (e.g., Laver, 1994; Ladefoged, 1990), or a semi-vowel (e.g., Tragger & Smith, 1975).

In the literature on Arabic phonetics, there is no agreement on the voicing dimension of this sound. While Obrecht (1968) and Abu-Mansour (1996) report that it is voiced [ɦ], Al-Ani (1970) and Thelwall and Sa’adeddin (1990) describe it as voiceless except intervocalically. More recently, however, Garellek et al. (2021) noted that phoneticins have long recognised the great variability in the voicing of glottal sounds. Analysing a corpus of laryngeal sounds from 131 languages and 153 speakers, Garellek et al. (2021) reported that there are no differences between /h/ and / ɦ / intervocalically, and that the difference in voicing in word-initial positions is negligeable. In any case, what is immediately relevant to the sequencing of /h/ in Lafz Al-Jalalah is the fact that /h/ does not change the quality of adjacent vowels (Ghowail, 1987). On the contrary, /h/ is, unarguably, known to carry over most of the acoustic properties of the preceding vowel, most notably the formant structure of the vowel (see e.g., Denning & Kemmer, 1990; Ladefoged, 2001; Roach, 2009). In terms of cross-linguistic distribution, /h/ is attested in 1703 inventories, constituting 56% of the inventories in the Phoible .02 (Moran & McCloy 2019) database. Its voiced counterpart is only found in 109 inventories, which makes up only 4% of the inventory pool. In the next section, we will see how this combination of sounds in this order enhances the perceptibility and acoustic salience of Lafz Al-Jalalah. The next section details the acoustic and perceptual properties of each of these sounds.

4 Acoustic and perceptual properties of Lafz Al-Jalalah

4.1 Acoustic and perceptual properties of the low vowel

In standard phonetics books, /a/ and its allophonic varient [ɑ] are classified as a low unrounded vowesl (e.g., Ladefoged, 2001; Laver, 1994; Roach, 2001). The articulatory production of the low vowel involves air flowing unimpeded along the oral cavity. This effect is achieved by lowering the jaw while making no lingual obstruction to the airflow. The acoustic effect of these articulatory maneuvers is a high concentration of acoustic energy in the middle band of the vowel spectrum. This results from the close approximation of the first formants[5] F1 and F2 of the low vowel. This effect is known in the phonetic literature as ‘focalisation’ after Schwarts et al’s (1997a, 1997b) Dispersion-Focalisation theory of vowel systems published in 1997.

The spectrograms[6] in Figure 1 below illustrate the convergence of F1 and F2 of the low vowel. It is obvious from the spectrograms that [ɑ:] has the greatest concentration of acoustic energy compared to [i:] and [u:]. The concentration of acoustic energy in the middle band of the vowel spectrum during the production of [ɑ] ensures both its acoustic salience and robust perceptibility. In other words, [ɑ] is acoustically salient, as it has the highest intrinsic amplitude (see e.g., Jacewicz & Fox, 2008; Lehiste, 1970; Shih & Ao, 1997) and duration that a vowel can have, all else being equal (see e.g., Allen et al., 1987; House & Fairbanks, 1953; Lehiste, 1970, Solé, 2007).

According to Henke et al’s (2012) model of conrast recoverability and perceptual cue robustness, the louder a vowel, the better cue-bearing capacity it will have. More importantly, however, the focalisation degree for [ɑ] is even greater in the context of [lˤ] than in the context of plain [l], as Figure

2 below illustrates. As the figure shows, in the spectrogram of the word [wɑlˤ:ɑ:h] 'by God', the trajectory of the second formant looks smooth and unbroken. There are no formant discontinuities in either formants (F1 and F2) throughout the word, except when we get to the sound [h]. The picture is different for the word [wɑl:ɑ:h] 'he appointed him'. We notice formant discontinuities in the formant trajectories during the productions of the plain lateral [l], the following vowel, and [h]. The figure also displays the intensity profile of these two words. It is clear that the intensity of the word with the pharyngealised lateral is higher than that of the word with the plain lateral.

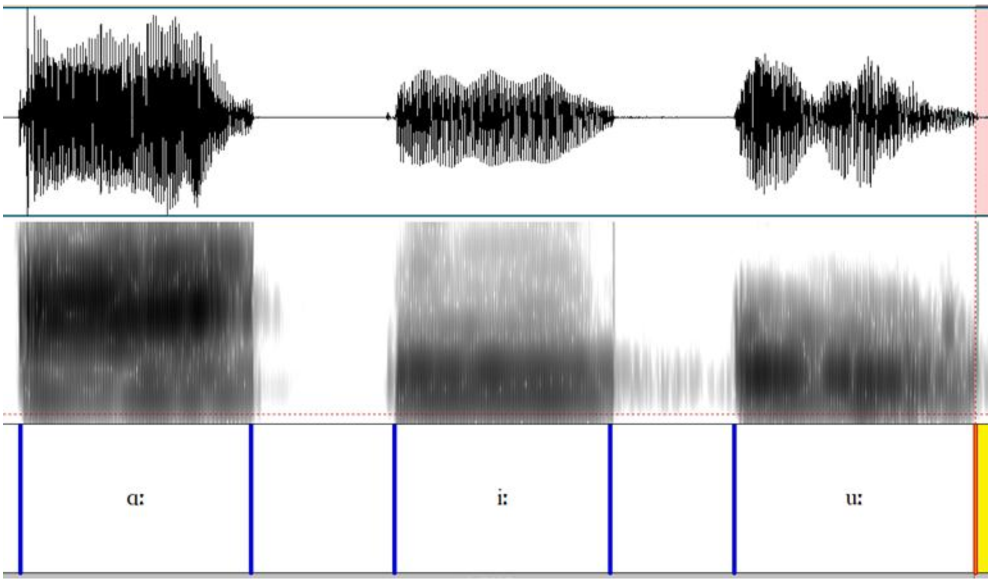

Figure 1: Waveform displays and spectrograms of [ɑ:], [i:], and [u:] graphing the amounts of acoustic energy in these vowels. The illustration is generated by Mariam Almihmadi using Praat 6.2.07 (Boersma & Weenink, 2022).

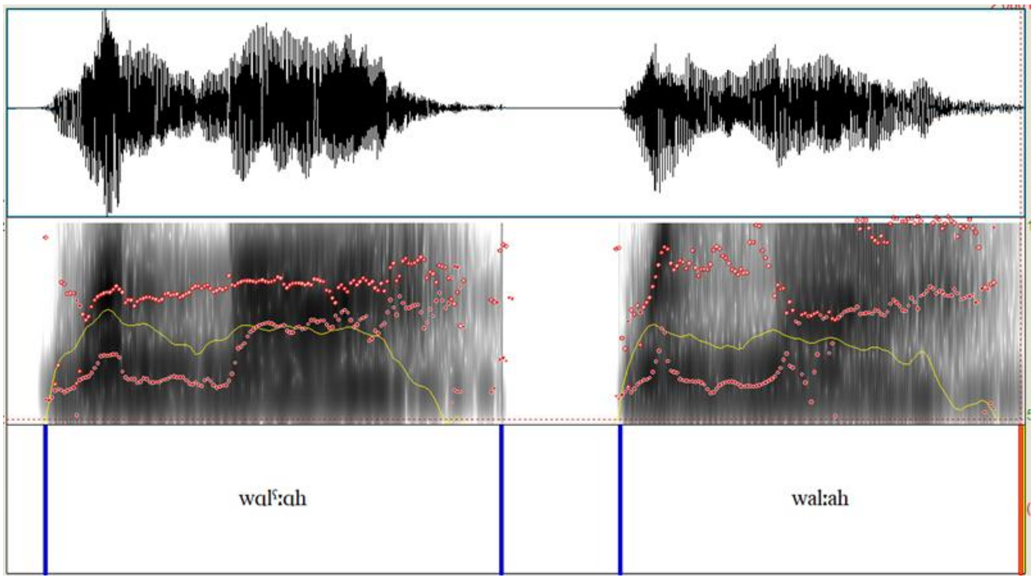

Figure 2: Waveforms and Spectrograms of the vowel [ɑ] in the context of pharyngealised [lˤ] (left panel) and in the context of plain [l] (right panel). The dotted lines are the trajectories of F1 and F2. Intensity is shown by the thin light lines. The illustration is generated by Mariam Almihmadi using Praat 6.2.07 (Boersma & Weenink, 2022).

The perceptibility of [ɑ] is also robust, as a result of the auditory merging of its first formants into a single spectral peak (Schwartz, et. al., 1997a, 1997b; Harris & Lindsey, 2000). This effect has made its way into the impressionistic scales of sonority, which are popular in the phonological literature (see e.g., Blevins, 1995; Clements, 1990; Parker, 2002; Price, 1980; Prince & Smolensky, 1993; Selkirk, 1984, among many others). All of the various versions of sonority scales published in the phonological literature consistently classify low vowels as the universally most sonorant vowels.

4.2 Acoustic and perceptual properties of [lˤ]

4.2.1 Steady-state

The acoustics of the steady-state portion of [lˤ] resembles that of vocoids. [lˤ] is more similar to vowels and vowel-like sounds than it is to consonants. It is clear from the spectrograms in Figure 2 above that the steady-state portion of [lˤ] appears darker and has more clearly-defined formant structure than that of plain [l]. Traditionally, plain [l] is referred to as clear [l], while pharyngealised [lˤ] and velarised [ɫ] are known as dark [l]. Such traditional reference auditorily captures this acoustic difference. Note also that the formant structure of the dark lateral bears a more pronounced resemblance to the formant structure of the adjacent vowels than to that of clear [l]. It is also very important to note that the articulation of clear [l] introduces acoustic irregularity and discontinuity into the pulsing of the sound wave. This irregularity radiates to the adjacent vowels, causing a significant drop in intensity and acoustic salience. In other words, acoustic energy is greatly reduced in the production of clear [l] compared to dark [lˤ].

Interestingly, it has been proclaimed in the phonetic literature that dark [ɫ] can have more acoustic energy (therefore be more sonorant) than the non-syllabic version of the high back vowel [u] (Oliver et al., 1993). In gestural-phonology terms (Browman & Goldstein, 1988, 1989, 1992), velarised [ɫ] has both a consonant and a vocalic gesture, whereas clear [l] only has a consonantal gesture. The proposition naturally covers [lˤ], especially that the pharyngealised articulation is already pulling the sound towards semi-vowels (cf. Laufer, 1996). The difference between dark and clear [l] in terms of acoustic salience and resemblance to vowels explains the well-known phonological pattern of dark [l] vocalisation to [u]/[w] (see e.g., Harris, 1994; Johnson & Britain, 2007). The suggested explanation of this phenomenon states that dark [l] vocalises by losing its consonantal gesture while retaining its vocalic gesture (see e.g., Sproat & Fujimura, 1993).

4.2.2 Dynamicity: Transitions of [lˤ]

The fact that [lˤ] is intervocalic means that we can study the dynamic properties of the transitions into and out of the sound. As Figure 2 above shows, the transition from [ɑ] into [lˤ] is smooth and continuous. There are two important things to observe here. Firstly, the transition from the vowel into [lˤ] does not affect the formant trajectories of the vowel, indicating little, if any, articulatory overlap. More importantly, however, vowel quality remains unchanged. This is not what we observe in the case of the transition from the vowel into clear [l] in the figure above. Here, F1 and F2 are further apart than they are before [lˤ]. This gap results from F2 leaving its target trajectory and moving up to meet the purely lingua-alveolar production of clear [l], which has a high F2 target. This dynamic maneuver in the actual trajectory of the low vowel before clear [l] reduces the degree of acoustic focalisation of the vowel, and introduces a transient gliding effect into the auditory impression of the word.

Secondly, in the transition from the low vowel into [lˤ], there are no “formant discontinuities that are typical of lateral juncture” (Oliver et al, 1993, p. 203). The dark bands of acoustic energy at the F1, F2, and F3 regions of the vowel continue almost unbroken. By way of contrast, in the transition from the low vowel into clear [l], we notice that these dark bands change in energy level, almost at the F2 region and above. At high-frequency regions, acoustic energy is greatly reduced and an amount of irregularity seems to permeate the acoustic signal of the whole word. This effect is entirely absent from the acoustic signal of the word with the pharyngealised lateral.

The dynamic differences between vowel-to-[lˤ] and vowel-to-[l] transitions are more pronounced in the lateral-to-vowel transitions. Looking at Figure 2 above, we see that the gap between F1 and F2 widens in the transition from clear [l], an effect unseen in [lˤ]-to-[ɑ] transitions. At the same time, the degree of focalisation is greatly reduced in [l]-to-[a] transitions, but it is almost unchanged in [lˤ]-to-[a] transitions. This should indicate that the perceptibility of the low vowel is enhanced after [lˤ] but is reduced after [l].

Furthermore, there is little change in acoustic energy at the formant regions of F1, F2, and F3. In contrast, acoustic energy of the vowel is even more dramatically reduced after clear [l]. At the same time, the amount of acoustic irregularity is even greater in the vowel following clear [l] than following pharyngealised [lˤ]. Taken together, these dynamic and stationary differences between pharyngealised [lˤ] and clear [l] establish that pharyngealised [lˤ] is both acoustically and perceptually more salient than clear [l].

4.3 Acoustic and perceptual properties of [h]

As pointed out in section 3, according to an accepted phonetic account, [h] is an approximant, not a fricative. More specifically, [h] is a voiceless vowel that takes on the spectral shape of the adjacent vowels (see e.g., Denning & Kemmer, 1990; Ladefoged, 2001; Roach, 2009). In Arabic, the articulatory-acoustic status of [h] has not been investigated from this perspective. However, as the spectrograms in Figure 3 below show, the spectral properties of [h] are very much like those of its vocalic context. Importantly, frication is attenuated in the intervocalic context in the spectrograms, a fact that can be taken as an argument for the approximant account above.

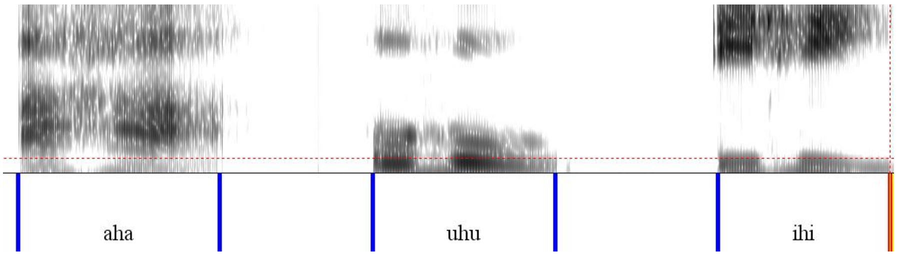

Figure 3: Spectrograms of intervocalic [h] in three vowel contexts. The illustration is generated by Mariam Almihmadi using Praat 6.2.07 (Boersma & Weenink, 2022).

To fully appreciate the contribution of [h] to the acoustics and perceptibility of Lafz Al-Jalalah, a bit of contextualisation is in order. Firstly, phrase-final sounds in Arabic are subject to the well-known and pervasive process of phrase-final devoicing. Now it is hypothesised that when [h], which is already voiceless, occurs phrase-finally, it takes the brunt of this pervasive process, acting as a shield that protects the preceding sounds from devoicing. Applied to the word ‘Allah’, the vowel [ɑ], according to this account, will remain voiced throughout its entire duration. Conversely, when the vowel is phrase-final, not followed by [h], the argument goes, we expect the vowel to devoice for a substantial portion of its duration. This is exactly what we see in the waveform of the sequence [wɑlˤ:ɑ] ‘or (in some dialects of Arabic)’ in Figure 4 below. The pulsing as displayed by the vertical lines on the wavform is broken. There are several missing pulses in the second half of the vowel. Importantly, consistent with the hypothesis, the entire duration of [ɑ] and a good-sized portion of the phrase-final [h] remain voiced (as shown by the pulsing lines in the figure) in the word [wɑlˤ:ɑh], which terminates in [h].

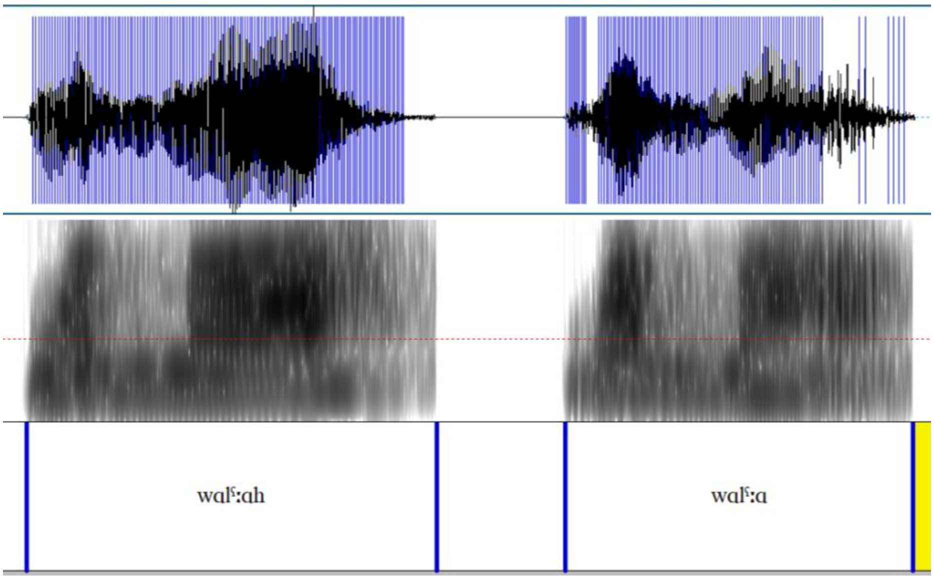

Figure 4: Waveforms and Spectrograms of the words [wɑl:ɑh] ‘by God’ and [wɑl:ɑ] ‘or (in some dialects of Arabic)’ illustrating vowel devoicing in the absence of phrase-final [h]. Voicing as pulsing is shown by the stright vertical lines on the waveforms at the top panel. The illustration is generated by Mariam Almihmadi using Praat 6.2.07 (Boersma & Weenink, 2022).

Secondly, in Standard Arabic, it is only when the word ‘Allah’ is phrase-final that it ends in [h]; otherwise (e.g., phrase-medially), the word is marked for case, with the vowels [a], [i], or [u] affixed to it, as in (2) below. In this case, [h] is no longer word-final, but is intervocalic. The acoustic and perceptual consequence of this, as explained above, is the continuity of the vocalic gesture and the concomitant enhancement of acoustic and perceptual salience of Lafz Al-Jalalah.

(2) [ɑlˤ:ɑ:h-u jafʕalu ma: juri:d] ‘Allah does what He pleases’
[wɑlˤ:ɑ:h-i laqad raʔjtuhum] ‘I swear to Allah I have seen them’
[ɑlˤ:ɑ:h-a naʕbud] ‘We worship Allah’

5 Conclusion

This paper has surveyed the phonetic properties of Lafz Al-Jalalah. It has put together an acoustic and perceptual account of the features of the word, both in terms of sound composition and sequencing, and also in terms of stationary and dynamic effects. The acoustic properties of the individual sound segments and sound sequencing ensure a high concentration of continuous acoustic energy. This unbroken band of acoustic energy is auditorily converted into a single prolonged stretch of speech prominence. Taken together, these properties guarantee maximally robust perceptibility. Spectrographic and waveform illustrations of these features have been presented throughout the paper.

المستخلص

الخصائص الصوتية للفظ الجلالة

مريم مسلم المحمادي

توثق هذه الورقة الخصائص الصوتية للفظ الجلالة، وقد اشتملت محاور التحليل على تأثيرات ساكنة وديناميكية متعلقة بالتكوين الصوتي والتسلسلي للكلمة، وقد أظهرت نتائج الدراسة أن لفظ الجلالة يكّون حزمة غير متقطعة من الطاقة الصوتية، والتي يتم تحويلها في الناحية السمعية إلى إمتداد صوتي مطول من البروز الصوتي والإدراك السمعي. وستتم مناقشة دلالات هذه النتائج من منظور البروز الصوتي والسمعي.

الكلمات المفتاحة: لفظ الجلالة؛ الصوتيات؛ البروز الصوتي؛ الإدارك السمعي.

[1] A phoneme is a contrastive unit of phonology with the capacity to distinguish words in a given language. Phonemes are found in minimal pairs like the English words ‘pin’ and ‘bin’.

[2] According to Newman (2002, p. 65), the number of phonemic consonants is 30, with a trill /r/ and a tap /R/. in this apaper, however, I adopt Thelwall and Sa’adeddin’s (1990) view. I justify that further below in section 2.

[3] An allophone is a predictable, contexual phonetic rendition of a phoneme. Allophones occur in complementary distribution, where no meaning contrasts can be established based on sound differences. For example, unreleased [p] and aspirated [p^h] are allophones of the phoneme /p/ in English.

[4] The occurrence of the glottal stop [ʔ] is entirely phonological and is restricted to phrase-initial positions. Phrase-medially and finally, however, [ʔ] is neither produced nor heard. The phonological constraint that conditions [ʔ]-epenthesis is that, in Arabic, phrase-initial syllables need to have an onset. For more on this, see Abu-Mansour (1995), Btoosh (2006), and Al-Ani (1970).

[5] In the acoustic literature, formants are peaks of energy that correspond to a resonating frequency of the air passage of the vocal tract. For the purposes of analysing vowels, phoneticians are usually only interested in the first three formants. These are standardly referred to as F1, F2, and F3.

[6] I used Praat 6.2.07 (Boersma & Weenink, 2022) to generate spectrograms and waveform displays in this paper.

References

Ahmed, S., Grosvald, M. (2019). Long-distance vowel-to-vowel coarticulation in Arabic: Influences of intervening consonant pharyngealization and length. Language and Speech, 62, 2: pp. 399-424.

Alzaidi, M. S., Xu, Y., & Xu, A. (2019). Prosodic encoding of focus in Hijazi Arabic. Speech Communication, 106: pp. 127-149.

Abu-Mansour, M. (1995). Optimality and conspiracy in syllable structure of Arabic. In: Beckmang, J., Walsh Dickey, L., Urbanczyk, S. (Eds.), University of Massachusetts Occasional Papers in Linguistics 18: Papers in Optimality Theory: pp. 1-20.

Abu-Mansour, M. H. (1996). Voice as a privative feature: Assimilation in Arabic. Amsterdam Studies in the Theory and History of Linguistic Science Series 4: pp. 201-232

Aissiou, M. (2020). A genetic model for acoustic and phonetic decoding of standard Arabic vowels in continuous speech. International Journal of Speech Technology, 23, 2: pp. 425-434.

Al-Ani, S. H. (1970). Arabic Phonology: An Acoustical andPhysiological Investigation. The Hague: Mouton.

Allen, J., Hunnicutt, M., Klatt, D. (1987). From text to speech: The MITalk system. Cambridge: Cambridge University Press.

Almasri, M., Jongman, A. (2004). Acoustic correlates of emphasis in Jordanian Arabic: preliminary results. Proceedings of the 2003 Texas Linguistic Society Conference: pp. 96-106.

Altairi, H., Brown, J., Watson, C., & Gick, B. (2017). Tongue retraction in Arabic: An ultrasound study. In Proceedings of the Annual Meetings on Phonology, 4. DOI: https://doi.org/10.3765/amp.v4i0.3995

Al-Tamimi, F., Alzoubi, F., & Tarawnah, R. (2009). A videofluoroscopic study of the emphatic consonants in Jordanian Arabic. Folia Phoniatrica et Logopaedica, 61(4), 247-253.

Blevins, J. (1995). The syllable in phonological theory. In: Goldsmith, J. (Ed.), The Handbook of Phonological Theory: pp. 206-244.

Boersma, P., Weenink, D. (2022). PRAAT: Doing Phonetics by Computer (Version 6.2.07) [Computer software]. http://www.praat.org/

Browman, C., Goldstein, L. (1988). Some notes on syllable structure in articulatory phonology. Phonetica 45: pp. 140–155.

Browman, C., Goldstein, L. (1989). Articulatory gestures as phonological units. Phonology 6: pp. 201-251.

Browman, C., Goldstein, L. (1992). Articulatory phonology: an overview. Phonetica 49: pp. 155–180.

Btoosh, M. (2006). Constraint interactions in Jordanian Arabic phonotactics: An Optimality-theoretic approach. Journal of Language and Linguistics 5, 2: pp. 192-221.

Catford, J. C. (1990). Glottal consonants… another view. Journal of the International Phonetic Association, 20, 2: pp. 25-26.

Clements, G. (1990). The role of the sonority cycle in core syllabification. In: Kingston, J., Beckman, M. (Eds.), Papers in Laboratory Phonology I: Between the Grammar and Physics of Speech: pp. 283-333.

Davis, S. (1995). Emphasis spread in Arabic and Grounded phonology. Linguistic Inquiry 26, 3: pp. 456-498.

Denning, K., Kemmer, S. (Eds.) (1990). On language: Selected writings of Joseph H. Greenberg. Stanford: Stanford University Press.

Farchi, M., Karim, T., & Mouhsen, A. (2019). Arabic Vowels Acoustic Characterization. Colloque sur les Objets et systèmes Connectés, Ecole Supérieure de Technologie de Casablanca (Maroc), Institut Universitaire de Technologie d'Aix-Marseille (France), Jun 2019, CASABLANCA, Morocco. ffhal-02296812

Ferguson, C. (1956). The emphatic l in Arabic. Language 32, 3: pp. 446-452.

Garellek, M., Chai, Y., Huang, Y., & Van Doren, M. (2021). Voicing of glottal consonants and non-modal vowels. Journal of the International Phonetic Association: pp. 1-28. DOI: 10.1017/S0025100321000116.

Ghowail, T. I. (1987). The acoustic phonetic study of the two pharyngeals /ħ, ʕ/and the two laryngeals/ʔ, h/ in Arabic. PhD dissertation. Indiana University.

Green, C., Moran, S. (2019). Tadaksahak sound inventory (GM). In: Moran, Steven & McCloy, Daniel (eds.) PHOIBLE 2.0. Jena: Max Planck Institute for the Science of Human History. (Available online at http://phoible.org/inventories/view/1372, Accessed on 2022-01-06.)

Harris, J. (1994). English sound structure. Oxford: Blackwell publishers.

Harris, J., Lindsey, G. (2000). Vowel patterns in mind and sound. In: N. Burton-Roberts, P. Carr, G. Docherty (Eds.), Phonological knowledge: Conceptual and empirical issues. Oxford: Oxford University Press: pp. 185-205.

Heffner, R. M. S. (1969). General Phonetics. The University of Wisconsin Press.

Hellmuth, S. (2014). Investigating variation in Arabic intonation. In Perspectives on Arabic Linguistics XXIV-XXV: Papers from the annual symposia on Arabic Linguistics. Texas, 2010 and Arizona, 2011, 1. John Benjamins Publishing Company.

Hellmuth, S. (2020). Contact and variation in Arabic intonation. Arabic and contact-induced change, 583.

Henke, E., E.M. Kaisse & Richard Wright. (2012). Is the sonority sequencing principle an epiphenomenon? In Steve Parker (ed.), The Sonority Controversy, pp. 65–100. Berlin: De Gruyter Mouton.

Hermes, Z., Barlaz, M., Shosted, R., Liang, Z. P., & Sutton, B. P. (2021). Articulatory and acoustic correlates of pharyngealization and pharyngealization spread in Cairene Arabic. Experimental Arabic Linguistics, 10, 23.

House, A., Fairbanks, G. (1953). The influence of consonant environment upon the secondary acoustical characteristics of vowels. Journal of the Acoustical Society of America 22: pp. 105–113.

Jacewicz, E., Fox, R. (2008). Amplitude variations in coarticulated vowels. Journal of Acoustical Society of America 123, 5: pp. 2750-2768.

Johnson, W., Britain, D. (2007). L-vocalisation as a natural phenomenon: explorations in sociophonology. Language Sciences 29: pp. 294-315.

Ibn Al-Qayyim Al-Jawziyyah. (1997). Asmaa Allah-u Al-Husna. Damascus: Dar Al-Kalim At-Tayyib.

Iivonen, A., & Hunt, G. (1992). Letters to the Editor: How [h] became a glottal fricative: Comments on the letter by Martin Kloster-Jensen in JIPA 21 (1991). Journal of the International Phonetic Association, 22: pp. 61-64.

Kalaldeh, R. (2018). Acoustic analysis of Modern Standard Arabic vowels by Jordanian speakers. International Journal of Arabic-English Studies, 18, 1: pp. 23-48.

Kloster-Jensen, M. (1991). Letter to the Editor. Journal of the International Phonetic Association, 21, 1: p. 42

Kotby, M. N., Saleh, M., Hegazi, M., Gamal, N., Salam, M. A., Nabil, A., & Fahmi, S. (2011). The Arabic vowels: Features and possible clinical application in communication disorders. Folia Phoniatrica et Logopaedica, 63, 4: pp. 171-177.

Ladefoged, P. (1990). Some proposals concerning glottal consonants. Journal of the International Phonetic Association, 20, 2: pp. 24-25.

Ladefoged, P. (2001). A course in phonetics. New York: Harcourt Brace.

Ladefoged, P., Maddieson, I. (1996). The sounds of the world's languages. Oxford: Blackwell.

Laufer, A. (1991). The 'glottal fricatives'. Journal of the International Phonetic Association, 21, 2: pp. 91-93.

Laufer, A., & Baer, T. (1988). The emphatic and pharyngeal sounds in Hebrew and in Arabic. Language and Speech, 31, 2: pp. 181-205.

Laver, J. (1994). Principles of phonetics. Cambridge: Cambridge University Press.

Mohammed, A.J. (2006) Schools of Phonology in Arabic. The Rise and the Development. Beirut: Dar AL-Kotob Al-Ilmiya (in Arabic).

Moran, Steven & McCloy, Daniel (eds.) (2019). PHOIBLE 2.0. Jena: Max Planck Institute for the Science of Human History. (Available online at http://phoible.org, Accessed on 2022-01-06.)

Newman, D. (2002). The phonetic status of Arabic within the world's languages: the uniqueness of the lughat al-daad. Antwerp papers in linguistics, 100: pp. 65-75.

Norlin, K. , (1987). A phonetic study of emphasis and vowels in Egyptian Arabic. Lund University Department of Linguistics Working Papers, 30: pp. 1–119.

Obrecht, P. H. (1968). Effects of the second formant on the perception of velarization consonants in Arabic. The Hague: Mouton.

O'Connor, J. D. (1980). Phonetics. London: Penguin Books Ltd.

Olive, J., Greenwood, A., Coleman, J. (1993). Acoustics of American English speech: A dynamic approach. New York: Springer.

Parker, S. (2002). Quantifying the sonority hierarchy. PhD dissertation. University of Massachusetts Amherst.

Pike, K. L. (1943). Phonetics: A critical analysis of phonetic theory and a technic for the practical description of sounds. University of Michigan Publications. Language and Literature, 21.

Price, P. (1980). Sonority and syllabicity: Acoustic correlates of perception. Phonetica 37: pp. 327-343.

Prince, A., Smolensky, P. (1993). Optimality Theory: Constraint Interaction in Generative Grammar. RuCCS Technical Report 2. Rutgers University and the University of Colorado, ROA 537.

Procházka, S. (2021). Arabic Dialectology. In David Wilmsen & Karin Ryding (eds.), The Cambridge Handbook of Arabic Linguistics: pp. 214–243.

Recasens, D., Espinosa, A. (2005). Articulatory, positional and coarticulatory characteristics for clear /l/ and dark /l/: evidence from two Catalan dialects. Journal for the International Phonetic Association 35: pp. 1-26.

Roach, P. (2009). English phonetics and phonology: A practical course. Cambridge: Cambridge University Press.

Rosenhouse, J. (2007). Arabic phonetics in the beginning of the third millenium. In Proceedings of the16th International Congress of Phonetic Science, pp. 131-134.

Selkirk, E. (1984). On the major class features and syllable theory. In: Aranoff, M., Oehrle, R. (Eds.), Language Sound Structure: Studies in Phonology Presented to Morris Halle by his Teachers and Students, pp. 107-136.

Shih, C., Ao, B. (1997). Duration study for the Bell Laboratories Mandarin Text-to-Speech system. In: van Santen, J., Sproat, R., Olive, J., Hirschberg, J. (Eds.), Progress in Speech Synthesis: pp. 383-399.

Shosted, R. K., Fu, M., & Hermes, Z. (2017). Arabic pharyngeal and emphatic consonants. In The Routledge handbook of Arabic linguistics: pp. 48-61.

Solé, M. J. (2007). Compatibility of features and phonetic content. The case of nasalization. In Proceedings of ICPhS 16: pp. 261-266.
Schwartz, J. L., Boë, L. J., Vallée, N., & Abry, C. (1997a). Major trends in vowel system inventories. Journal of phonetics, 25, 3: 233-253.
Schwartz, J. L., Boë, L. J., Vallée, N., & Abry, C. (1997). The dispersion-focalization theory of vowel systems. Journal of phonetics, 25, 3: 255-286.
Sproat, R., Fujimura, O. (1993). Allophonic variation in English /l/ and its implications for phonetic implementation. Journal of Phonetics 21: pp. 291–311.
Stevens, K. N. (1998). Acoustic Phonetics. Cambridge, MA: MIT Press.
Thelwall, R. & Sa'Adeddin, M. K. (1990). Arabic. Journal of the International Phonetic Association, 20, 2: pp. 37–39.
Trager, G. L., & Smith, H. L. (1951). An outline of English structure (Studies in Linguistics. Occasional papers, 3: pp. 11-52.
Versteegh, K.. (2014). The Arabic Language. NED-New. Second edition. Edinburgh: Edinburgh University Press.
Wateed, M. (2010). Khasais Lafz Al-Jalalah fi Al-Arabiyyah—diraasah lughawiyyah. Journal of Humanity 25, College of Arts at Damanhur.
Watson, J. (1999). The directionality of emphasis spread in Arabic. Linguistic Inquiry 30, 2: pp. 289-300.
Zawaydeh, B. A. (1999). The phonetics and phonology of gutturals in Arabic. Indiana University.
Zhou, X., Espy-Wilson, C., Tiede, M., Boyce, S. (2010). An MRI-based articulatory and acoustic study of lateral sound in American English. ICASSP 2010: pp. 4182-4185.
Younes, M. (1993). Emphasis spread in two Arabic dialects. In: Eid, M., Holes, C. (Eds.), Perspectives on Arabic Linguistics: pp. 119-145.