The Phonetics and Phonology of Ḥarsūsi: An Instrumental Phonetics Study

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Abstract

Ḥarsūsi is one of six Modern South Arabian Languages (henceforth MSAL), spoken in Jiddat Al-Harasis /d͡ʒiddɐt el ħɐrɐːsiːs/ in Central Oman. The MSAL branch of languages came to the attention of European scholars around 1830s, with Ḥarsūsi first mentioned in scholarly works by Thomas Bertram in 1929. Other work was conducted on Ḥarsūsi by Thomas Bertram in the 1930s and by Thomas Johnstone in the 1970s. To date, however, scholarly works on Ḥarsūsi remain scarce. Ḥarsūsi is labelled as a definitely endangered language by UNESCO (Moseley, 2010).

This thesis is the first analysis of the Ḥarsūsi sound system based on first-hand field data since Johnstone's work conducted over 43 years ago, and constitutes the first step towards a full linguistic documentation of Ḥarsūsi.

Qualitative and quantitative methods are applied to the investigation of the phonetics and phonology of Ḥarsūsi. A database of audio, video and written text materials of transcribed and analysed word lists, narratives and conversations was produced for linguistic analysis. Acoustic analyses were done using the linguistic analysis programme PRAAT (Boersma & Weenink, 2020). Linear-mixed model tests were run using the statistical programme R to provide statistically founded results. Chapter One: Introduction introduces the Ḥarsūsi language, then presents the aims and objectives of the study, research questions and the structure of the thesis. Chapter Two: Literature Review presents the literature review in terms of linguistic diversity in Oman, the MSAL, Ḥarsūsi, and emphatics in Semitic. Chapter Three: Methodology describes the

methodology in terms of fieldwork, consultants, data collection, transcription, and acoustic and statistical analysis.

Chapter Four: Phonetics and Phonology of Ḥarsūsi presents an overview of the Ḥarsūsi sound system. It considers the consonant phonemes and their allophones, provides an overview of the vowel phonemes and their allophones, and lays particular focus on the class of consonants known in the literature on Semitic languages as 'emphatics'. The chapter demonstrates that the emphatics pattern phonologically with the voiced consonants as opposed to the voiceless consonants.

Chapter Five: The Phonetic Realisation of Ḥarsūsi Stops investigates the Ḥarsūsi stops by examining temporal and non-temporal acoustic parameters in an attempt to establish a) how the emphatic stops are realised phonetically, b) how the emphatic stops differ from their non-emphatic counterparts, and c) the extent to which the phonological patterning of the emphatic and voiced stops is reflected in their acoustic phonetics. The temporal parameters examined are Voice Onset Time (henceforth VOT) and oral closure duration, while the non-temporal parameter is the presence or absence of glottal closures exhibited by each segment across the data.

Chapter Six: The Phonetic Realisation of Ḥarsūsi Fricatives investigates the fricatives in Ḥarsūsi. As for the stops, temporal and non-temporal acoustic parameters are examined in an attempt to establish a) how the emphatic fricatives are realised phonetically, b) how the emphatic fricatives differ from their plain counterparts, and c) the extent to which the phonological patterning of the emphatic and voiced fricatives is reflected in the acoustic phonetics. In terms of temporal parameters, frication duration and overall segment duration are measured to establish how the emphatic fricatives differ from their plain counterparts. In terms of non-temporal parameters, it looks at the number of pre- and post-frication silent lags, frication intensity and Centre of Gravity of the spectrum[1] (henceforth CoG) to establish whether Ḥarsūsi emphatic fricatives are realised typically as ejectives or as backed consonants.

Drawing evidence from the acoustic characteristics of the emphatics and their plain counterparts and from their phonological patterning, the thesis presents overall results that support the laryngeal categorisation of Ḥarsūsi consonants as one based on airflow (breath), as argued by Heselwood (2020) and Watson & Heselwood (2016) for the sister languages of Ḥarsūsi, Mehri and Śḥerɛ̄t, rather than the traditional categorisation based on voicing. The emphatics and canonically voiced consonants are 'unbreathed', while the consonants traditionally termed 'voiceless' are 'breathed'.

[1] It is a measure that quantifies the average elevation of frequencies within a spectrum.

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List of Abbreviations

AJD	Adjective
ADV	Adverb
B	Burst
C	Common gender
CoG	Centre of Gravity
CV	Creaky Voice
DEM	Demonstrative
DEAMSA	Documentation and Ethnolinguistic Analysis of Modern South Arabian project
ELAR	Endangered Languages Archive
F	Feminine
1	First person
FUT	Future
GC	Glottal Closure
GR	Glottal Release
IMP	Imperative
IPFV	Imperfective
LOC	Locative
M	Masculine
MSAL	Modern South Arabian Languages
N	Noise
OC	Oral Closure
OR	Oral release
PA	Pre-aspiration
PFV	Perfective
PG	Pre-glottalisation
PL	Plural
2	Second person
SG	Singular
S	Stressed
US	Unstressed
VOT	Voice Onset Time

Note on Transcription Methods

Detailed phonetic transcription using IPA symbols was done only at the start for the Swadesh list, other word lists, and one text to help determine the phonemes of Ḥarsūsi. The majority of the data later were phonemically and broad phonetically transcribed using IPA symbols. The broad phonetic transcriptions were used in the case of certain phonemes, such as the long vowels that undergo diphthongisation in certain phonetic environments (discussed in 4.4). With regard to names of languages, the spelling style that got the higher number of hits in Google was adopted and other known names and spellings were also given in case of the non-Semitic languages. In case of the Semitic languages, and particularly the MSAL, the spelling style used in Semitic studies was adopted. In terms of place names, names of governorates, cities, towns, and villages, they were given in Roman orthography as they are found on Google maps and were phonemically transcribed to the best of my knowledge.

It should be noted here, however, that the phonemic transcription of names of governorates, places, cities, towns, and villages was based on Arabic pronunciation of these names; and that the symbol /ˤ/ which is used for emphatic sounds does not assume them being pharyngealised per se. Similarly, the same symbol /ˤ/ is used in transcribing some of the emphatic phonemes in Ḥarsūsi indicating that they are backed.

All the data in the illustrative images were transcribed phonemically and broad phonetic transcriptions were given in case of some long vowels which undergo diphthongisation process. In the illustrative images, only the segment being discussed was segmented with all the details.

1. Chapter One: Introduction

1.1. Background to Study

This study of Ḥarsūsi is the first to emerge after the scholarly works of Thomas Johnstone in the 1970s. Ḥarsūsi, an endangered Semitic language from the MSAL family, is spoken only in the Sultanate of Oman within Jiddat Al-Harasis (19°57′54″N , 56°16′43″E) by around 3500-4000 speakers (Moseley, 2010) from the Ḥarsūsi tribe. After the first mention of Ḥarsūsi and Ḥarāsīs by Thomas Bertram in 1929 and the data collected by Thomas Bertram in the 1930s and later by Thomas Johnstone in the 1970s, no other major work has been done on Ḥarsūsi based on first-hand data.

The main goal of this thesis is to provide a linguistic analysis of Ḥarsūsi focusing on aspects of the phonetics and phonology of the language. The main areas of interest are the sound system of the language in general and the class of 'emphatic' sounds in particular. In addition, through the recording of everyday activities of the speakers and other cultural activities practised in the area for analyses purposes, the study documents aspects of community's culture and lifestyle.

The study is based on first-hand data, elicitations, and natural speech recordings, collected in four one-month visits since 2016 from speakers of Ḥarsūsi in several visits to Al-Wusta /ʔɐl wostˤɐ/ governorate in Oman in the town of Abu Mudhabi /ʔɐbu meðˤɐːbi/ which is around 50 kilometres east of the city of Haima /hɐimɐ/ (19° 81' 92.2" N, 56° 68' 97.3" E) in Jiddat Al-Harasis on the way to Al-Duqm /ʔɐd duqm/. It should be noted here that the names of larger settlements, places, and areas are given using Roman orthography as found on Google Maps and sometimes on road signs in Oman (see 3.5).

1.2. Overview of Aims and Context

This thesis is the first step towards the documentation of the Ḥarsūsi language by studying its phonetics and phonology. Given the fact that Ḥarsūsi is an endangered language, it is important to collect all the possible data to help in preserving the language and its linguistic characteristics.

This thesis provides a descriptive analysis of phonemes, consonants and vowels, and a quantitative analysis of Ḥarsūsi obstruent speech sounds. It establishes a phoneme inventory, identifies the natural classes of phonemes, and investigates the patterns of allophony in different contexts.

One area of focus of the thesis is the class of emphatics in Ḥarsūsi. Given the fact that very little is known about these sounds in MSAL in general and in Ḥarsūsi in specific, this thesis examines how these sounds are articulated in Ḥarsūsi in comparison to other MSAL and Arabic dialects. It attempts to establish the nature of 'emphatic' sounds in Ḥarsūsi, and suggest the most suitable laryngeal categorising system for Ḥarsūsi sounds.

1.3. Research Questions

The research questions this study addresses can be subsumed under the following general questions:

- What are the different phonemes and allophones of Ḥarsūsi?
- What is the nature of emphatic sounds in Ḥarsūsi?
- What are the phonetic characteristics of the emphatics compared to their plain counterparts in Ḥarsūsi?
- Is the laryngeal category in Ḥarsūsi based on voice or on breath?

The first question is addressed through minimal and near-minimal pairs analysis. The phonemes' occurrences in various contexts in both elicited and natural speech recordings are investigated in detail to establish patterns of allophony.

The second question is addressed by investigating relevant acoustic parameters to establish the nature of emphatics in Ḥarsūsi. VOT and occurrence of glottal closures and releases are checked in the case of stops, while the occurrence of pre- and post-frication silent lags (which may either be oral or glottal closures), frication duration, and frication intensity are investigated in the case of fricatives.

The third question is dealt with by investigating the following acoustic parameters which have been shown to be relevant in the study of emphatics: VOT, oral closure duration, glottal closure/release, segment duration, frication duration, and frication intensity.

The fourth question is answered by looking into the results of the acoustic characteristics of Ḥarsūsi voiced, voiceless and 'emphatic' obstruents and their phonological patterning.

1.4. STRUCTURE OF THESIS

The thesis comprises seven chapters and is structured as follows:

Chapter One: Introduction briefly introduces the language and the study itself. It sets the aims and objectives, context, questions, and structure of the thesis.

Chapter Two: Literature Review introduces the linguistic situation in the Sultanate of Oman where Ḥarsūsi is spoken. It provides information about the different languages spoken in Oman from three language families: Semitic, Indo-European, and Bantu. Then, it focuses on the Semitic language family and specifically on the MSAL and Ḥarsūsi. Finally, it provides a detailed literature review on the class of emphatics in Semitic languages.

Chapter Three: Methodology describes the general methodology followed in the thesis. It provides overall information about the fieldwork, data sources, language consultants, data collection, transcription, and analyses systems. Detailed methodological information for phonetic investigations is provided within relevant chapters (see 5.2 and 6.2).

Chapter Four: Phonetics and Phonology of Ḥarsūsi provides an overview of the phonetics and phonology of Ḥarsūsi. It analyses the different classes of consonant phonemes and their allophones. Then, it gives an overview of the vowel phonemes and their allophones and the diphthongs.

Chapter Five: The Phonetic Realisation of Ḥarsūsi Stops is a phonetic study of Ḥarsūsi stops. It examines the acoustic characteristics of stops and especially the emphatics to establish whether they are realised as ejectives as in Ethio-Semitic languages, or backed[2]

[2] The term 'backed' is used in this work from Bellem (2007) to refer to non-ejective emphatic sounds avoiding their categoristion as either pharyngealised/uvularised/velarised/.

(pharyngealised/uvularised) as in some varieties of Arabic. In addition, it investigates the acoustic parameters of VOT, glottal closure/release, and oral closure duration to check if they distinguish the emphatics from their plain counterparts.

Chapter Six: The Phonetic Realisation of Ḥarsūsi Fricatives is a phonetic study of Ḥarsūsi fricatives. It investigates a number of acoustic parameters to a) establish the nature of Ḥarsūsi emphatic fricatives, b) show how the emphatic fricatives differ from their plain counterparts, and c) investigate how the phonological patterning of emphatics and their voiced counterparts is exhibited in acoustic phonetics.

Chapter Seven: Discussion and Conclusion lists the overall outcomes of the thesis and provides a brief conclusion on the project. In addition, it lists the limitations of this project, and provides directions and areas of interest in researching Ḥarsūsi in future works.

2. Chapter Two: Literature Review

2.1. Linguistic Diversity in Oman

Located on the south-eastern edge of the Arabian Peninsula, the Sultanate of Oman is home to a number of languages besides Arabic, the official and national language of the country. A total of 11 languages are spoken in Oman which are Arabic, Balochi, Swahili, Kumzari, Zadjali, Lawati, Śḥerɛ̄t, Hobyōt, Baṭḥari, Mehri, and Ḥarsūsi; and these languages differ in the number of their speakers and level of endangerment (Al-Jahdhami, 2015). This linguistic diversity makes Oman the most linguistically diverse country in the Arabian Peninsula. Since the national language of the country is Arabic, many speakers of these other languages are either bilingual, trilingual, or in rare cases multilingual as they use these languages for different purposes. However, it should be noted that the degree of bilingualism differs from one speaker group to another. In addition, many speakers who are trilingual or multilingual do not speak any of the other small group languages of Oman, but rather other non-endangered and international languages, such as Arabic and English.

Despite the rich linguistic diversity of the country, no language other than Arabic is given any formal attention or status. The formal education system in Oman started in 1970 and before that there were several informal Quranic schools where students were mainly taught Quran and maths. The language policy of the country was formed with the establishment of formal schooling making Arabic the official language of the country and the medium of instruction in schools. All students and teachers irrespective of their regions or mother tongues are mandated to use only Arabic in schools. All courses except English language courses are taught in Arabic. Books are written in standard Arabic and there is a course of Arabic language itself that includes studying both the linguistic features of Arabic and literary works written in it. All student exams and assignments are required to be written in standard Arabic. Moreover, even in courses such as science and geography the written language is assessed. Many teachers require the students to write in intelligible, grammatical standard Arabic. Poor language usage affects the overall grade in the test or assignment. In short, all the policies and actual school practices are aimed at mainstreaming the students and turning them into competent users of Arabic with no regard to their mother tongues, thus, affecting the other languages of Oman adversely.

The other languages in the Sultanate of Oman, and especially the MSAL, enjoyed isolation from the main language Arabic to a certain degree before 1970 at least in their own environments. Johnstone (1977) mentioned that he found most of the Ḥarāsīs women monoglots of Ḥarsūsi, while some men spoke the Omani Bedouin dialect of Arabic as a second language which he said was a dialect of Eastern Arabian type. It could be assumed he meant the Omani Bedouin dialect spoken by the Janabah /d͡ʒanabah/ and Wehaiba /wehajba/ tribes in the area of Al-Duqm and its surroundings. Considering the political situation of Oman before 1970, it could be inferred that before the 1970s most of the languages were mainly used in their own environments and speaker communities had very limited contact with other languages, especially those spoken in their own isolate environments. However, with the introduction of modern schooling, all these languages became prone to the threats of Arabic, the lingua franca of the country. The threats increased on these other languages since they do not receive any form of governmental attention or support. None of the other languages is used anywhere in formal situations in the country. The other languages are not taught in schools or even offered as courses in other educational institutions such as colleges and universities. The students are not allowed to use any language in such institutions other than Arabic. Also, there are no research centres to study and analyse these languages and exert efforts in saving them from extinction.

Even though the Sultanate of Oman is linguistically rich, according to Al-Jahdhami (2015), scholarly work focused on the languages in Oman is scarce. Indeed, apart from Kumzari (Thomas, 1930; Anonby, 2011; Al-Jahdhami, 2013; Van der Wal Anonby, 2015; Al-Jahdhami, 2016), Śḥerɛ̄t (also known as Jibbali) (Johnstone, 1981; Hofstede, 1998; Al-Aghbari, 2012; Rubin, 2012; Gravina, 2014; Rubin, 2014, 2015b), and Mehri (Johnstone, 1987; Stroomer, 1999; Rubin, 2010; Watson, 2012; Bendjaballah & Ségéral, 2014; Ridouane, Gendrot, & Khatiwada, 2015; Rood, 2017; Rubin, 2018; Watson, A. M. al-Mahri, A. al-Mahri, B.M al-Mahri, & A. al-Mahri, 2020) which have been studied by linguists, most of the other languages of Oman have not received much attention. The literature on other languages in Oman is very limited and what makes this issue of scarcity a concern is that like Śḥerɛ̄t and Kumzari, many of these small group languages such as Baṭḥari, Ḥarsūsi, Hobyōt, Zadjali and Lawati are highly endangered (Simons & Fennig, 2018).

The languages in Oman, including Arabic, belong to three language families: Niger-Congo (Bantu), Indo-European, and Semitic. Among the 11 total languages spoken by the citizens in the Sultanate of Oman, one belongs to the Niger-Congo/Bantu language family (Swahili), four belong to the Indo-Iranian sub-family of Indo-European family (Balochi, Kumzari, Lawati and Zadjali) and six belong to the Semitic language family (Arabic, Śḥerɛ̄t, Mehri, Hobyōt, Baṭḥari and Ḥarsūsi). Out of these languages, 4 are considered migrant languages and are spoken in other parts of the world including Balochi, Swahili, Zadjali, and Lawati. The other languages including Arabic, Kumzari, Mehri, Baṭḥari, Hobyōt, Śḥerɛ̄t, and Ḥarsūsi are native to Oman.

The sections below provide a general overview of the three language family languages. The first section is on the Niger-Congo/Bantu languages; the second section is on the Indo-European/Iranian languages; the third section is on the Semitic languages where emphasis is given to Ḥarsūsi.

2.1.1. Niger-Congo/Bantu Language

According to Al-Jahdhami (2015), several languages contributed to the development of the Swahili language including Persian, English, Portuguese, German, Hindi, and Arabic. The lexicon of Swahili borrowed heavily from Omani Arabic dialects (Al-Jahdhami, 2015). The reason behind Swahili being heavily influenced by Arabic is language contact that occurred in the Island of Zanzibar and other coastal areas of Africa when the Omanis had control over these areas from the 18^{th} century until the mid-20^{th} century. The actual number of Swahili language speakers in Oman is unknown. However, it is spoken by millions of people in Africa. Ethnologue estimated the number of its speakers in Oman as 22,000 (around 0.75% of the current total population) (Simons & Fennig, 2018). Similar to the other small group languages in Oman, Swahili is also facing endangerment in the Omani context as it is not being transmitted to the younger generation. Scholarly work on Swahili include Keach & Rochemont (1992); Mohamed (2001); Vitale (2019).

2.1.2. Indo-European Languages

There are four Indo-European languages in Oman: Balochi, Kumzari, Lawati and Zadjali. Apart from Kumzari which is native to Oman, the other three languages are migrant languages that moved into Oman and are spoken in other parts in the world as well. Below is an overview of each of these languages.

2.1.2.1. Balochi

Balochi (known as Balushi in Oman), a migrant Indo-European language to Oman, is spoken mainly in the governorates of Muscat /mɐsqɐtˤ/ and Al Batinah-North /ʔɐl bɐːtˤinɐh/, but it can also be found spoken in certain areas of Al-Sharqiyah /ʔɐʃːɐrqijːɐh/ governorates, both North and South. Apart from Oman, it is also spoken in Iran, Pakistan, Afghanistan, some other Gulf countries, Turkmenistan, India, East Africa, North America, Europe, and Australia (Jahani & Korn, 2013), and there is some scholarly work on it (Korn, 2005; Jahani & Korn, 2013). In Oman, it is spoken by the members of the 'Balushi' tribe and there is more than one dialect of it. The number of Balochi language speakers in Oman is probably higher than the other small group languages, however, many members of the tribe especially from the new generation do not use the language or have even lost it. A number of tribe members are passive users[3] of the language who can understand it to certain levels but are unable to produce it. Moreover, it is not surprising to find people from the tribe, especially in remote areas surrounded by mainly Arabic language

[3] The term 'passive users' is used to refer to individuals who can understand a language to some extent, but are unable to produce it and use it in their speech.

speakers, who do not speak the language or even understand it. Some of the scholarly work on Balochi include Korn (2005); Axenov (2006); Jahani & Korn (2013); Jahani (2019)

2.1.2.2. Kumzari

Kumzari is the only language from the Indo-European language family which is spoken in Oman as a native language. Unlike the other Indo-European languages, Kumzari can be considered a native Indo-European language to Oman as it is not found anywhere else beyond migrant communities, and it is not known when it arrived in Oman. Its closest relatives are Indo/Iranian languages spoken mostly in Iran and especially Laraki which is considered a dialect of Kumzari by Anonby (2011). Kumzari is spoken in the coastal village of Kumzar /kumzɐːɾ/ in the Musandam /musɐndɐm/ Peninsula north of Oman near the straits of Hormuz /hoɾmoz/; however, some sources mention that fewer numbers of Kumzari now reside in other countries such as the United Arab Emirates (Anonby, 2011; Van der Wal Anonby, 2015). The number of Kumzari speakers is estimated to be around 5,000 (Around 0.17% of current total population), but the language is severely endangered as the younger generation does not learn the ethnic language (Al Jahdhami, 2015). Moreover, many Kumzaris, due to work and other reasons, are moving out of their ancestral village Kumzar and settling in other areas in Oman, such as Khasab /xɐsˤɐb/ where they are surrounded by Arabic speakers (Van der Wal Anonby, 2015). Scholarly work on Kumzari include Thomas (1930); Anonby (2011); Al-Jahdhami (2013); Van der Wal Anonby (2015); Al-Jahdhami (2016).

2.1.2.3. Lawati

Lawati (also known as Luwati) is another migrant Indo-European language in Oman. It is spoken by the Lawati tribe in the governorates of Muscat and Al Batinah-North /ʔɐl bɐːtˤinɐh/. The speakers of the language are known as Lawatiya, Khoja or Hyderabadis (Salman & Kharusi, 2012). It is grouped as a Sindhic language related to Kachchi (Hammarström, Forkel, & Haspelmath, 2019). The actual number of its speakers is unknown; nonetheless, Al Jahdhami (2015) estimated the number of the Lawatis in Oman to be a few thousand with a considerable number of them being non-speakers of the Lawati language. Ethnologue estimates the speaker population at 30,000, but there are no confirmed numbers (Around 1% of current total population) (Simons & Fennig, 2018). Salman & Kharusi (2012) estimated the number to be between 30,000 and 50,000 in 2010. Many younger generation Lawatis are passive users of the language who can understand it to some extent but cannot produce it as I experienced with a number of them in Muscat /masqat/.

2.1.2.4. Zadjali

The third migrant Indo-European language to Oman is Zadjali (also known as Jadgali). It is mainly spoken in the governorate of Muscat and some coastal areas of the governorate of Al Batinah-North /ʔɐl bɐːtˤinɐh/. Similar to Lawati, it is spoken by a small number of Zadjali tribe members and the actual number of its speakers is unknown, but it is estimated to be a few hundred speakers (Al Jahdhami, 2015). Most Zadjali speakers in Oman are elderly and do not seem interested in transmitting their language to the younger generation (Al-Jahdhami, 2017).

The language closely resembles Balochi in its lexicon, and this has led some to consider it a dialect of Balochi. Al-Jahdhami (2017) mentioned that although Zadjali resembles both Balochi and Sindhi in its lexicon, mutual intelligibility does not exist as speakers of both Balochi and Sindhi do not understand Zadjali speech; therefore, Zadjali could be considered a separate language of its own. Scholarly work on Zadjali is rare and the only data available is a Swadesh list of 100 words in Al-Jahdhami (2017).

2.1.3. Semitic Languages

Among the languages spoken in Oman, six belong to the Semitic language family. All these languages belong to the Western branch of the Semitic language family tree. Within the Western branch, Arabic, belongs to the Central Semitic branch while the other five belong to the MSAL branch[4]. The MSAL are Śḥerēt, Hobyōt, Baṭḥari, Mehri, Ḥarsūsi and Soqoṭri. Figure 2.1 below shows the Semitic language family tree as proposed by Huehnergard & Rubin (2011).

[4] Modern South Arabian languages are labelled as MSA in Figure 2.1 which is adopted from the reference.

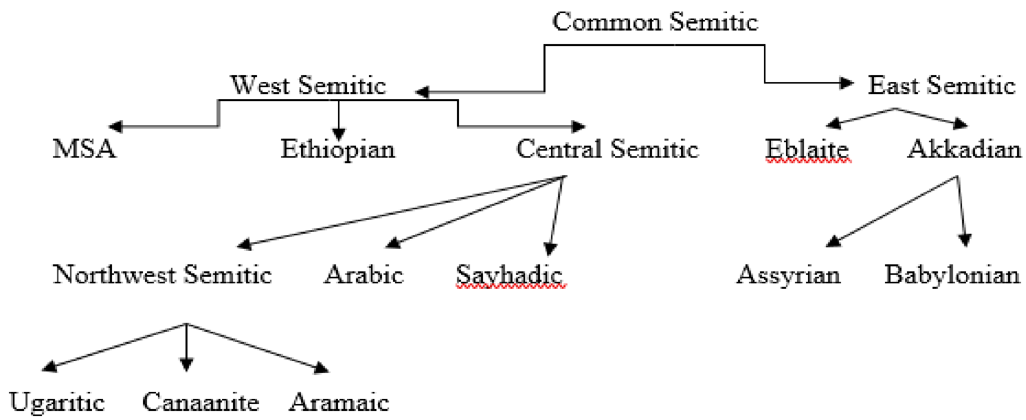

Figure 2.1: Semitic language family tree (Huehnergard & Rubin, 2011).

Arabic, the national language of the Sultanate of Oman, is an established lingua franca used by speakers of all the languages of Oman. As mentioned above 2.1, the educational system is based on the Arabic language; therefore, most speakers of the other languages, especially the younger generation, are bilingual in both Arabic and their own language. Nonetheless, fluency in the other language(s) varies from one speaker to another and from one language to another.

In section 2.2 below, a brief overview is given for each of the MSAL in Oman. The Ḥarsūsi language is presented in detail in section 2.3 separately.

2.2. MSAL

As mentioned in section 2.1.3, five of the six MSAL are spoken in Oman. The MSAL in Oman are Śḥerε̄t, Hobyōt, Baṭḥari, Mehri and Ḥarsūsi. All the MSAL in Oman are spoken in their own communities and have no official status or recognition. In addition, the younger generation are shifting from speaking these languages to Arabic, and in the case of some of these languages children's learning level is not clear, as in Hobyōt (Rubin, 2015a).

Based on the literature available on the MSAL, they are the most recent languages discovered by western linguists and researchers among the Semitic language family. The existence of these languages was not known to the western scholarly community before the third decade of the 18th century. Three of the MSAL, Mehri, Śḥerɛ̄t and Soqoṭri, were first heard about by the 1830s and 40s (Rubin, 2015a). The earliest publications on MSAL mentioned by Simeone-Senelle (1997) are a wordlist of 236 items in Soqoṭri by Wellsted (1835) and a description of Śḥerɛ̄t by Fresnel (1838). After these works, no major studies or data collections were done on MSAL until towards the end of the 19th century. According to Simeone-Senelle (1997), the Imperial Academy of Vienna's expedition 'Sudarabische Expedition' in 1898 was a turning point for MSAL as texts were collected and "…studied grammatically and lexically later on by Bittner (1908-1917), Jahn (1915) Leslau (1938) and Wagner (1953)" (Simeone-Senelle, 1997, p. 380). Almost 40 years after the Imperial Academy of Vienna's expedition, Thomas (1929) mentioned another two MSAL, Ḥarsūsi and Baṭḥari, in his memoir 'Among some unknown tribes of South Arabia' and provided linguistic information on some of the MSAL in 'Four strange tongues from Central South Arabia – The Hadara Group' (1937). Nothing was heard about MSAL until the works of Thomas Johnstone in the 1960s and 70s when he published the lexicons of Mehri (Johnstone, 1987), Śḥerɛ̄t 'Jibbali' (Johnstone, 1981) and Ḥarsūsi (Johnstone, 1977) in addition to some articles (Johnstone, 1968, 1970a, 1970b, 1973, 1975, 1980b, 1980a). The last MSAL language discovered by western researchers was Hobyōt, which was first mentioned by Thomas Johnstone in the late 1970s (Rubin, 2015a).

The geographical distribution of the MSAL is limited to the southern part of the Arabian Peninsula. Three of the MSAL, Śḥerɛ̄t, Baṭḥari and Ḥarsūsi, are spoken exclusively in Oman. Mehri and Hobyōt are also found in the Republic of Yemen. Soqoṭri is exclusively spoken on the Island of Socotra in the Republic of Yemen. Mehris are also present in Saudi Arabia in the border areas between the Kingdom of Saudi Arabia and Yemen; therefore, Mehri is indigenous in Oman, Yemen, and Saudi Arabia. Figure 2.2 below is a map from Simeone-Senelle (2011) which shows the geographical distribution of the MSAL in Southern Arabia and the Islands of Soqotra (Republic of Yemen) and Kuria Muria /kuːɾjɐ muːɾjɐ/ (now known as Jazirat Al Hallaniyyah /d͡ʒɐziːɾɐt ʔɐl ħɐllɐːnijːɐh/, Sultanate of Oman).

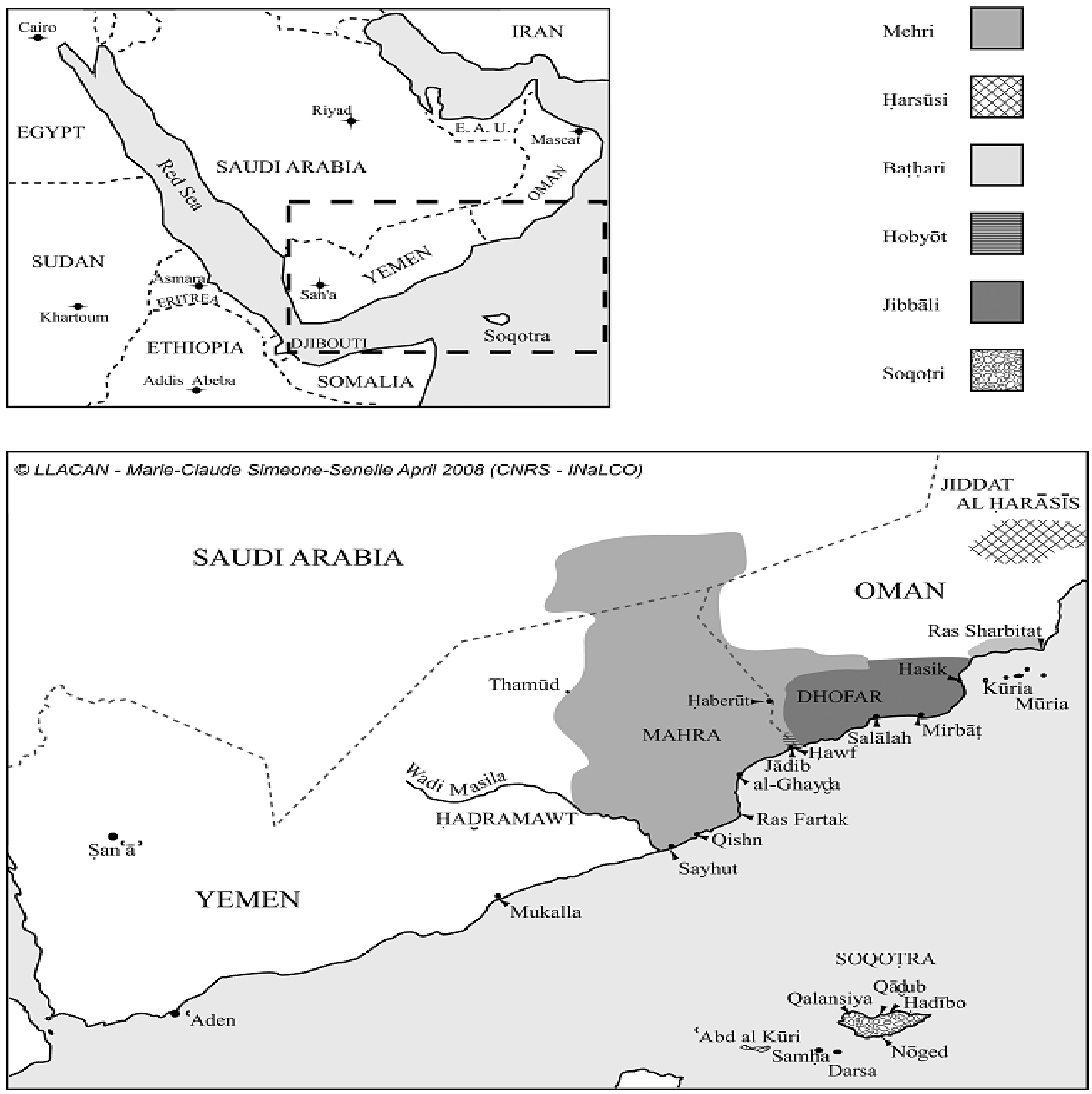

Figure 2.2: Geographical distribution of MSAL (Simeone-Senelle, 2011, p. 1078).

All the MSAL are traditionally unwritten languages and lack alphabets of their own; nonetheless, some speakers nowadays do use the Arabic script in text messaging in MSAL in Oman and Yemen. Since there is a lack of alphabet and systematic education in these languages, there is a general idea among many of the speakers and other citizens in Oman that the MSAL are dialects of Arabic rather than separate languages. Thus, there is an impression of these languages being inferior and not as important as Arabic. From personal encounters with speakers and others, it is clear that the idea of these not being languages stems mainly from the false view that a language must be written.

The sections below 2.2.1 to 2.2.4 provide general overviews of four of the MSAL of Oman, Śḥerɛ̄t, Hobyōt, Baṭḥari and Mehri, while Ḥarsūsi is dealt with in section 2.3.

2.2.1. Śḥerɛ̄t

Among Omanis, Śḥerɛ̄t (also known as Shehri/Shahri or Jibbali) is the most renowned language in Oman among the MSAL branch of Semitic languages. It is spoken in different areas in the governorate of Dhofar /ðˤofɐːɾ/ especially in mountainous towns and villages. It is also spoken in the main city of Salalah /sˤɐlɐːlɐh/ and other coastal towns such as Mirbat /miɾbɐːtˤ/ and Taqah /tˤɐːqɐh/. It can also be found spoken by smaller numbers in the Gulf diaspora (Miranda Morris, personal communication). Simeone-Senelle (1997) mentioned that speakers of Śḥerɛ̄t live in the mountains of Dhofar rearing cows and goats and the coastal villages of Raysut /ɾɐisuːt/, Salalah, Mirbat /miɾbɐːtˤ/, and Sadah /sɐdɐħ/ doing fishing and other jobs. Unlike the other MSAL, it is not the language of one tribe or clan, but rather a language used by different people in the region (Johnstone, 1975). Indeed, many Mehris, and especially those living in areas where Śḥerɛ̄t is spoken, are bilingual in both Mehri and Śḥerɛ̄t. Johnstone (1975) mentioned that some Mehris spoke little Śḥerɛ̄t, some in the mountain area were bilingual in Śḥerɛ̄t and Mehri, and some settled in the coastal area were bilingual in Śḥerɛ̄t and Arabic. Ethnologue estimated the number of its speakers to be 25,000 in 1993 (around 0.85% of current total population)

(Simons & Fennig, 2018). Hofstede (1998) gave a higher number and estimated the number of speakers to be up to 50,000 (around 1.7% of current total population). Other more recent works claimed that native Dhofaris believe that 70% of the inhabitants of Dhofar speak or at least understand Śḥerɛ̄t (Al-Aghbari, 2012). Even though the scholarly works on Śḥerɛ̄t are scarce, compared to Mehri and Soqoṭri, it has been studied in more depth recently, including work by Johnstone (1981); Hofstede (1998); Al-Aghbari (2012); Rubin (2012); Gravina (2014); Rubin (2014, 2015b); Dufour (2017). Moreover, there is an audio-visual repository of the documentation of Śḥerɛ̄t which includes data from Eastern, Western, and Central dialects of Śḥerɛ̄t, in addition to images, transcription, and translations which were deposited by Watson & Morris (2016b).

2.2.2. Hobyōt

Hobyōt was the last MSAL language to be noted and recorded by researchers, and it is arguably the least known MSAL language spoken in Oman. It was discovered in the 1970s by T.M. Johnstone and the first publication on it was in 1981 (Rubin, 2015a). The exact number of its speakers is not known and there are different estimations. Ethnologue estimated there to be a hundred speakers (Around 0.003% of current total population) (Simons & Fennig, 2018), Simeone-Senelle (1997) estimated less than a hundred speakers, Al-Jahdhami (2015) estimated a few hundred, while Rubin (2015a) estimated one or two thousand. Out of these various estimations, I assume that Simeone-Senelle's estimate is closest to the actual situation given that she conducted fieldwork in the area for a long time. A Śḥerɛ̄t speaker (personal acquaintance) from the area said that there were only a few families in Oman that use Hobyōt as their home-language and their numbers are not many (Personal Communication). It is spoken in the governorate of Dhofar in a coastal mountain area and spans the Omani–Yemeni border. It is closely related to both Mehri and Śḥerɛ̄t languages in its structure and some lexemes and this has led some speakers to consider it a hybrid of both these languages (Peterson, 2004). Rubin (2015a) mentioned that there is a lot of interference in Hobyōt from both Mehri or Śḥerɛ̄t which makes it rather difficult to decide what is distinctively Hobyōt and what is interference. Nonetheless, Hobyōt is unintelligible to speakers of both Mehri and Śḥerɛ̄t (Peterson, 2004; The Omani-Encyclopedia, 2013b). Scholarly work on Hobyōt include Arnold (1993); Nakano (2013); Rubin (2015a). In addition, there is an archive of audio files, transcriptions, and translations deposited by Morris (2016a) as part of the Documentation and Ethnolinguistic Analysis of Modern South Arabian project (henceforth DEAMSA) on the Endangered Languages Archive[5] (henceforth ELAR). Morris is currently producing a book of transcribed, translated and annotated texts in Hobyōt.

2.2.3. Baṭḥari

Baṭḥari is spoken by the Al Baṭāḥirah tribe in the coastal areas of Al-Wusta and Dhofar governorates and by small numbers in the Gulf diaspora (Miranda Morris, personal communication). The Omani-Encyclopedia (2013a) mentioned that it is mainly spoken in the towns of Ash Shuwaymiyyah /ʔɐʃːuwɐimijːɐh/, Shalim /ʃeliːm/, Al-Lakbi /ʔɐllɐkbi/, Sharbithat /ʃɐɾbiθɐːt/, Azakhar /ʔɐzzɐːxeɾ/, Sawqirah /sˤɐwqiɾɐh/, and Al Hallaniyyat /ʔɐl ħɐllɐːnijːɐːt/

[5] See See https://www.elararchive.org/

Islands. Gasparini (2018), on the other hand, mentioned that the speakers live in Ash Shuwaymiyyah /ʔɐʃːuwɐimijːɐh/, Shalim /ʃeliːm/, Sharbithat /ʃɐɾbiθɐːt/, Al-Lakbi /ʔɐllɐkbi/, and Sawqirah /sˤɐwqiɾɐh/. Nonetheless, Miranda Morris who has been working in the field since the mid 1970s corrected that it is not spoken in Ash Shuwaymiyyah and Shalim. In addition, it is not spoken in Al Hallaniyyat Islands where they speak Śḥerēt. She added that it is spoken by one speaker in Al-Lakbi who moved there to marry, and spoken by a handful in Sharbithat, Azakhar, and Sawqirah (Miranda Morris, personal communication). Similar to the other MSAL, there are different estimations for the numbers of Baṭḥari speakers. Al-Jahdhami (2015) estimated the number of Baṭḥari speakers is estimated to be around a few hundred which makes it one of the endangered languages in Oman. However, Gasparini (2018) in his recent PhD study on the Phonology and Morphology of Baṭḥari stated that there are less than 15 speakers of Baṭḥari and from a sociolinguistic point of view it could be described to be a moribund language as it is not used in the daily lives of its speakers (Morris, Watson, & Eades, 2019). Gasparini (2018) mentioned that the younger generation has no interest in the language and does not speak it. Based on the most recent work on Baṭḥari, it can be said that it is at an alarming stage of decline and given small speaker numbers, it is obvious that Baṭḥari is the most endangered language of Oman. With regard to its relationships to other MSAL, it is closely related to Mehri and Ḥarsūsi and heavily affected by Arabic in its lexicon. Mutual intelligibility, however, between Baṭḥari and speakers of the other MSAL is not found (Al-Jahdhami, 2015; Gasparini, 2018). Other scholarly work on Baṭḥari and Baṭāḥirah include Walter (1960); Morris (1983). Morris has already produced a substantial archive of audio material on the ELAR archive, collected as part of the DEAMSA (Morris, 2016b). In addition, Morris produced a book of transcribed and translated texts of Baṭḥari (Morris, 2024). At the time of writing this work, I have been informed that Gasparini & Morris are preparing a grammar of Baṭḥari.

2.2.4. Mehri

Mehri is one of the largest MSAL spoken in Oman. The exact number of its speakers is not known, but there are several estimations given by scholars. Some scholars estimated the speakers of Mehri to be around 100,000 speakers (Rubin, 2010; Simeone-Senelle, 2011), while others gave higher numbers of 130,000 speakers (Rubin, 2018) or even up to 160,000 speakers (Watson, 2012). Among the MSAL, Mehri has the largest number of speakers and it is spoken over a wide area stretching from the eastern parts of Yemen from Qishn /qiʃn/ into Dhofar in Oman and up into the southern parts of central Saudi Arabia (Watson, 2012, p. 1). In addition, there are also some migrant Mehri communities in parts of the Gulf and in East Africa (Watson et al., 2020, p. 1). In Oman it is spoken in the governorate of Dhofar in the towns of Shalim /ʃeliːm/, Al-Mazyunah /ʔɐl mɐzjuːnɐh/, Thumrait /θumrɐjt/, and Hasik /ħaːsik/ (Al-Jahdhami, 2015). In Dhofar region, Mehri is also spoken in the mountains and in the Nagd /nɐgd/ area (Janet Watson, personal communication). Within the Semitic language tree, it is grouped together with Ḥarsūsi and Baṭḥari under the same branch (Rubin, 2015a), and lexically, there are a lot of similarities in both of them. Like the other MSAL, it is in close contact with Arabic and marked as a “definitely endangered” language by UNESCO (Moseley, 2010).

Mehri, along with Soqoṭri and Śḥerēt, was one of the first MSAL mentioned in western scholarly works. They were first heard of and brought to the attention of European language experts in the 1830s (Rubin, 2015a). The first grammatical studies of Mehri were by Jahn (1905) and Bittner (1909-1914) (Watson, 2012). Later, in 1987, Johnstone published a lexicon of Mehri. In recent years, a lot of studies have been conducted on Mehri including Johnstone (1970b, 1987); Stroomer (1999); Rubin (2007, 2010); Watson & Bellem (2010); Watson & Al-Azraqi (2011); Watson & Bellem (2011); Watson (2012); Bendjaballah & Ségéral (2014); Ridouane et al. (2015); Watson & Heselwood (2016); Dufour (2017); Rood (2017); Rubin (2018); Watson et al. (2020). Watson & Morris (2016a) deposited a collection of Mehri data on the ELAR archive as part of the DEAMSA project which includes photographs, audio and video materials, transcriptions, and translations of Mehri texts (see References).

2.3. Ḥarsūsi

Ḥarsūsi was noted and recorded by researchers in the late 1920s along with Baṭḥari (Thomas, 1929). It is known among its speakers by the name 'Ḥarsiyet' /ħɐɾsijɐt/ while the word 'Ḥarsūsi' /ħɐɾsuːsi/ is an Arabic word used to refer to both the language and the male speaker of it. Among the people of the language, a single male speaker, or just a member of the tribe, is known as 'Ḥarsi' /ħɐɾsi/. The members of the tribe are known as 'Ḥarāsīs' /ħɐɾɐːsiːs/ in both Arabic and Ḥarsūsi.

2.3.1. Previous Scholarship on Ḥarsūsi

Little is known about the Ḥarsūsi language when compared to Śḥerēt and Mehri. Although it was discovered by western researchers around the 1920s by Thomas Bertram, scholarly works on Ḥarsūsi remain scarce. Since the Ḥarāsīs also live near the Baṭāḥirah (see

2.3.2) in a waterless flat gravel desert, it might be possible that the scholars faced logistical difficulties in working with the Ḥarāsīs.

The first time Ḥarsūsi was ever referred to outside of the Arabian Peninsula in scholarly works was by the work of Thomas (1929) where he provided some ethnographic information about Ḥarsūsi and the Ḥarāsīs, and some other languages of Oman. Later, Thomas (1937) provided a brief grammatical structure of each of Mehri, Ḥarsūsi, Baṭḥari, and Soqoṭri in addition to phrases, sentences, names, and vocabularies. The other scholarly work touching the linguistic structure of Ḥarsūsi is 'Four modern South Arabic languages' by Leslau (1947); however, this work was mainly based on the data collected by Thomas Bertram earlier. After Leslau's work, no other scholarly work was done on Ḥarsūsi until the works of Thomas Johnstone in 1970s. Johnstone's main work on Ḥarsūsi was a Ḥarsūsi-English lexicon published in 1977 which remains the only lexicon available until now. In addition, he also published a few papers on certain grammatical issues in Ḥarsūsi and other MSALs in general. Johnstone's work include Johnstone (1970a, 1970b, 1973). After Johnstone's works, Ḥarsūsi was not seen in print until 2004 when Harry Stroomer, based on Johnstone's materials, published transcribed and translated Ḥarsūsi texts (Stroomer, 2004). Recently, Eades & Morris (2016) created a repository of Ḥarsūsi as an audio and audio-visual documentation of the language under the DEAMSA in the ELAR archive. The deposited material includes photographs, audio and audio-visual data, transcriptions, and translations.

2.3.2. Geographical Distribution and Population

Ḥarsūsi is spoken only in Oman in Al-Wusta governorate at the outskirts of the Arabian Desert 'The Empty Quarter'. The area where the Ḥarāsīs reside in the governorate is known as Jiddat Al-Harasis as seen in Figure 2.2 above. This area was and still is far away from other major cities in other governorates. The nearest city from the north is Adam /ʔadam/ which is 324 kilometres away in Al-Dakhiliyyah /ʔɐdːɐːxilijːɐh/ governorate. From the south, the nearest major town is Thumrait /θumrɐjt/ which is 420 kilometres away and the nearest city is Salalah which is 493 kilometres away in Dhofar governorate. There were no major cities or towns in the area before 1970; therefore, Ḥarsūsi enjoyed isolation to some extent from the other languages spoken in Oman and especially Arabic except for men who contacted surrounding tribes and towns for trade and other needs. However, after 1970, Haima became the centre and the main city in the governorate. Governmental services and buildings were built in Haima along with schools and social-funded houses for the Ḥarāsīs people. (Chatty, 1990) mentioned that the government built a tribal centre in Haima which included a complex of buildings, a water plant, a mosque, a petrol station, and a police station. He added that the availability of petrol and sweet water drew the tribesmen to Haima. Therefore, as time passed, the Ḥarāsīs started to settle down in Haima turning it into the largest populated area in the whole governorate.

Today, Haima is a big city with all the governmental and non-governmental services such as police stations, civil registration services, various ministry offices and services, shops and stores, companies and their offices, petrol stations, and industrial workshops. There is also a large school from grades one to 12 for both girls and boys.

Apart from Haima, Ḥarsūsi is also spoken in a number of smaller towns in the area which were also built and supported by the government through building social-funded houses and providing governmental services in order to help settle the people in central towns. For instance, Ḥarsūsi is spoken in the towns of Al-Ma'ber /ʔɐl mɐʕbɐɾ/, Abu Mudhabi, and Al-Aja'iz /ʔɐl ʕɐgɐːjez/ which are on the main highway east of the city of Haima to the city of Al-Duqm, in addition to Al-Ghubrah Al-Shamaliyah /ʔɐl ʁubɾɐh ʔɐl ʃɐmɐːlijːɐh/ and Al-Ghubrah Al-Janubiyah /ʔɐl ʁubɾɐh ʔɐl d͡ʒɐnuːbijːɐh/ which are farther south on the way to Salalah from Haima (see Figure 2.3 and Figure 2.4 below). Al-Ma'ber is considered a small village compared to the other smaller towns in the area as it has a limited number of houses and only two to three farms with no governmental buildings except a large radio communications antenna centre to the north of the village. Abu Mudhabi, around 50 kilometres from Haima, is a smaller town comprising around 60 government-built houses to help the Ḥarāsīs settle. It has a large school from grades one to 12 for both girls and boys, a petrol station, and a small water treatment plant, but has no health services yet. Al-Aja'iz, on the other hand, is around 110 kilometres east of Haima and is a larger town with more houses, a larger school, two petrol stations, and a small health-centre. The southern towns of Al-Ghubrah Al-Shamiliyah and Al-Ghubrah Al-Janubiyah are 120 and 182 kilometres from Haima, respectively. Al-Ghubrah Al-Janubiyah is a smaller town with around 25 houses and a school. Al-Ghubrah Al-Shamiliyah is a larger town with around 50 houses, a petrol station, a school, a health centre, and a few shops.

Apart from the area of Jiddat Al-Harasis and its towns, some Ḥarāsīs are settled in Al-Ghaydharanah /ʔɐl ʁɐiðˤɐɾɐːnɐh/ which is more than 300 kilometres north of Haima in Al-Dakhiliyyah governorate near Adam /ʔadam/. According to the Ḥarāsīs, people in the town of

Al-Ghaydharanah mostly use Arabic and many of the young generation are passive users of Ḥarsūsi.

Figure 2.3 below shows the area where Ḥarsūsi is spoken in Oman in general and Figure 2.4 gives a closer look of the position of the city of Haima and the other towns and villages described above.

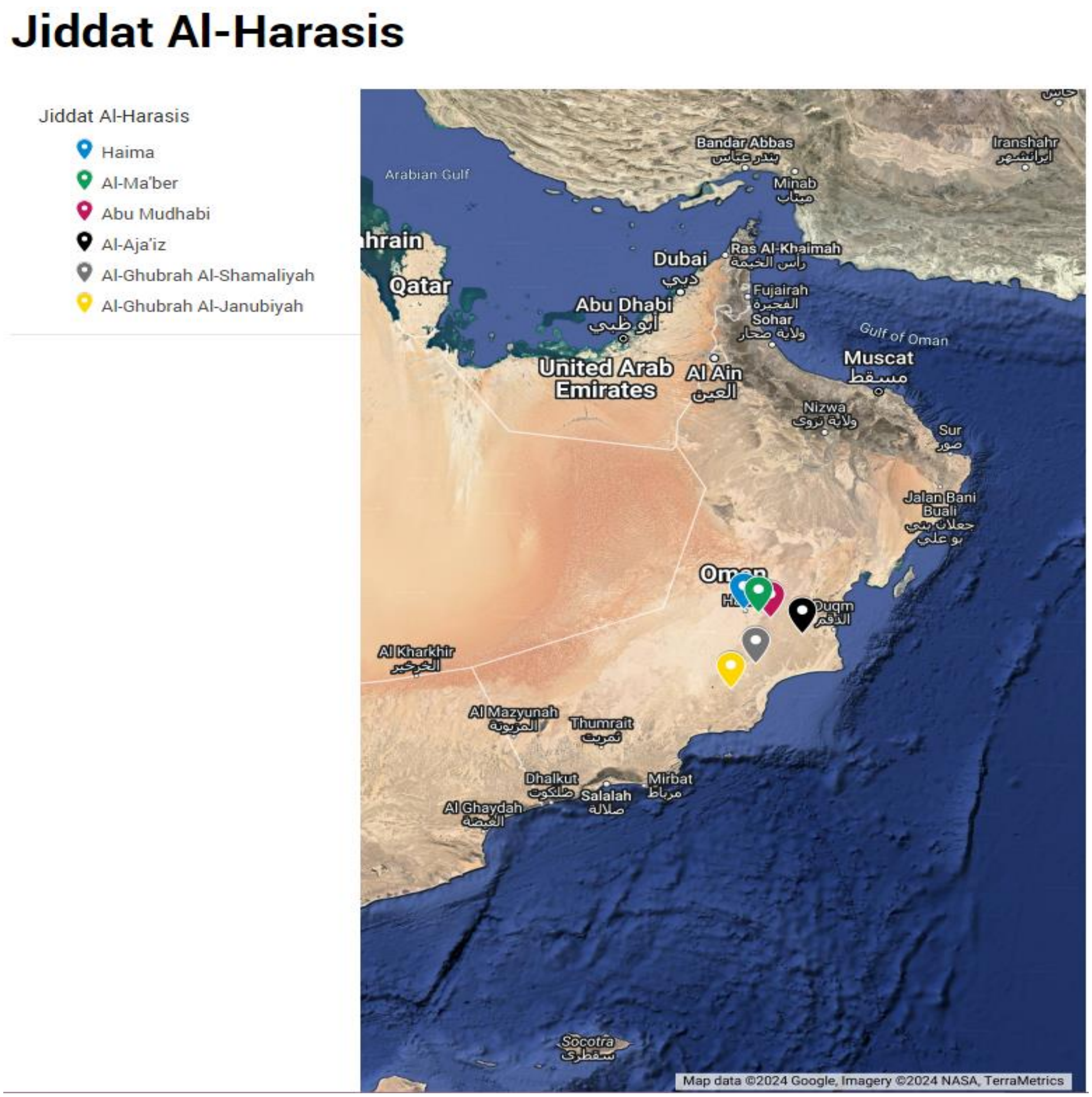

Figure 2.3: The area of Jiddat Al-Harasis (Google, n.d.).

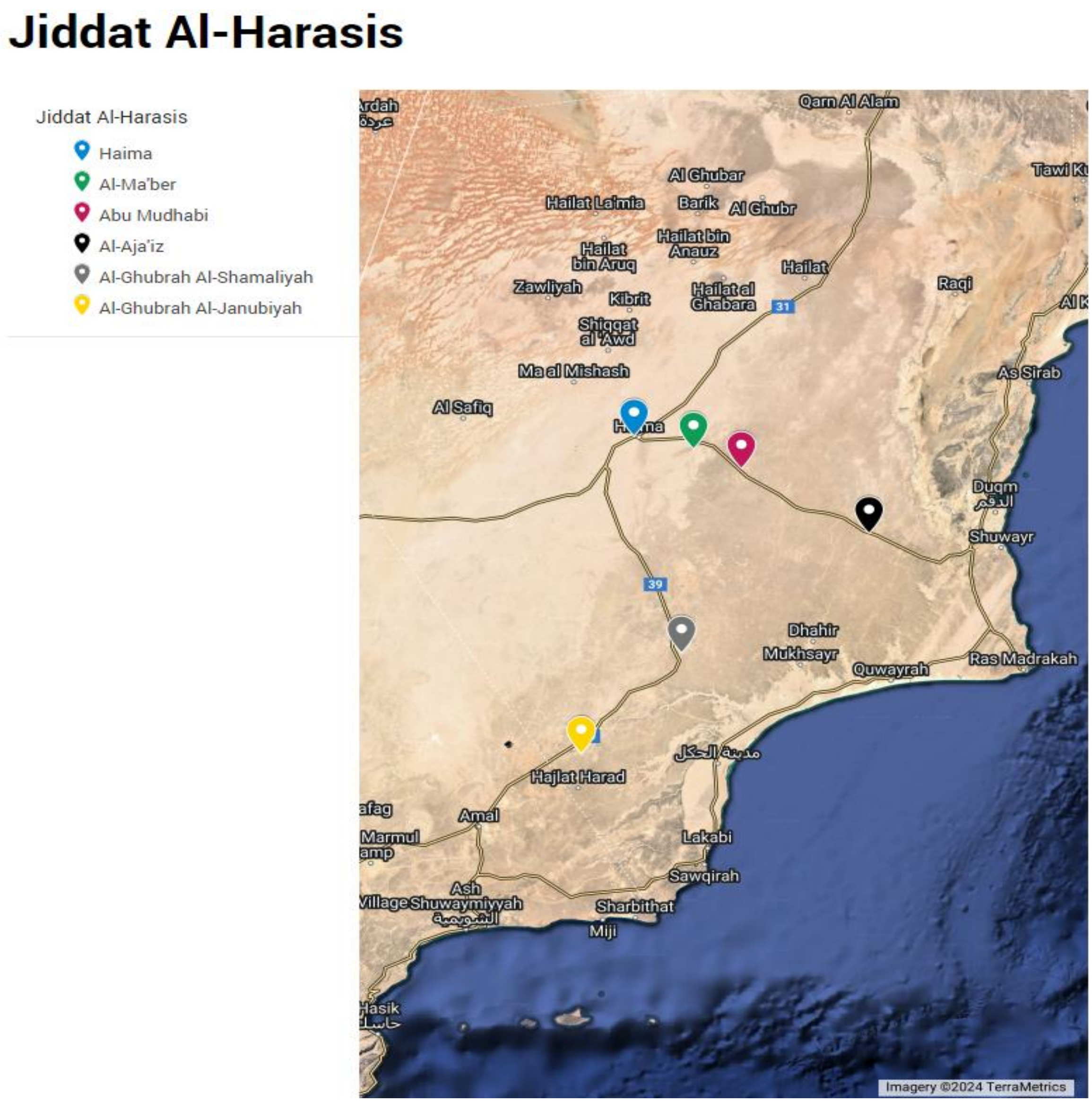

Figure 2.4: A closer look at Ḥarsūsi speaking towns and villages (Google, n.d.).

The exact number of Ḥarsūsi speakers is not known, but several estimations have been proposed at different times by different sources. The earlifiest estimations of the number of Ḥarāsīs gave very small numbers. The earliest works on Ḥarsūsi mentioned not more than 200 men by then (Thomas, 1929). After 48 years since the first estimation was given, Johnstone

(1977) mentioned around 600 in total, followed by Swiggers (1981) with not less than 1000 men. More recent scholarly works provide higher numbers, however. Some sources stated that the Ḥarāsīs are a tribe of about 3000 people (Chatty, 2002), while UNESCO said they are around 3500-4000 people (Moseley, 2010). The most recent estimation, however, is given by Al-Jahdhami (2015) who stated the Ḥarāsīs to be a few thousand speakers without providing any specific numbers. The exact number of Ḥarsūsi speakers is not known as there are no official or governmental sources in this regard. Moreover, all the previous estimations given by various scholars do not specify whether figures related to speakers of Ḥarsūsi or just members of the Ḥarsūsi tribe regardless of whether they are speakers of the language or not. Currently, and based on information from a revered official Ḥarsūsi tribal chief, the number of Ḥarāsīs is estimated to be around 6000 people (around 0.2% of current total population). This number is of all the Ḥarāsīs settled in various different towns in Jiddat Al-Harasis as well as in other Governorates. It is unknown how many of these are monolingual in Arabic and how many are passive users of Ḥarsūsi. Nonetheless, based on personal experience in the areas where Ḥarsūsi is spoken, only two people were found who were passive users of Ḥarsūsi who were residing in Al-Ghaydharanah in Al-Dakhiliyyah governorate. Moreover, no Ḥarāsīs monolinguals in Arabic were found in these areas except for two young boys who were on a visit to Jiddat Al-Harasis with their family and are settled in the United Arab Emirates.

2.3.3. People, Environment, and Lifestyle

The Ḥarāsīs refer to themselves as Badū Ḥarāsīs. They are not a very big tribe compared to the other Bedouin tribes around them such as the Janabah /d͡ʒanabah/ and Wehaibi /wehajbi/.

They have one chief sheikh for the whole tribe and other non-chief sheikhs for the different families who comprise the tribe. The Ḥarāsīs possess a sense of pride. Until today, they narrate to their younger generation stories of fights and wars with other tribes and hardships their ancestors went through. Stories of other tribes' attacks to loot the Ḥarāsīs' herds of camels and goats and the Ḥarāsīs' fights to bring their herds are very common. Thomas (1929) mentioned that the Ḥarāsīs are "a tribe with noble traditions" (p. 100). In addition, Johnstone (1977) stated "…there is no feeling of inferiority in Ḥarāsīs…" and "…Ḥarāsīs are of high social status…" (p. xi). Indeed, this sense of non-inferiority and high status is still evident in how the Ḥarāsīs talk about their tribe and how they explain the naming of the area they live in today, Jiddat al-Harasis. According to some Ḥarāsīs consultants, the area is named after their tribe because they were, are, and will be the protectors and are the only people able to survive in it. This sense of nobleness and non-inferiority is also evident in their tales of taking revenge on rival tribes in the old times. The Ḥarāsīs also say that no other tribes or rulers were able to have control over them or their territory since they were scattered across a vast waterless geographical terrain which made invasions for full control almost impossible.

As mentioned in sections 1 and 2.3.2, Jiddat Al-Harasis is almost a plain gravel land with very limited vegetation and water sources. In certain areas, and especially where the limited amount of rainwater flows and gathers (called /heglɐt/ 'lower ground F.SG' by Ḥarāsīs), a limited number of bushes and some acacia trees seen. Chatty (1990) mentioned that the vegetation cover of the area of the Jiddat Al-Harasis is determined by the amount of rainfall and the moisture available from the fogs. The climate is very dry and sunny throughout the year as the chances of rain are very low except during the winter when temperatures drop, and the area gets some limited rain. During the summer, humidity levels rise as a result of clouds rolling up from the sea and moving towards the Al-Huqf /ʔal-ħuqf/ escarpment creating dew over the limited vegetation in the area. This dew has been of key importance for both the people and the livestock. According to consultants, the process of dew collection was one source for sweet water in old times as they used to go in the early mornings and collect the dew formed on the leaves of the available vegetation using a cloth and rinsing it into a container. During the summer between the months of June, July, and August, temperatures can reach up to 48 and 49 Celsius during the day. Similar to the vegetation, wild animals are also limited in number and multiple species are facing extinction, some of which are part of a governmental conservation programme. These include desert hares, desert foxes, oryx, and Arabian gazelle. A number of these animals and certain types of birds can be found in the area of Al-Wusta Wildlife Reserve which is run and guarded by the Office for Conservation of the Environment under the Diwan of the Royal Court.

The Ḥarāsīs are mobile pastoral herders. In the past, they used to move from one place to another within Jiddat Al-Harasis based on the availability of grazing resources for their herds. According to the Ḥarāsīs, water was very scarce; thus, the primary cause of movement was search for grazing areas for the herds. They also say that they used to live on the milk their herds provided instead of water. There were a few watering areas at far places, but they were mainly used to water the herds at long intervals, and the water brought from these areas was used minimally. Being mobile pastoral herders in the desert, the Ḥarāsīs' herds consist mainly of camels and goats. The Ḥarāsīs have a very rich culture in camel husbandry and it holds a dear and important place in their life.

Today, the Ḥarāsīs live in towns and cities with all the amenities of modern life; however, they still practice their old lifestyle and move their herds from one place to another where grazing is available. Every household owns its own /ʕozbɐ/ which is an encampment to keep their camels and goats. These encampments, and especially the ones far from their houses, are looked after by South Asian workers who only feed and water the herds while the Ḥarāsīs take care of all other things needed such as selling, treating, and mating. Camel races and camel beauty contests are very important to the Ḥarāsīs and they try to take part in all such contests whether nationally or internationally in other Gulf countries. According to a Ḥarsūsi consultant, taking care of camels and taking part in such contests costs a lot of money with very little financial reward, yet they love to do it because it is a way of maintaining their life and tradition.

The Ḥarāsīs had a very limited diet in the past, consisting of dates brought from other areas in the north, milk from their camels and goats, and meat from their own herds and other animals they could hunt in the desert. Rice, wheat, and fish dried and fresh were rare commodities they had from time to time. In order to get dates, rice, and other products, the Ḥarāsīs had to go on their camels on month-long journeys to either Ibri /ʕibɾi/ in Al-Dhahirah /ʔɐ ðˤɐːhiɾɐh/ governorate or Nizwa in Al-Dakhiliyyah governorate. Today, rice has become a main meal in the Ḥarāsīs' diet, while dates are eaten only with coffee and they are not considered as a meal. Camel milk is still cherished by the Ḥarāsīs and they consider it of higher value than goat milk.

2.3.4. Ḥarsūsi Endangerment

The earliest predictions about the future of Ḥarsūsi were not very promising. Johnstone (1977) asserted that "the social pressures on Ḥarsūsi are very considerable, and it is difficult to believe that it can survive long in an ocean of Arabic" (p. x). Swiggers (1981) assumed that Ḥarsūsi would be replaced by Arabic within a few generations since it is surrounded by it. However, fieldwork in the area shows that Ḥarsūsi is still spoken by a few thousands in its native environment including by the younger generation. Most Ḥarāsīs children, at least those in the Jiddat al-Harasis, start learning Ḥarsūsi at home as their mother-tongue before joining school at the age of around five years.

Although it is spoken and learned by the younger generation at home, UNESCO labels it as a "definitely endangered" language (Moseley, 2010), while Ethnologue labels it as a "shifting language" (Simons & Fennig, 2018). These labels seem appropriate by taking into consideration the influence of Arabic on Ḥarsūsi today. Ḥarsūsi is not only surrounded by Arabic, but it can be said that its territory, Jiddat al-Harasis, has been invaded by Arabic since the introduction of modern schooling in the early 1980s. Johnstone (1977) mentioned that the Ḥarāsīs men were exposed to more Arabic in oil camps where they worked, while the women were "…quite often monoglot or practically so." (pp. x – xi). However, today all of the Ḥarāsīs are exposed to Arabic in their own communities with the introduction of modern schooling and other governmental services. Based on personal experience in the area and information from the consultants, it can be said that practically all the Ḥarāsīs in the area of Jiddat Al-Harasis are bilingual in Arabic and Ḥarsūsi today. Some of the younger generations are trilingual with some basic command of English as a result of modern education. The school in the town of Abu Mudhabi even includes a governmental kindergarten that provides pre-school programmes for children before being enrolled in grade one once they are six years old. As a result of such programmes, the Ḥarāsīs today are exposed to multiple languages early on.

“It is apparent, and can be quite clearly seen from the lexicon itself, that Ḥarsūsi is much more influenced by Arabic than is Mehri.” (Johnstone, 1977, p. xi). This influence today is much more evident in the number of Arabic words that made their way into the Ḥarsūsi lexicon. A lot of Ḥarsūsi words today are replaced by other Arabic words and especially by the younger generation. Many of the consultants in the elicitation sessions were not able to provide Ḥarsūsi words for certain items and further consultations were needed. Moreover, some Ḥarāsīs did not even know or recognise certain lexicon items from the Ḥarsūsi lexicon which was written by Johnstone in 1977. In addition, some of the Ḥarāsīs themselves claimed that they do not speak the ‘pure’ Ḥarsūsi anymore and that it is much more simplified today than it used to be. For instance, it took me days of consultation to get the Ḥarsūsi equivalent for the word ‘egg’. None of the younger male consultants was able to provide the word /bek’ˈleːt/ - [bəkˤ.ˈleːt̪ʰ] ‘egg F.SG’ which was learned from an older woman in one of the visits to a desert encampment. Similarly, when asked for an equivalent of the word ‘hose’ almost all the consultants provided either /hoːz/ or /beːp/ which are borrowed from English ‘hose’ and ‘pipe’ except one older consultant who after much thinking provided /ˈk’eɾd/ - [ˈk’eɾt̪] ‘trachea M.SG’ which he said was used in older times and many stopped using it now. In addition, one of my consultant’s sons, a young 9-year-old boy, was able to count from one to ten in both Arabic and English without difficulty, but was not able to do so in Ḥarsūsi without being reminded.

All the observations from the field suggest that Ḥarsūsi is endangered by shifting/changing and losing its own linguistic characteristics as it gets influenced more and more by Arabic. It should be mentioned here, however, that despite being affected more heavily by Arabic for decades now, Ḥarsūsi still survived despite the early expectations of its extinction. In addition, the survival of Ḥarsūsi to its current state is probably due to the lifestyle of the Ḥarāsīs people, the self-pride the Ḥarāsīs possess towards themselves and their culture, and the geographical isolation they enjoy to some extent in the Omani desert area of Jiddat al-Harasis.

2.4. Emphatics in Semitic

The Semitic languages are known to have two classes of consonants where one class has a double articulation. They share the same front place of articulation and differ in that one class has another back place of articulation at the back of the oral cavity or lower down in the pharynx. The class with this back place of articulation is known as emphatic. It should be noted that the term emphatic is an encompassing term that covers the sounds in Semitic languages with a back place of articulation, however, the exact place of this back articulation and its nature differ from one language to another ((Kingston, 1985; Bin-Muqbil, 2006; Bellem, 2007; Jongman, Herd, Al-Masri, Sereno, & Combest, 2011; Gallagher & Whang, 2014). Therefore, the emphatic sounds are known to be either ejectives or 'backed' consonants (Bellem, 2007).

Several different definitions were given in the literature on Semitic languages for this class of sounds, but one of the definitions of emphatics is provided by Lehn (1963):

> Emphasis is the cooccurrence of the first and one or more others of the following articulatory features: (1) slight retraction, lateral spreading, and concavity of the tongue and raising of its back (more or less to what has been called velarization), (2) faucal and pharyngeal constriction (pharyngealization), (3) slight lip protrusion or rounding (labialization), and (4) increased tension of the entire oral and pharyngeal musculature resulting in the emphatics being noticeably more fortis than the plain segments. (pp. 30-31)

With regard to the articulation, both ejectives and 'backed' sounds are articulated by employing more than one articulatory gesture. According to Ladefoged & Maddieson (1996) there is a difference in traditional phonetics based on a scale of strictures; closure, narrow approximation, and open approximation, between segments produced with double articulations and segments with secondary articulations (p. 328). Segments articulated with two simultaneous articulations of same degree of stricture are called doubly articulated, while segments articulated with two simultaneous articulations of different degrees of stricture are labelled as having a primary and a secondary place of articulation where primary is labelled for the greater degree of stricture (Ladefoged & Maddieson, 1996). The ejectives are articulated by having two constrictions which are at the level of the oral cavity and the level of the larynx (see 2.4.1). On the other hand, the 'backed' sounds are articulated by having a constriction at the level of the oral cavity and a simultaneous retraction of the tongue towards the posterior wall of the pharynx (Ghazeli, 1977; Giannini & Pettorino, 1982; Laufer & Baer, 1988; F. Al-Tamimi, Alzoubi, &

Tarawnah, 2009). Therefore, they are known to have a primary place of articulation and another secondary place of articulation.

It should be noted here, however, that Esling, Moisik, Benner, and Crevier-Buchman (2019) proposed a new model for the articulation of sounds such as pharyngeal, epiglottal, pharyngealisation and epiglottalisation effects, laryngealisation, glottalisation, and an array of lower-vocal-tract volume effects. Esling et al. (2019) 'Laryngeal Articulator Model' views the pharynx as an active articulator with a main role in the articulation of sounds (p. 4). The model proposes that sounds such as pharyngeals, epiglottals, epiglottalisation effect, laryngealisation, glottalisation, and any other involving lower vocal tract volume effects are produced by the aryepiglottic constrictor mechanism in addition to tongue retraction and larynx raising (Esling et al., 2019, p. 5). Such a mechanism of the aryepiglottic constrictor and tongue retraction change the shape of the lower vocal tract and create new points of vibration (Esling et al., 2019). This proposed model does not look at the tongue as the main articulator and the larynx as a passive articulator in the articulation of pharyngeal sounds, it rather looks at the lower part of the vocal tract as an articulator comparable to the tongue in the oral vocal tract. Following this model, (J. Al-Tamimi, 2017) investigated a number of acoustic correlates of pharyngealisation in Jordanian and Moroccan Arabic and concluded that the realisation of pharyngealised sounds involves a constriction much lower in the pharynx, an epiglottis retraction, and a raising of the larynx which results in a creaky voice quality (p. 26).

With regard to the origin of emphatic sounds in Semitic, researchers have proposed different theories about the origin and spread of emphatic sounds among Semitic languages. Martinet (1953), Cantineau (1960), and Dolgopolsky (1977) as cited in Bellem (2007) take the view that the emphatics in Semitic were originally ejectives and developed into other types in some languages. On the other hand, a contrasting view is adopted by Leslau (1957) and Ullendorff (1955) as cited in Bellem (2007) that assumes the proto-semitic emphatics to have been as found in Arabic, such as pharyngealised/uvularised. However, Bellem (2007) stated that the supporters of the view that assumes the emphatics to have been different than ejectives originally are those who believe the Semitic languages spread from Arabia into the Horn of Africa.

Bellem (2007) mentioned arguments supporting the view of the origin of Semitic emphatics as ejectives. The view that emphatics in Semitic were ejective is backed by the fact that there is strong evidence derived from the works on Afro-Asiatic languages that Semitic spread into Arabia from the Horn of Africa, and it is those languages of the Horn of Africa that have ejectives as their class of emphatics (Bellem, 2007, pp. 150-151). In addition, when looking at the Semitic languages within the context of Afro-Asiatic, it can be found that the glottalics[6] are found in most of the sound systems except Berber which has ‘backed’ emphatics, and given that Berber emphatics have not been historically borrowed from Arabic, it is logical to conclude that the Semitic emphatics were ejectives and the ‘backed’ emphatics, as found in Arabic, are a later development (Bellem, 2007, p. 151). Furthermore, from a typological perspective, ejectives are more common cross-linguistically than ‘backed’ consonants as they are found in up to 20% of the world’s languages, making them the fourth most common type of stop (Bellem, 2007, p. 151). Based on the arguments mentioned in Bellem (2007), and the fact that ejective emphatics are also found in some MSAL in Arabia such as Mehri (Watson & Bellem, 2010, 2011; Watson

[6] Glottalics is a general term that includes ejectives and other types of sounds produced with a glottalic air stream.

& Heselwood, 2016) and Baṭḥari (Gasparini, 2017), it is reasonable to assume the emphatics in Semitic were ejectives.

Given the origin and the later developments of emphatics, today they are realised differently in various Semitic languages and their dialects. They are either realised as ejectives as in Ethio-Semitic languages (Demolin, 2004; Seid, 2011; Shosted & Rose, 2011), or as pharyngealised sounds as in Arabic and Hebrew (Giannini & Pettorino, 1982; Laufer & Baer, 1988; Al-Solami, 2013). Recent works have shown that some Semitic languages include both types of these emphatics in their class of emphatics. For instance, it has been found that the group of emphatics in MSAL Mehri and Baṭḥari include both ejectives and 'backed' sounds (Watson & Bellem, 2010, 2011; Watson & Heselwood, 2016; Gasparini, 2017). In Mehri, Bellem & Watson (2014) showed that the phonological context plays a large role in the nature of emphatics. A similar mixed system was also found in Baṭḥari (Gasparini, 2017, 2018) where the occurrence of these types of sounds is context dependent. For instance, the velar emphatic /ḳ/[7], as transcribed in Gasparini (2017), was found to be glottalised in most contexts, while the alveolar emphatic /ṭ/, as transcribed in Gasparini (2017), was only pharyngealised in intervocalic position. Other studies on emphatics in dialects of Arabic and Mehri include Watson & Asiri (2007); Watson & Al-Azraqi (2011); Ridouane et al. (2015).

Apart from emphatics being ejectives or 'backed' in different languages and dialects, various studies on Arabic dialects and other languages showed an acoustic effect of emphatics on surrounding sounds. Several studies found a co-articulation influence on vowels adjacent to emphatics (Ghazeli, 1977; Watson, 1999; Bin-Muqbil, 2006; Embarki, Yeou, Guilleminot, & Al

[7] A dot under the phoneme symbol as in /ḳ/ is notation widely followed in Semitic linguistics.

Maqtari, 2007; Jongman et al., 2011; J. Al-Tamimi, 2015). The studies have found that in the presence of a ‘backed’ emphatic sound compared to a non-emphatic sound, the F1 for the adjacent vowel is usually higher and the F2 is lower (Zawaydeh, 1999; Shar & Ingram, 2010; Jongman et al., 2011; J. Al-Tamimi, 2017).

Ḥarsūsi also makes a distinction between plain consonants and emphatics; however, information on these sounds is scarce since Ḥarsūsi is one of the least studied languages among the MSAL. There are no acoustic studies thus far that investigate the nature of emphatics in Ḥarsūsi and their effect on surrounding sounds.

In the sections 2.4.1 and 2.4.4 below, ejective and ‘backed’ emphatic sounds are discussed. In section 2.4.4, the effect of emphatics on surrounding vowels is discussed.

2.4.1. Ejectives

The ejective sounds are one type of the sounds known as glottalics. The glottalics are consonants which are produced with a glottalic airstream mechanism (Maddieson & Disner, 1984, p. 99). They involve two constrictions, one at the oral cavity level and another at the level of the larynx. According to Maddieson (2013), glottalic sounds are produced either with a constriction of the vocal folds, an upward or downward short distance movement of the larynx, or both. The glottalics that involve a downward movement of the larynx are known as implosives, while the ones that involve an upward movement are known as ejectives (Maddieson & Disner, 1984; Maddieson, 2013). In addition, Maddieson (2013) adds a third type of glottalic sounds termed ‘glottalised resonants’ which can be produced with a constriction of the vocal folds which modifies or interrupts the normal voicing. Among these different types of glottalic sounds, ejectives are the most widespread both genetically and geographically (Maddieson & Disner, 1984, p. 100). Nonetheless, this prevalence is mainly for ejective stops and not ejective fricatives. Henton, Ladefoged, and Maddieson (1992) stated that the ejectives are the fourth most common stop type among the world's languages (p. 91). Maddieson & Disner (1984) mentioned that out of 317 languages included in UCLA Phonological Segment Inventory Database (UPSID), 52 languages contain ejectives, which is around 16.4%. Fallon (1998) stated that another version of the UCLA Phonological Segment Inventory Database (UPSID) (1992) contained 69 languages with ejectives out of a sample of 417 languages, which is around 16.5%. Another estimation is given by Warner who stated the ejectives occur in approximately 16% of the world's languages (Warner, 1996, p. 1525). On the other hand, ejective fricatives were found only in 10 languages out of 317 languages (3.2%) in the UCLA Phonological Segment Inventory Database (UPSID) (Maddieson & Disner, 1984, p. 109). In addition, the implosive type of glottalics is found in fewer languages and are more limited geographically than ejectives (Maddieson & Disner, 1984, p. 101), and they are found in 10.1% of the languages included in the UCLA Phonological Segment Inventory Database (UPSID) (Maddieson & Disner, 1984, p. 111).

In terms of the articulation process of ejectives, Bellem (2007) stated that ejectives are articulated by having two co-occurring constrictions which are at the larynx and at some other point of the supra-laryngeal tract. Warner (1996) said that the ejective stops were different than other pulmonic stops in terms of articulation as they are articulated with an oral closure while simultaneously closing the glottis and moving the larynx upward. The constriction at the larynx stops air from the lungs, and the upward movement of the larynx compresses the air available between the two constrictions, which rushes out quickly at the release of the supra-laryngeal constriction (Ladefoged & Maddieson, 1996; Warner, 1996; Bellem, 2007; Seid, Rajendran, & Yegnanarayana, 2009). Given this articulatory process, it could be said that the ejectives are doubly articulated segments since they have two constrictions of equal degree of stricture (Ladefoged & Maddieson, 1996, p. 328).

With regard to place of articulation, the velar and the alveolar places of articulation are preferred, and the presence of an alveolar ejective in a language implies the presence of a velar ejective (Maddieson & Disner, 1984). Moreover, among the languages analysed, Maddieson & Disner (1984) found that the presence of a bilabial ejective in a language implies the presence of a velar ejective (p. 103).

The release of ejective sounds can be either strong or weak, and this depends on a number of factors including the time of the glottal release in relation to the supra-glottal release and the place of the supra-glottal constriction. Kingston (1985, pp. 16-17) stated that the variation found within ejectives is the timing between the oral and glottal releases. According to Kingston (1985), the glottal closure may be released along with the oral release, soon after the oral release, or significantly delayed, and there is an impression that ejectives with simultaneous oral and glottal releases are weaker than those where the glottal release is delayed after the oral release (p. 17). Bellem (2007) mentioned that the ejectives in which the glottal and oral releases are simultaneous are weaker than those in which the glottal release is delayed. Strong ejectives are the result of glottal closure release preceding the release of the supra-glottal gesture, while weak ejectives result from the glottal closure release being simultaneous with the supra-glottal release (Bellem, 2007; Gallagher & Whang, 2014, p. 135). Another factor that seems to play a role in the forcefulness of ejectives is the distance between the place of constriction in the supra-glottal tract and the glottal constriction: the shorter the distance between both constrictions, the stronger the realisation of the ejective sound. Watson & Bellem (2011) and Watson & Heselwood (2016) found that, in Mehri, the ejective burst of the velar stop is stronger than that of the coronal stop since the air pressure in the oropharyngeal cavity is greater in case of the velar.

2.4.2. Ejectives in MSAL

As pointed out by Bellem & Watson (2014), the first mention of emphatics in MSAL being ejective, produced with an egressive glottalic airstream, was by Fresnel (1838) where he described the emphatics in Śḥerɛ̄t 'Jibbali' as ejectives. Nonetheless, this view was not followed up until Johnstone in 1970s described them, based on his fieldwork in Oman, as "glottalised consonants" in his works (Bellem & Watson, 2014). Johnstone mentioned the realisation of glottalised (ejective) emphatics in MSAL is not as strong as in some Ethio-Semitic languages such as Amharic, and that the degree of glottalisation varies depending on a number of factors, such as the phonological context (Johnstone, 1975, p. 98).

More recent works on MSAL provide different observations with regard to the emphatics. Some works observed that emphatics in MSAL are glottalised consonants as Johnstone found, while others observed that not all emphatics in MSAL are glottalised consonants. Simeone-Senelle (1997) mentioned that the emphatics in MSAL are not velarised as in Arabic, but "post-glottalised" ejectives as in Ethiopian languages, and that the degree of glottalisation varies depending on the phonological context of the consonant and dialect (p. 381).

Similarly, in an instrumental study based on acoustic data in Mehri, Ridouane & Gendrot (2017) mentioned that the emphatic fricatives in Mehri were typically ejectives. Other studies stated the Mehri emphatics to be of a mixed system including both ejective and backed segments where they could be realised as ejectives in certain positions (Watson & Bellem, 2010; Bellem & Watson, 2014). Furthermore, Gasparini (2017) mentioned that Baṭḥari includes both ejective and pharyngealised emphatics where only the velar stop could be realised as an ejective in most positions (p. 77).

In Ḥarsūsi, the emphatics were first described as glottalised by Johnstone (1977, p. xii). He mentioned that all the emphatics were post-glottalised, while the emphatic interdental /ðˤ/ was pre-glottalised. In addition, glottalisation was found to be weak in positions other than initial and final (Johnstone, 1977, p. xii). Following Johnstone, Swiggers (1981) presented a similar view. He stated that all the emphatics in Ḥarsūsi are glottalised especially in initial and final position (Swiggers, 1981). He further added that there are two types of glottalisation in complementary distribution in Ḥarsūsi: pre-glottalisation which he referred to as "implosive realisation" and post-glottalisation which he referred to as "ejective realisation" (Swiggers, 1981, p. 361). According to Swiggers (1981), post-glottalisation in Ḥarsūsi occurs with all the voiceless emphatics, while pre-glottalisation occurs with the only emphatic /ðˤ/, which he transcribed as /ḍ/ (p. 361). After Swiggers, the realisation of Ḥarsūsi emphatics was not referred to in detail or dealt with from an instrumental phonetic point of view up until now.

2.4.3. Acoustic Parameters of Ejective Stops

The acoustic characteristics of ejective sounds can vary cross-linguistically (Bellem, 2007; Gasparini, 2017). Various works on ejectives in different languages showed that there is a considerable acoustic and articulatory variation among sounds labelled 'ejective stops' in descriptive work. Nonetheless, there are a number of criteria proposed to distinguish between ejective stops and other plain counterparts in languages in which they occur. A number of studies showed that ejective stops can be distinguished from their plain voiceless counterparts in terms of VOT, visible glottal release and spike typical of glottalic pressure, closure duration, and presence of creaky voice on the following vowel (Hajek & Stevens, 2005; Gordon & Applebaum, 2006; Seid et al., 2009; Watson & Bellem, 2010; Gallagher & Whang, 2014; Gasparini, 2017; Ridouane & Gendrot, 2017).

VOT is the amount of time between the release of a consonant and the onset of voicing (Holton, 2001, p. 408). Fallon (1998) mentioned that Catford (1983) defined VOT in ejectives as the time-lag between the oral release and the onset of glottal vibrations, and that ejectives vary greatly in terms of their VOT (p. 387). Indeed, a number of studies found different results with regard to the VOT of ejective sounds. In Cochabamba Quechua, spoken in Peru, Gallagher & Whang (2014) found that the ejectives were characterised by a long VOT. Similarly, “languages such as the Navajo coronals (108 ms; McDonough and Ladefoged 1993) and Bzhedug (114 ms; Catford 1992:194-5)” (Fallon, 1998, p. 388) have long VOTs. On the other hand, in Waima’a, an Austronesian language spoken in East Timor, Hajek & Stevens (2005) found that the ejectives had an intermediate VOT between aspirated and unaspirated voiceless stops. In Amharic, the VOT for the ejective stop sounds was significantly shorter compared to their “unvoiced” counterparts (Seid et al., 2009, p. 2289). Other languages with short VOTs include Hunzib, Ingush, Pocomchi, and others as reported in Fallon (1998, p. 388).

VOT can also be used in distinguishing between strong and weak ejective sounds. Lower pressure in the oral cavity produces less intense burst for ejectives and the VOT is generally shorter (Fallon, 1998, p. 392). Therefore, higher pressure would probably produce more intense burst for ejectives and the VOT would be longer. Indeed, Hajek & Stevens (2005) stated that increased VOT value is associated with strong ejectives. By contrast, when the pressure in the oral cavity for producing an ejective is less, the burst of the ejective is weaker, and the VOT is shorter (Fallon, 1998, p. 392). However, it should be noted here that in cases of 'post-glottalisation' the VOT can be longer as well since the glottal closure duration is longer.

The contrasting results on VOT show that the ejectives do not behave in a similar manner in all languages. Some ejectives have long VOT of over 100 ms, while others have very short VOT which matches that of voiced stops (Fallon, 1998, p. 388). Nonetheless, the varying VOT measures reported for the different languages show that they behave differently than their plain counterparts in various languages, and VOT can be a good cue to capture the difference between ejectives and their plain counterparts. In the MSAL Baṭḥari, for instance, the emphatics were found to differ clearly in terms of VOT from their plain counterparts as they had higher VOT values (Gasparini, 2017, p. 77).

The visible glottal release and spike typical of glottalic pressure in the waveforms has been found to be a helpful criterion in distinguishing ejectives from plain stops. Gasparini (2017) mentioned that the ejective burst was clearly visible in the waveforms which was a cue for the glottalisation of Baṭḥari /ḳ/ and /ṭ/, as transcribed in Gasparini (2017), in some environments. For example, the data of three of the four speakers included in the study showed that the emphatic velar /ḳ/ was glottalised in initial and intervocalic positions in Baṭḥari as the ejective burst was visible in the waveform (Gasparini, 2017, p. 77). Watson & Bellem (2010) found that in Mehri the emphatic /ḳ/, as transcribed by Watson & Bellem (2010), oral release showed a sharp spike in the waveform which is typical of glottalic initiation. In Waima'a, a visible oral release which was followed by a weaker glottal release accompanied the articulation of ejective sounds (Hajek & Stevens, 2005, p. 2890). It should be noted, however, that in Waima'a the release of the glottal closure in the waveforms or spectrograms was not always distinguishable from the onset of voicing in all tokens analysed (Hajek & Stevens, 2005, p. 2890). Ridouane & Buech (2022) found that the ejective stops in Mehri were characterised with silent lags after the oral release, but these lags were found mainly in the productions of two speakers out of their seven (p. 3435).

Another cue for ejective sounds which has been found in some languages is the presence of creaky voice on the following vowel segment (Bellem, 2007).The presence of the creaky voice is the result of the glottis state change from complete closure to normal phonation (Seid et al., 2009). Esling et al. (2019) stated that a prominent feature of creaky voice is the action of the aryepiglottic constrictor, and that creakiness is characterised by an extreme degree of constriction in the larynx (p. 65). They added that the connection between aryepiglottic action and the production of glottal stop, pharyngeal, and epiglottal articulations is associated with creaky voice since it is observed preceding or following glottal arrest (glottalisation) in speech (Esling et al., 2019, p. 65). Creaky voice as a cue for glottalization was found in Waima'a (Hajek & Stevens, 2005), Amharic (Seid et al., 2009), and Navaho (Monaka, 2001). In addition, Ridouane & Buech (2022) found a significant difference in phonation as vowels following ejective stops in Mehri had a lower H1*-H2* value (p. 3435). It should be noted here, however, that J. Al-Tamimi (2017) also found creaky voice as a correlate of pharyngealisation in Jordanian and Moroccan Arabic which he said is indicative of an epilaryngeal constriction (p.26).

The closure duration was also examined in ejective stops of different languages and different results were obtained. Seid et al. (2009) found that the ejective stops in Amharic had significantly longer closure duration than their plain counterparts (p. 2289). On the other hand, in the Northeast Caucasian language Ingush, Warner (1996) found that the closure duration was not statistically significant between the ejectives and the pulmonic voiceless stops (p. 1526). In another study of the Austronesian language in East Timor Waima'a, ANOVA tests across the stop types did not show any differences in closure duration across the different stop types (Hajek & Stevens, 2005, p. 2891). Nonetheless, the added measurements of VOT and closure duration to get the overall duration of stops showed that the ejective stops had an intermediate overall duration compared to the aspirated, which had the longest duration, and the unaspirated stops, which had the shortest duration (Hajek & Stevens, 2005, p. 2891). The results of ANOVA tests on overall durations showed that the differences in stops types in Waima'a were statistically significant (Hajek & Stevens, 2005, p. 2891). In Mehri, Ridouane & Buech (2022) found that the closure duration was significantly longer in ejective velar stops than in voiceless stops (p. 3435).

2.4.4. Acoustic Parameters of Ejective Fricatives

Ejective fricatives are considerably less common in the world's languages. Gordon & Applebaum (2006) mentioned that they are very rare sounds cross-linguistically (p. 161). In the UCLA Phonological Segment Inventory Database (UPSID), only 10 languages (3.2%) out of the

317 examined were found to have ejective fricatives in their sound inventories (Maddieson & Disner, 1984, p. 109). Shosted & Rose (2011), based on a literature survey of ejective fricatives, added another 14 languages to the (UPSID) list of languages with ejective fricatives, which included five of the MSAL: Mehri, Hobyōt, Śḥerēt/Jibbali, Baṭḥari, and Ḥarsūsi (p. 42). Even after adding the 14 languages mentioned by Shosted & Rose (2011), assuming all include ejective fricatives in their sound inventories, to the (UPSID) list of languages with ejective fricatives, the number still remains very small (24 languages in total out of 317 UPSID + 14 from Shosted & Rose (2011)) considering the large number of the world's languages proving the rarity of such sounds.

As was mentioned above in 2.4.1, the ejectives are produced with a constriction at the oral cavity level and another at the level of the larynx. The raised larynx compresses the air trapped between these two constrictions which rushes out with the release of the oral cavity constriction causing a burst, then, the constriction at the level of the larynx is released allowing the air from the lungs to pass through (Shosted & Rose, 2011, p. 42). According to Shosted & Rose (2011) the production of ejective fricatives involves an aeroacoustic dilemma as they require an increased air pressure for ejectivity, as well as a sustained venting of air for frication (p. 42). Nonetheless, different explanations have been put forward to achieve the requirements of producing ejective fricatives. For example, Shosted & Rose (2011) mentioned that Maddieson (1997) suggested the reduction of the size between articulators in the oral cavity constriction in order for the intraoral pressure to raise and produce ejective fricatives using the air trapped above the larynx (pp. 42-43). Another suggestion by Maddieson (1997) was to sequence the frication and glottal closure, as in Yapese; however, this raises the issue of whether sounds produced in such a manner could be called ejectives as frication is not produced simultaneously with glottal closure (Shosted & Rose, 2011). A third suggestion assumes an oral closure preceding the period of frication to allow for air pressure build up, and this is known as the ‘affrication hypothesis’ which is used in realising ejective fricatives in Tigrinya (Shosted & Rose, 2011, p. 43). However, this hypothesis as well raises questions regarding the nature of ejective fricatives as closure and frication are characteristic of affricates (Shosted & Rose, 2011, p. 43).

Regardless of the aeroacoustic dilemma in producing ejective fricatives, different languages include ejective fricatives in their sound inventories such as Tigrinya (Shosted & Rose, 2011), Amharic (Demolin, 2004), and Turkish Kabardian (Gordon & Applebaum, 2006). The ejective fricatives are distinguishable from other plain counterparts following a number of acoustic criteria. For instance, ejective fricatives were found to differ from their plain counterparts in terms of frication duration (Gordon & Applebaum, 2006; Shosted & Rose, 2011; Puderbaugh, 2015; Gasparini, 2017; Ridouane & Gendrot, 2017), overall duration (Seid et al., 2009), frication intensity (Gordon & Applebaum, 2006; Gasparini, 2017; Ridouane & Gendrot, 2017), and presence of pre- or post-frication silent lag (Gordon & Applebaum, 2006; Shosted & Rose, 2011; Ridouane & Gendrot, 2017). In addition, in a recent study of Mehri, Ridouane & Gendrot (2017) found that the emphatics, which they referred to as ‘ejectives’, differed from their pulmonic voiceless counterparts in terms of CoG as the emphatics had a higher CoG value.

One of the parameters found to distinguish ejective fricatives from their plain counterparts is frication duration. In Tigrinya, for instance, it has been found that the ejective fricatives had shorter frication releases than their pulmonic fricative counterparts (Shosted & Rose, 2011, p. 54). Similarly, in Turkish Kabardian, significantly shorter frication durations were found in ejective fricatives compared to non-ejective counterparts (Gordon & Applebaum, 2006, p. 174). Other languages where ejective fricatives were found to differ from their plain counterparts include Tlingit (Shosted & Rose, 2011) and Amharic (Demolin, 2004), where ejective fricatives had shorter frication duration than their plain counterpart. Ridouane & Gendrot (2017) similarly argued that Mehri ejective fricatives showed shorter frication durations (p. 155). On the other hand, Gasparini (2017) found that some of the emphatic fricatives in Baṭḥari such as /ðˤ/ and /sˤ/ (transcribed as /ð̣/ and /ṣ/, respectively in Gasparini (2017)) had longer frication durations than their plain counterparts, while others such as /ɬˤ/ (transcribed as /ṣ́/ in Gasparini (2017)) had shorter frication duration (p. 82). It should be noted here, however, that Gasparini (2017) mentioned the emphatic fricatives in Baṭḥari were pharyngealised and not ejectives.

In terms of overall duration, Seid et al. (2009) mentioned that the Amharic ejective fricatives had shorter overall duration than their plain unvoiced counterparts (p. 2289). According to Seid et al. (2009), the unvoiced /s/ had longer overall durations in word initial, medial, and geminated positions compared to the ejective /s'/ in Amharic. However, they do not clarify in the study what exactly the overall duration means.

Another cue that distinguishes ejective fricatives from plain counterparts is frication intensity. Previous studies have found it to be different in ejective fricatives compared to their non-ejective counterparts, although actual results were language dependent. In a study of fricatives in Turkish Kabardian, a Northwest Caucasian language, Gordon & Applebaum (2006) found that the ejective fricatives were significantly less intense relative to adjacent vowels than non-ejective fricatives (p. 176). By contrast, Gasparini (2017) noted that Baṭḥari emphatic fricatives in initial position had higher intensity than their plain counterparts except the lateral fricative /ɬˤ/ (p. 82). On a similar manner, Ridouane & Gendrot (2017) stated that in initial fricatives, the ejectives in Mehri had higher intensity values than their plain counterparts (p. 150).

Another acoustic parameter for ejective fricatives in various languages has been found to be the presence of pre- or post-frication silent lags (see Figure 2.5 below). Shosted & Rose (2011) found that ejective fricatives in Tigrinya were more likely to have periods of glottal lag/laryngealisation (periods of low-amplitude aperiodicity before regular glottal vibration and onset of voicing in ejective fricatives) than pulmonic fricatives (p. 58). They also found that 80% of ejective fricatives had periods of pre-release silence suggesting an affrication in Tigrinya ejective fricatives. Other languages where ejective fricatives were found with pre- or post-frication silent lags include Tlingit (Shosted & Rose, 2011, p. 49) and Turkish Kabardian (Gordon & Applebaum, 2006). In Turkish Kabardian, Gordon & Applebaum (2006) found that there was a gap between the release of the fricative and the start of voicing in the following segment (p. 174). Similarly, Ridouane & Gendrot (2017) found that the Mehri ejective fricatives may display a pre- or post-frication silent lag (p. 148), but with some inter-speaker variability: 61% of word-initial ejectives showed a post-frication silent lag compared to 27% of intervocalic ones (p. 155). In addition, 15% of ejectives in intervocalic position also showed a pre-frication silent lag (Ridouane & Gendrot, 2017, p. 155). By contrast, Gasparini (2017) mentioned that his data on Baṭḥari systematically lacked any pre- or post-frication silent lags in the emphatic fricatives (p. 80).

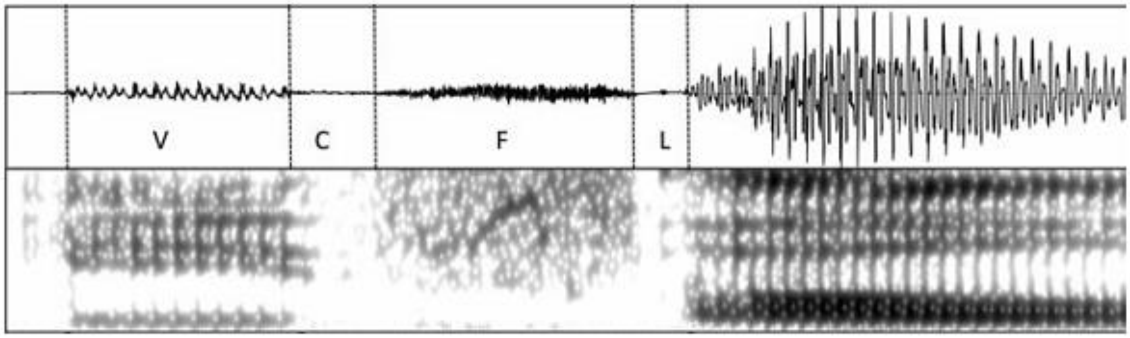

FIGURE 2 *The temporal intervals measured: V = preceding vowel duration, C = pre-frication closure interval, F = frication noise, L = post-frication glottal lag. Token [iϑ’u:bər] “to blame”, for speaker s2.*

Figure 2.5: Pre- and post-frication silent lags as shown in Ridouane & Gendrot (2017, p. 147)

Ridouane & Gendrot (2017) measured the CoG of Mehri emphatic fricatives, which they describe as ‘ejective fricatives’, and their pulmonic voiceless counterparts. The data, a total of 397 tokens, was recorded in Oman from five male speakers of Mehri and the segments were found in initial and intervocalic positions. The results showed that the emphatic fricatives had higher CoG values than their pulmonic counterparts in both initial and intervocalic positions (Ridouane & Gendrot, 2017).

2.4.5. Backed (Pharyngealised/Uvularised/Velarised)

The ‘backed’ emphatic sounds are well attested in a number of Semitic languages, such as Arabic and Hebrew. They are articulated by having a constriction at the level of the oral cavity and a simultaneous retraction of the tongue towards the posterior wall of the pharynx (Ghazeli, 1977; Giannini & Pettorino, 1982; Laufer & Baer, 1988; F. Al-Tamimi et al., 2009). They include a secondary place of articulation at the back of the oral cavity in addition to primary coronal place of articulation. Nonetheless, the exact place of the secondary articulation is debated among scholars and it differs from one language or dialect to another. In a recent ultrasound study of three Arabic dialects, Al-Solami (2017) stated that it is agreed that the secondary articulation in emphatics is a retraction of tongue body but it is difficult to pinpoint it due to cross-dialectal variation and different methodologies used in the experiments. He added that it is agreed that the articulation of uvulars and emphatics involves tongue dorsum retraction, but the direction and degree of this retraction differs (Al-Solami, 2017).

Various studies have looked at the articulatory processes of these sounds and found varying results regarding the place of the secondary articulation (Ghazeli, 1977; Giannini & Pettorino, 1982; Laufer & Baer, 1988; Jongman et al., 2011). According to Jongman et al. (2011), there is still no agreement on the exact nature of the posterior constriction. Ghazeli (1977) and F. Al-Tamimi et al. (2009) mentioned in Jongman et al. (2011) found that the production of 'backed' emphatics involves tongue retraction towards the posterior pharynx wall near the uvula. These studies concluded that tongue retraction happens in the oropharynx at the level of the second vertebra (Jongman et al., 2011). Other studies such as Giannini & Pettorino (1982) and Laufer & Baer (1988) found that the constriction is not at the level of the uvula, but much lower than that. For instance, Giannini & Pettorino (1982) found that the greatest constriction is at the level of the lower pharynx. Laufer & Baer (1988) studied the production of 'backed' emphatics in Arabic and concluded that they were produced with the epiglottis forming a constriction with the pharynx wall while the tongue root retracted backwards as well. All these different articulatory observations which have been proposed for the production of 'backed' emphatic sounds has resulted in the use of different terms. They are known as pharyngealised, velarised, and/or uvularised sounds (Ghazeli, 1977; Giannini & Pettorino, 1982; Laufer & Baer, 1988; F. Al-Tamimi et al., 2009; Faircloth, 2020). However, all studies agree on the fact that the tongue root retracts towards the pharynx during the production of these sounds.

Even though the exact place of the secondary articulation is not agreed upon, and therefore different terms such as pharyngealised/uvularised/velarised are used, research in different languages and dialects have found that the emphatics affect the surrounding sounds acoustically. This phonological effect of emphatics has been studied by various researchers in different languages and dialects. The studies differ in their results for the direction and degree of influence on surrounding sounds. In the following section the results of some of these studies are discussed in more detail.

2.4.6. Emphatic Effect

As was mentioned above in 2.4.5, the emphatics in Arabic are 'backed' and are known by different terms such as pharyngealised, velarised, or uvularised. Studies on different dialects of Arabic have shown that the emphatics have a coarticulation effect on surrounding sounds known as the 'emphasis effect' (Ghazeli, 1977; Watson, 1999; Bin-Muqbil, 2006; Embarki et al., 2007; Jongman et al., 2011; J. Al-Tamimi, 2015). The presence of emphatics in Arabic was found to cause allophonic changes on surrounding vowels which results in backer and lower vowels. In vowels surrounding the emphatics, F1 is usually higher and F2 is lower compared to other contexts (Yeou, 1997; Zawaydeh, 1999; Al-Masri, 2009; Shar & Ingram, 2010; Jongman et al., 2011; J. Al-Tamimi, 2015, 2017).

This effect of the emphatics in Arabic was found to be both rightward and leftward in direction both within word boundaries and across word boundaries (Watson, 1999). Davis (1995) mentioned that the effect of emphasis is dialect dependent as it spreads in some dialects to the entire word, while in others it rarely spreads beyond an adjacent vowel (p. 466). Jongman et al. (2011) asserted that the pattern of emphasis spread to surrounding sounds varies across dialects of Arabic. In Cairene Arabic, the emphasis effect of the emphatic sounds spreads over the entire word. Other studies found that the direction of the spread can even cross word boundaries leftward to the previous word when the emphatic is in initial position in the target word (Watson, 1999). Ali & Daniloff (1972) found that the emphatic sounds effect spreads both rightward and leftward but with a great emphasis on the rightward. They added that the effect does not spread throughout the word. It is clear that emphasis spreads in both directions; however, the scope and degree of this effect differs. This difference in results might be due to the type of words and methodologies used in these studies and to the position of the emphatic with regard to the surrounding syllables and sounds in addition to cross-dialectal differences.

Although there is variation in the direction and extent of emphatic influence on surrounding sounds, there is consistency across varieties and studies in the observed nature of the effect. The various studies found that the emphatic influence shows on adjacent vowel F1 and F2 formants. Vowels following emphatics were found to have higher measurements for (F1) and lower measurements for (F2) compared to the same vowels following plain consonant sounds (Watson, 1999; Shar & Ingram, 2010; Jongman et al., 2011; J. Al-Tamimi, 2015).

In a study by Shar & Ingram (2010) on the Asiri dialect of Arabic in Saudi Arabia, ANOVA tests showed preceding emphatics had a significant effect on the F1 and F2 values of following vowels as the F1 was significantly higher while F2 was significantly lower when the vowel was preceded by an emphatic sound. The study involved five native speakers of the Asiri dialect of Arabic who produced the four emphatics /sˤ, tˤ, ðˤ and dˤ/ and their plain counterparts /s, t, ð, d/ followed by the vowels /a, i, u/ in initial and medial positions. The stimuli used included minimal pairs of real Arabic words. In a study that involved five speakers of central Saudi Arabia dialects, Bin-Muqbil (2006) measured F1 and F2 values of vowels following emphatics, plain counterparts of emphatics, gutturals (uvular and pharyngeal sounds), and the velar /k/ in Modern Standard Arabic words and found that F1 and F2 formants of vowels following emphatics were higher and lower, respectively, compared to the others. The data Bin-Muqbil (2006) relied on came from a list of words containing the consonants and the vowels /i, a, u/ in #CV and VC# contexts, which were repeated three times by five Arabic speakers from Saudi Arabia. Both of the previous studies measured F1 and F2 at onset and midpoint of the vowels and the effect of emphatics was found to be significant on vowel formants. Jongman et al. (2011) in their study of urban Jordanian Arabic-Irbid dialect, which involved 12 speakers (6 males and six females) and included two emphatic stops and two emphatic fricatives and their plain counterparts in real and nonsense words, found that the F1 of the vowel following an emphatic was significantly higher at onset and midpoint, but not offset, while F2 was lower throughout the vowel. On the other hand, Al-Masri (2009), in his study that involved eight speakers of urban Jordanian Arabic, found that the effect was stronger near the emphatic consonant for F2, being lower at the point closest to the target consonant (Al-Masri, 2009). All the studies show that the effect of emphatic consonants seen on the vowel formants of the vowel preceding or following the target consonant.

As for the quality and length of the following vowel and the influence of the emphatic, Yeou (1997), in his study which involved 10 male Moroccan speakers of Modern Standard Arabic, found a greater lowering of F2 at midpoint in short vowels compared to long vowels. His study consisted of real word and nonsense word CVCVCVC sequences with short and long vowels which were measured at onset and midpoint. In comparison, Jongman et al. (2011) did not find any significant difference of emphasis based on vowel length. Formants were measured at the beginning, middle and end of the vowel. According to Jongman et al. (2011), short vowels had higher F1 and lower F2 than long vowels, but this was not significant based on ANOVA results. They explained the results of previous studies to have reflected the greater distance from the target consonant in taking the vowel midpoint measurements in long vowels. Jongman et al. (2011) results are supported by Al-Masri (2009) who also found that the greater effect of emphasis was at the point closest to the target consonant. Thus, the distance from the emphatic seems to be a defining factor in this case and not vowel length per se. Regarding vowel quality, Al-Masri (2009) found that low front vowels show the greatest drop in F2 at midpoint followed by high front vowels and finally high back vowels. Similar results were found by Jongman et al. (2011) and Yeou (1997) as the results of their studies showed that the greatest lowering of F2 was seen in the low front vowel /æ/ followed by the front high vowel /i/ and high back rounded vowel /u/.

All the previous studies show that there is a general tendency in all those different varieties of Arabic where the emphasis spreads leftward and rightward causing higher (F1) and lower (F2) values compared to non-emphatics.

2.5. Patterning of Consonants in MSAL

Several previous studies on MSAL languages have shown a phonological patterning of the group of sounds known as ‘emphatics’ in Semitic languages and the canonically voiced consonants, to the exclusion of voiceless consonants (Johnstone, 1975, 1977, 1980a; Watson et al., 2020; Rubin, 2023). The phonological patterning is morphologically evident in the process of definition of nouns and adjectives and in the prefixing of some verb forms in some of the MSAL languages. Johnstone (1975) showed that morphological features indicate that the MSAL group the voiced consonants with the emphatics, which he termed ‘glottalised’ (p. 98).

Johnstone (1975) mentioned that in Mehri, Ḥarsūsi, and Śḥerēt/Jibbali, words beginning with both emphatic and voiced consonants are prefixed with a definite article, while words beginning with voiceless consonants are not (p. 98), as shown in Table 2.1 below. In his work on Ḥarsūsi, he stated that the definite article /ɑ-/ occurs before voiced and ‘glottalised’ consonants (Johnstone, 1977).

	Emphatic	Voiced	Voiceless
Mehri	ɑ-k’ɑːb	ɑ-geːd	kɑwb
Ḥarsūsi	ɑ-k’ɑlb	ɑ-goːd	kɑwb/koːb
Śḥerēt/Jibbali	ɛ-k’ɛlb	ɛ-jɔːd	kɔːb
Gloss	‘the heart’	‘the skin	‘a/the wolf’

Table 2.1: Emphatic and voiced consonants patterning adapted from Johnstone (1975).

In recent work, Watson et al. (2020) mentioned that the realisation of definite article on nouns or adjectives in Mehri depends on whether it belongs to a special lexical class or on the initial consonant of the word (p. 34). According to them, the first consonant in the definite form is geminated if it is a “breathed” (voiceless) consonant followed by a vowel and not geminated in other cases as in /əkkənsīd/ “the shoulder” and /əttōmər/ “the dates” vs. /əbōb/ “the door” and /əṣɑyd/ “the fish” (Watson et al., 2020, pp. 34 - 35). Similarly, in the most recent work on Ḥarsūsi based on Johnstone’s audios, Rubin (2023) stated that the rules of definite article in Ḥarsūsi follow those found in Mehri where the morpheme ɑ- appears only before voiced or glottalic consonants, or a cluster of two “idle glottis” (= voiceless) consonants (p. 334). He provided some examples where he thinks Johnstone missed marking expected articles including /ɑmšēġərət/ “the second”, /ɑġəllēt/ “the mist”, and /ɑsḥētəs/ “her slaughter” (Rubin, 2023, p. 335). In addition, Rubin (2023) showed in his transcriptions of Ḥarsūsi words that the initial voiceless consonant only is geminated in definite forms similar to Mehri and Śḥerɛ̄t/Jibbali as in /wə-ttōmər/ “the dates” and /wə-kkōb/ “and the wolf” (p. 335).

In verbal morphology, Johnstone (1975) mentioned that the intensive-conative verbal forms in Mehri, Ḥarsūsi, and Śḥerɛ̄t/Jibbali take a prefix that shows only before voiced and ‘glottalised’ consonants as in the following Ḥarsūsi words /ɑgeːrəb/ “to try” and /ɑk’ɑːbel/ “to point to the qiblah” vs. /keːrəm/ “to be generous” (p. 7). Moreover, Watson & Bellem (2010) showed that in the Mahriyōt dialect of Mehri spoken in Eastern Yemen the root-initial consonant in some verb forms is geminated when it is a voiceless consonant which is not the case when it is either an emphatic or a voiced consonant (p. 347). For instance, the first consonant is geminated in the inflected verbs of /ɑffōkɑr/ “to think” and /ɑttōfɑġ/ “to wash one’s face with water”, but not in /ɑjōrɑb/ “to try” and /ɑṣōfi/ “to cleanse”.

2.6. LARYNGEAL PROPERTIES

The Arab grammarian, Sibawayh, categorised the Arabic consonants into two groups he called *majhūr* and *mahmūs*. The *majhūr* consonants included /aː, b, d͡ʒ, d, ð, r, z, dˤ, tˤ, ðˤ, ʕ, ʁ, q, l, m, n, w-uː, j-iː, ʔ/ and the *mahmūs* consonants included /t, θ, ħ, χ, s, ʃ, sˤ, f, k, h/ (Heselwood & Maghrabi, 2015, p. 135).

According to Heselwood & Maghrabi (2015), the interpretation for Sibawayh's categorisation as voiced for *majhūr* and voiceless for *mahmūs* has been the most common one among modern scholars; nonetheless, such a distinction is problematic since the *majhūr* category includes voiceless sounds such as /tˤ, q, ʔ/ as well. Therefore, different views were proposed to solve this issue. Some proposed that Sibawayh mistakenly took these as voiced consonants and grouped them with *majhūr* consonants, while others proposed that these sounds were actually voiced during Sibawayh's time (Heselwood & Maghrabi, 2015, p. 132). Heselwood & Maghrabi (2015), based on textual evidence and evidence from modern instrumental phonetics, argued that Sibawayh was probably not mistaken in his distinction, but rather that taking his distinction of *majhūr* and *mahmūs* as parallel to voiced and voiceless is not accurate, and there are better ways to categorise the sounds in these languages.

Heselwood & Maghrabi (2015) claimed that Sibawayh's distinction of Arabic consonants is accurate and accounts well for these consonants. However, the appropriateness of such a distinction relies on a careful and suitable interpretation of these terms. The common interpretation of the terms *majhūr* and *mahmūs* as voiced and voiceless (Danecki, 2011) based on categories established for other languages raises problems; a better interpretation of the terms is one based on the control of airflow by glottal states (Heselwood & Maghrabi, 2015, p. 171).

They stated that the importance in these definitions lies in the flow of breath, and whether it is constricted during articulation or not (Heselwood & Maghrabi, 2015, p. 135). They state that their findings are consistent with the *majhūr–mahmūs* distinction being based on airflow (Heselwood & Maghrabi, 2015, p. 158), and the terms ‘unbreathed’ and ‘breathed’ are the best supported by their aerometric results as interpretations for *majhūr* and *mahmūs* (Heselwood & Maghrabi, 2015, p. 159). Their results, based on their study of Modern Standard Arabic spoken by eight speakers of Arabic from different Arab countries, showed that the airflow of *majhūr* consonants /tˤ/ and /q/, canonically voiceless, is similar to the canonically voiced /d/ and significantly lower than the *mahmūs* /t/ and /k/. The volume-velocity airflow was measured by wearing an Aerophone II aerometry system. They concluded that what defines *majhūr* sounds in Arabic is low airflow which is controlled by glottal constriction (Heselwood & Maghrabi, 2015, p. 132).

Heselwood & Maghrabi (2015) showed that their VOT results are also consistent with the maj*hūr co*nsonants /tˤ, q/ in Arabic being not aspirated, with less air flow than the ma*hmūs co*nsonants /t, k/ (p. 163). Across all the eight speakers in their study, they found that the VOT for /tˤ, q/ was shorter with an average of 19.6ms in comparison to the VOT of /t, k/ with an average of 37.6ms (Heselwood & Maghrabi, 2015, p. 157).

Based on phonological patterning and instrumental phonetic analyses, Watson & Heselwood (2016) argued that the consonants in Mehri, Śḥerēt, and San’ani /sˤanʕaːni/ Arabic can be grouped into two categories, with the distinction between these two groups of sounds lying in the presence or absence of voiceless turbulence and not the presence or absence of voicing. By voiceless turbulence, they mean unimpeded audible airflow. The acoustic analyses of data showed three phonation categories: aspirated, voiceless unaspirated, and voiced which are parallel to open, narrowed, and closed glottal states (Watson & Heselwood, 2016). Based on phonological patterning, they grouped the three phonetic categories into two phonologically distinctive categories (Watson & Heselwood, 2016, p. 5). Their data, based on two speakers of San'ani /sˤanʕaːni/ Arabic and five speakers of Mehri, showed that the canonically voiced stops and emphatic stops pattern together by being glottalised in pre-pausal position. Moreover, the canonically voiceless consonants /t/ and /k/ showed the presence of voiceless turbulence. Watson & Heselwood (2016)Watson & Heselwood (2016) mentioned that researchers previously noted the 2-way patterning of these consonants; however, the phonation features of these groups of consonants have not been identified. In light of their results, Watson & Heselwood (2016)Watson & Heselwood (2016) suggested a phonological model for phonation where the distinction between the two group of sounds can be diagrammed as [open] versus [closed] glottis. According to this model, [open] glottis accounts for a wide-open glottis state and abduction of the vocal folds in voiceless aspirated consonants, while [closed] glottis accounts for voiced, voiceless unaspirated, and ejective consonants which involve a closed glottis and degrees of adduction of the vocal folds (Watson & Heselwood, 2016, p. 33).

An alternative approach is the laryngeal realism approach which received attention in recent years (Bahrani & Kulikov, 2024, p. 5). It proposes a link between phonological representation and phonetic detail, where the acoustic properties correspond to privative distinctive features which specify the laryngeal contrasts in phonology (Al-Gamdi, Al-Tamimi, & Khattab, 2019, p. 2051).

The laryngeal realism approach assumes that in aspirating languages the laryngeal contrast is specified by the feature [spread glottis], while in voicing languages the contrast is specified by the feature [voice] (Al-Gamdi et al., 2019, p. 2051). Such an approach solves the issue of phonologically representing three phonetic categories, which are voiced, voiceless unaspirated, and voiceless aspirated, which were traditionally categorised using a binary feature in Keating's (1981) model (Bahrani & Kulikov, 2024, p. 5).

Al-Gamdi et al. (2019) showed that Najdi Arabic includes both prevoiced and aspirated stops in its phonology. Using binary phonological features following the "traditional approach" (Bahrani & Kulikov, 2024, p. 5) is problematic, raising questions about the nature of the phonological representations of such contrast (Al-Gamdi et al., 2019, p. 2054). Therefore, Al-Gamdi et al. (2019) propose following the laryngeal realism approach in suggesting that the laryngeal system in Najdi Arabic is over-specified in the phonology with the feature [voice] for voiced stops and the feature [spread glottis] for voiceless stops as found in Qatari Arabic and Swedish (p. 2054).

3. Chapter Three: Methodology

3.1. Fieldwork

My first attempts to establish contacts in the Ḥarsūsi-speaking communities were done in summer 2016 between July and August, the hottest time of the year in the area. Through both sheer coincidence and good luck, I met someone from the Diwan of Royal Court, whose department oversees Al-Wusta Wildlife Conservation. Through this contact, my first visit of three days was facilitated at the Wildlife Conservation where its manager introduced me to his Ḥarāsīs employees. In this visit, my first point of contact and consultant was identified. This consultant introduced me to the Ḥarāsīs communities at Al-Aja'iz, Abu Mudhabi, and Haima. Based on my own observation and consultant's recommendation, I decided to work with the Abu Mudhabi community since it was in the middle geographically among these communities and had very few non-Ḥarāsīs families (mainly non-Omani schoolteachers' families from Egypt and Sudan). Haima, compared to Abu Mudhabi and Al-Aja'iz, had a lot of non-Ḥarāsīs whether Omanis or non-Omanis who were there for employment reasons. Al-Aja'iz geographically is closer to Al-Duqm and to areas which are populated by non-Ḥarāsīs tribes who speak Bedouin Arabic, the dialect of the Janabah /d͡ʒanabah/ and Wahaibah /wahajbah/. Therefore, the village of Abu Mudhabi seemed a suitable place for both linguistic and logistic reasons.

In summer 2017, the second fieldwork visit of almost a month was conducted and focused on fostering a bond with the community and learning the basics of Ḥarsūsi to be able to communicate with the Ḥarāsīs in the area. During this visit, data were also collected to explore the sound system of Ḥarsūsi. The data type were mostly natural speech recordings and some basic everyday usage words to help learn the language. The bond was established by visiting different families of the community in either their houses or the encampments and joining their various occasions such as weddings, guest-receptions, and other events. During these visits, future consultants were also identified.

In the summers of 2018 and 2019, field visits of one month each year were conducted for learning Ḥarsūsi primarily, but also collecting some more data. During these visits, in addition to natural speech recordings, data through elicitation of specific lists of words were also recorded. In summer 2020, the plan for a field visit for more data collection was cancelled due to the global pandemic COVID-19 and measures taken by the Omani government to stop the disease. Hence, face-to-face data collection was not possible, and the consultants were consulted on previously collected data remotely using social media applications such as WhatsApp and other software such as Zoom.

Through the process of learning Ḥarsūsi, it was clear that it includes some distinctive speech sounds such as alveolar-lateral fricatives and emphatics. Thus, in early 2021, another field visit of around three weeks was conducted to obtain data via elicitation of words containing these sounds from more than one speaker to be used for further phonetic analysis. The main consultant during these visits was very helpful in both providing data and convincing others to take part in the study.

The data recording process was not always planned in terms of having a specific designation. Some of the data were recorded in consultants' own houses or encampments, while some, and especially these needed for phonetic analysis, were recorded in my own residence in the community or in the main consultant's residence to keep external noise as low as possible. Sometimes data were also collected during outings with the Ḥarāsīs around the area in leisure times.

There were several challenges in the process of collecting the data. The main challenge was the weather and the heat during the summer. Temperatures of 46-49°C made it impossible to work outside except at night. Even within houses, it was impossible to work without having air conditioners on which created a lot of background noise, thus, forcing me to use noise-reduction microphones and headsets. Another crucial challenge was the gender rules in the area and in Arabia in general. It was impossible to have women consultants in the area to help in recording data. Therefore, the data were entirely collected from male consultants. A third challenge was having a good flow of work with the consultants during each session. Most of the elicitation sessions were around an hour each with breaks and conducted more than once during the day except for everyday conversations.

3.2. Data Sources

Various types of data were collected, consisting of both elicited and non-elicited recordings for this thesis.

The elicited data collected are a Swadesh list of basic words adopted from Haberl (2009), a list of 92 Arabic verbs adopted from Kasz (2013), and a precursor list of 224 words adopted from Morris et al. (2019) for comparative purposes. The list of 92 verbs was elicited in perfective, imperfective, and future for first, second, and third singular and plural speakers. In addition, two lists of Ḥarsūsi words including emphatic consonants and their plain counterparts in utterance-initial, medial, and final positions were elicited in isolation and used mainly for the results of chapters 5 and 6. The lists included pairs of emphatics and their plain counterparts in stressed and unstressed syllables in different utterance positions. Johnstone's 1977 Ḥarsūsi Lexicon was consulted extensively in finding the words including the target consonants in various positions; however, the Ḥarsūsi consultants were also consulted to elicit more items which could not be found in Johnstone's work, and for checking the accuracy of some of the selected items. The lists are given below in chapters 5 and 6, and are also used to support the results of chapter 4 along with the other data.

The daily interactions with community members and the environment also provided some words not included in the previous lists. The efforts of learning the language at the very beginning and the notes taken during the process also provided a good deal of elicited material. The data from the learning material are lists of various items and short everyday essential conversation sentences translated from Arabic to Ḥarsūsi. These data were also consulted for the results presented in chapter 4.

The non-elicited natural speech data are folktales, poems, camel-related cultural information, historical stories, children's stories, instructions, and natural conversations in the community. In addition, there are three narrative recordings kindly provided by Eades & Morris (2016) which were transcribed and translated in the field. Some of these data were also consulted for the results presented in chapter 4. It should be noted here, however, there are many recordings deposited in the ELAR archive by (Eades & Morris, 2016) which include narratives, descriptions, conversations, and elicitations. However, not many of these were used in the current project because one of the approaches was to have first-hand data collected in the field that reflects the current situation of the language. In addition, the time constraints and the experimental requirements and nature of this research did not allow the privilege of making use of more of the previously mentioned recordings.

3.3. LANGUAGE CONSULTANTS

The whole community, to a lesser extent pubescent girls and women, of Abu Mudhabi served as consultants in conducting this study since they helped in the process of learning the language in one way or another by either teaching or practising the language with the researcher. Elicitations and purposeful recordings were conducted for 20 male speakers in previous field visits from 2017 to 2019. Out of all of the speakers, 17 were 20-40 years old. One speaker was over 60 years old, while two were 42 and 45. All the speakers were bilingual speakers of Arabic and Ḥarsūsi and native speakers of Ḥarsūsi since childhood who used Ḥarsūsi as their main everyday language. As a researcher, I was hosted by number of them in their houses, especially at the early stages of the project when I was trying to learn the language, and I found they used mainly Ḥarsūsi with the older generations and Arabic was kept to minimal with some young children only. The language among the parents and grandparents was Ḥarsūsi.

All speakers below 40 years old (17 in total) were school educated, and some pursued university and college-level education. The educated consultants, and especially those at college and university levels, also knew English, but their command of it was very basic. All consultants were residents of Abu Mudhabi except the 60-year-old man who lived in Al-Aja'iz.

The data used for chapters 5 and 6 were recorded in early 2021 from 10 male native speakers of Ḥarsūsi aged between 20 – 40. All participants were residents of the same Ḥarsūsi-speaking town Abu Mudhabi. All participants had lived in the same town for most of their lives and did not leave Haima for long periods of time. However, five of the participants did spend some time of their early childhood in the village of Al-Ghaydharanah near Adam /ʔadam/ in Al-Dakhiliyah governorate where a number of Ḥarsūsi-speaking households are settled. None of the participants had any known history of speech and/or language disorders at the time of recordings. Three of the participants attended college and had some basic level English proficiency.

3.4. Data Collection

All the audio data, including elicitations and natural speech recordings, for this thesis were collected using a Tascam DR100-MKII 2-channel Portable Digital Recorder. A Shure SM12A-CN headset microphone with a frequency response of up to 15000 Hz was used to record all the data from all the consultants and a Shure WH20 XLR dynamic headset microphone with a frequency response of up to 15000 Hz was worn by the researcher during elicitation sessions.

Participant consent was obtained verbally through audio recording before the start of any data recording. Eckert (2014) mentioned that participants' understanding of what they are asked to do in the research and the implications of doing so are the responsibility of the researcher. Thus, when a potential participant was chosen, a short meeting was conducted to explain the research aims, needs, and expected outcomes. Participants' questions were answered during these meetings, and it was explained to them that their participation was totally voluntary and they can choose to stop their participation at any point. Before recording any data from any participant, the information in the written consent form was read for the participant and the following consent statement was recorded verbally:

> "I have been informed about this study's purpose, procedures, possible benefits and risks, and I have received a copy of this form. I have been given the opportunity to ask questions before giving consent, and I have been told that I can ask other questions at any time. I voluntarily agree to participate in this study."

The majority of the data were collected indoors, but some data were also collected outdoors in encampments or outings with members of the community in the area. In order to reduce the external noise in the recordings, a foam microphone windscreen (DeadCat Wind Muff) was used on the Shure SM12A-CN headset microphone which helped in getting very clear recordings with minimum external noise. All the recorded data were saved in WAV format with a sample rate of 44100 Hz. The video data were recorded in MOD format using a Panasonic SDR-S50 Camcorder. All the data were saved on an external password protected Hard-Drive, University of Leeds' password protected cloud storage OneDrive, and a password protected HP Folio 1020 EliteBook laptop. The same laptop was later used for analysing the data.

Ethical approvals for this study were obtained from University of Texas, Austin under IRB reference: 2015-12-0037 and University of Leeds under ethics reference: FAHC 19-024.

3.5. Analysis

Various linguistic analysis programmes were used to transcribe and analyse the data. The audio data were phonetically/phonemically transcribed and analysed in PRAAT (Boersma & Weenink, 2020). Phonemic transcriptions of some natural speech data were also done using SayMore (SIL International, 2019b) and ELAN (Max Planck Institute for Psycholinguistics, 2019). The transcribed data were later transferred to FLEx (SIL International, 2019a) for further future work.

The previously mentioned programmes were used for analysis purposes of the data in addition to MS Word and Excel in certain cases. The statistical programmes R R Core Team (2019) and R studio RStudio Team (2020) were also used for statistical analysis while working on the emphatics and their plain counterparts in Ḥarsūsi for chapters 5 and 6.

All segmentation analyses were made using the PRAAT speech analysis software (Boersma & Weenink, 2020). Segmentation was based on waveforms and wideband spectrograms at a window length of 0.05. The number of formants in the spectrogram was set at five formants and the maximum formant frequency was set at 5000 Hz for plosives, 11000 Hz for fricatives. In spectrogram settings, the range of viewed frequencies was set between 0-5000 Hz. The window length was set at 0.005 in spectrogram settings.

All data were segmented and annotated in textgrids manually. However, before segmenting the data needed for chapters 5 and 6 specifically, a number of PRAAT (Boersma & Weenink, 2020) scripts were run for different purposes. A sound converting script was run to convert all the WAV files into Mono sound files (Kawahara, 2009). After converting the files, textgrid files were created for each sound file with the various needed tiers. Then, another script adapted from a pause marking script by Lennes (2002) was run to mark pauses boundaries in all needed tiers. Pause boundaries were later manually fixed during manual segmentation. After marking the pauses, another script adopted from Styler (2008) was run to facilitate the transcription of target words in the transcription tier and their translations in the translation tier. At the end, a separate script was run to get the various measurements for stops and fricatives. For example, the script for stops measured their VOTs and closure durations, in addition to the presence or absence of glottal closure and release in utterance-initial, medial, and final positions.

After running the PRAAT (Boersma & Weenink, 2020) scripts and obtaining the measurements, the data were analysed in R software for statistical computing (R Core Team, 2019). A number of R software packages were used in analysing the data, including: tidyverse (Wickham et al., 2019), dplyr (Wickham, François, Henry, Müller, & Vaughan, 2021), car (Fox & Weisberg, 2019), lme4 (Bates, Mächler, Bolker, & Walker, 2015), lmerTest (Kuznetsova, Brockhoff, & Christensen, 2017), afex (Singmann, Bolker, Westfall, Aust, & Ben-Shachar, 2021), ggpubr (Kassambara, 2020), readxl (Wickham & Bryan, 2019), effects (Fox & Weisberg, 2019), emmeans (Russell, 2022), sjmisc (Lüdecke, 2018), sjlabelled (Lüdecke, 2022a), and sjPlot (Lüdecke, 2022b).

4. Chapter Four: Phonetics and Phonology of Ḥarsūsi

This chapter presents the results of the phonetics and phonology of Ḥarsūsi. It consists of four sections. The first section presents and discusses the different consonantal phonemes of Ḥarsūsi and their corresponding allophones in different environments. It aims to provide a summary of the observations and the phonological analysis. More detail on some phonemes such as pharyngeals, glottals, and emphatics will be given in later sections with full illustration. The second section presents the status of the glottal stop /ʔ/ and the pharyngeal fricative /ʕ/. The third section discusses the status of the emphatics in Ḥarsūsi which include 'backed' and glottalised ejectives. This section investigates the emphatics in detail and provides illustrations of the observations in the data. The last section outlines the vowel phonemes of Ḥarsūsi and their corresponding allophones in addition to the approximants.

All the data collected during different field visits were used for the analyses of this chapter. The analysis was primarily auditory and the available minimal and near-minimal pairs in the data were used to establish the phonemic inventory of the language. Waveforms and spectrograms of vowel and consonant sounds were visually inspected using PRAAT (Boersma & Weenink, 2020) to establish the allophonic realisations of phonemes. Generative phonological rules were used based on the distribution of sounds in different environments to present the allophony statements of sounds (Odden, 2005).

There are 30 consonant phonemes and seven vowel phonemes in Ḥarsūsi. The consonants consist of eight stops, 14 fricatives, three laterals, two nasals, one tap, and two glides. Similar to some other Semitic languages, Ḥarsūsi has a class of consonants within its phonemic inventory that has a secondary place of articulation, generally known as emphatics. Interestingly, however, the emphatics in Ḥarsūsi are articulated either as ‘backed’ or glottalised (see 4.3). There are five long vowels and two short vowels. The long vowels in Ḥarsūsi can also be shortened in certain environments resulting in short allophones.

4.1. CONSONANT PHONEMES

The phonemic inventory of Ḥarsūsi is larger than Arabic, but not as large as the phonemic inventories of other MSALs, such as Mehri, Soqoṭri, or Śḥerɛ̄t. It has a total of 30 distinct consonantal phonemes.

The following sections 4.1.1 to 4.1.6 discuss and explain the distinct phonemes of Ḥarsūsi following the manner of articulation. The phonemes are transcribed phonemically and presented in tables showing them in utterance-initial, utterance-medial, and utterance-final positions. It should be noted here, however, that broad phonetic transcriptions are used in cases of allophonic alternations, such as diphthongization and shortening of long vowels.

Table 4.1 below shows the phonemic inventory of Ḥarsūsi.

	Phonation	Labial	Labio-dental	Interdental	Dental	Alveolar	Post-Alveolar	Palatal	Velar	Post-velar	Pharyngeal	Glottal
Stop	Voiceless				t				k			
	Voiced	b			d				g			ʔ
	Emphatic				tˁ				k’			
Fricative	Voiceless		f	θ		s	ʃ			χ	ħ	h
	Voiced			ð		z				ʁ	ʕ	
	Emphatic			ðˁ		sˁ	ʃˁ					
Lateral	Voiceless					ɬ						
	Voiced					l						
	Emphatic					ɬˁ						
Nasal	Voiced	m				n						
Tap	Voiced					ɾ						
Approximant	Voiced	w						j				

Table 4.1: Phonemic inventory of Ḥarsūsi consonants.

4.1.1. Stops

As seen in Table 4.1 above, the stops in Ḥarsūsi are categorised into voiceless, voiced, and emphatic. The voiceless stops are: a dental /t/ and a velar /k/. The voiced stops are: a labial /b/, a dental /d/, a velar /g/, and glottal /ʔ/, and the emphatics are: a dental /tˤ/ and a velar /k'/. Table 4.2 shows all the stop phonemes in initial, medial, and final environments. The examples in the table show some of the phonemes in both stressed and unstressed syllables as Ḥarsūsi has lexical stress.

Phoneme	Initial	Medial	Final
/b/	/ˈbuːmeh/ 'here DEM.LOC' /ˈberk/ 'in LOC'	/ħeˈbuːɾ/ 'cold ADJ' /kɐbˈkoːb/ 'stars M.PL' /ʃɐbeˈdiːt/ 'liver M.SG'	/ˈħɐːbuːb/ 'people M.PL' /ˈðˤɐɾb/ 'twig M.SG' /kɐbˈkiːb/ 'star M.SG'
/d/	/deˈfeːɾ/ 'to push 2M.SG.IMP'	/heˈddoːt/ 'cradle F.SG' /ˈθoːdi/ 'breast M.SG' /jeˈdiːn/ 'new M.SG'	/jeˈluːbed/ 'to hit 3M.SG.IPFV' /ˈtˤɐːd/ 'one M.SG' /ˈgoːd/ 'skin M.SG'
/t/	/ˈtɐθ/ 'woman F.SG' /ˈtewi/ 'meat M.SG' /teɾɐːˈkiːb/ 'cooking-setup M.PL'	/ʔɐˈtoːm/ 'you 2M.PL' /heˈtoːm/ 'sky F.SG' /ðɐnˈbuːten/ 'tails F.PL'	/ˈhiːt/ 'you 2C.SG' /ʔɐɾˈboːt/ 'four F.PL' /jeˈtiːt/ 'six F.PL'
/tˤ/	/ˈtˤoːb/ 'type of plant F.SG'	/jeˈloːtˤem/ 'to slap 3M.SG.IPFV'	/ˈmɐtˤtˤ/ 'to pull 3M.SG.PFV'
/g/	/ˈgoːd/ 'skin M.SG' /geˈleːd/ 'skins M.PL' /ˈgɐːɾ/ 'fell 3M.SG.PFV'	/ʁeˈgeːn/ 'male-child M.SG' /ˈɬˤɐjgɐ/ 'house M.SG' /ʁegeˈnoːt/ 'girl-child F.SG'	/ˈʁɐjg/ 'man M.SG' /ʁeˈjuːg/ 'men M.PL' /neˈħɐːg/ 'to play 3M.SG.PFV'
/k/	/ˈkɐllen/ 'all' /keɾˈmeːm/ 'mountain M.SG' /kehˈloːnɐ/ 'to know 3M.SG.FUT'	/ˈðɐkmeh/ 'that M.DEM' /kebˈkiːb/ 'star M.SG' /ʔesˈkeːb/ 'to pour 3M.SG.IMP'	/ˈberek/ 'knee F.SG' /beˈreːk/ 'knees F.PL' /ʔenˈθoːk/ 'to bit 3M.SG.PFV'

/k'/	/ˈk'ɐjd/ 'rope M.SG'	/ħelˈk'ɐːt/ 'circle F.SG'	/χetˤˈrɐːk'/ 'stick F.SG'
/ʔ/	/ʔɐˈtoːm/ 'you 2M.PL' /ʔɐˈteːn/ 'you 2F.PL'	/sˤɐːˈʔeːt/ 'nine F.PL'	

Table 4.2: Ḥarsūsi stop phonemes.

As seen in Table 4.2, Ḥarsūsi has one labial stop /b/ which has two allophones. In utterance-initial and utterance-medial positions, it occurs as a voiced [b] as seen in Figure 4.1 below, while in utterance-final positions it occurs as an ejective [p'] as seen in Figure 4.2 below.

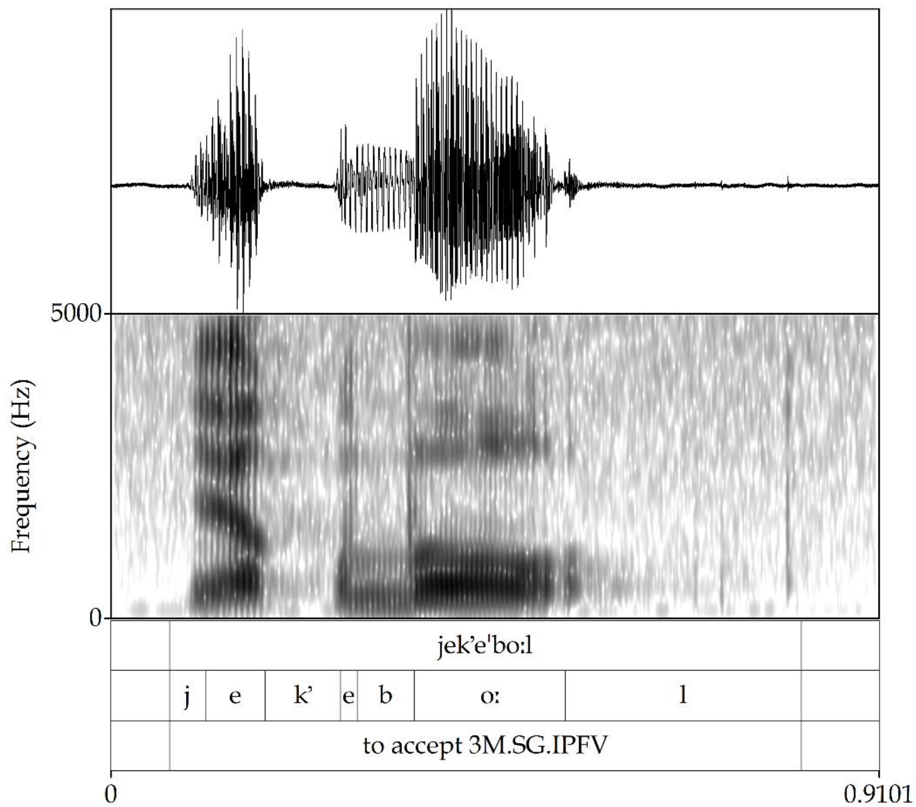

Figure 4.1: Spectrogram and waveform showing /b/ in /jek''bo:l/ 'to accept 3M.SG.IPFV'.

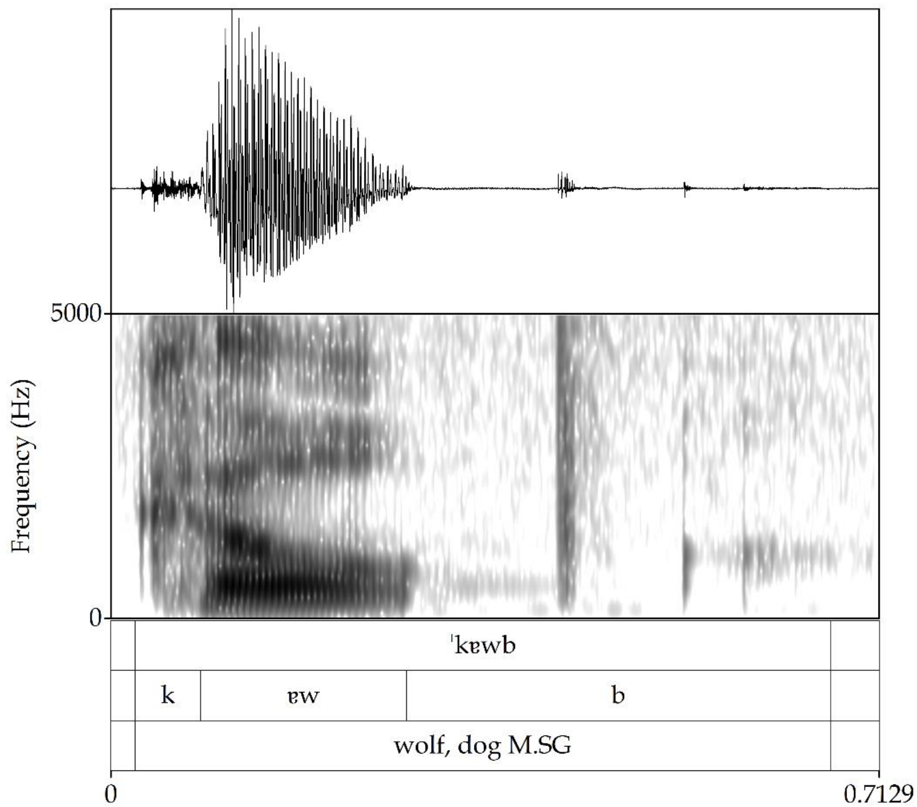

Figure 4.2: Spectrogram and waveform showing /b/ in /ˈkɐwb/ 'wolf, dog M.SG'.

Table 4.3 below shows these allophones in their respective environments.

Position	Non-Final	Final
Example	/keˈtebem/ - [kə.ˈt̪ʰʌ.bəm] 'to write 3M.PL.PFV'	/keˈtoːb/ - [kə.ˈt̪ʰoːp̚] 'to write 3M.SG.PFV'

Table 4.3: /b/ allophones.

Table 4.3 shows that the voiced [b] and ejective [p’] allophones of the labial stop /b/ are in complementary distribution since the data shows no occurrences of non-final ejective and final voiced stops. Consequently, there is no minimal pair in the data that could suggest the [b] and [p’] as separate phonemes. The distribution of the allophones can be stated by the following rule:

Rule 1:

/b/ → [p’] / __#

[b] elsewhere

In terms of dental stops, Ḥarsūsi has /d/, /t/, and /tˤ/. These three dentals can be established as separate phonemes in Ḥarsūsi given the minimal pairs in Table 4.4 below.

Phoneme	Example
/d/	/ˈdɐːb/ - [ˈd̪ɐːp’] ‘snake M.SG’
/t/	/ˈtɐːb/ - [ˈt̪ʰɐːp’] ‘to repent 3M.SG.PFV’ /ˈtoːb/ - [ˈt̪ʰoːp’] ‘to get tired 3M.SG.PFV’
/tˤ/	/ˈtˤoːb/ - [ˈt̪ˤo̞ːp’] ‘type of a plant F.SG’

Table 4.4: Minimal pairs of /d/, /t/, and /tˤ/.

The data in Table 4.4 show that each dental is in contrastive distribution with the other which prove them to be separate phonemes. In addition, unlike the voiced and voiceless dentals /d/ and /t/, the emphatic /tˤ/ affects the formants of the following vowels, discussed in detail in section 4.3.

Similar to the labial /b/, the voiced dental stop /d/ has two allophones, and one can be interpreted as the result of a devoicing process. In utterance-initial and medial positions, it has a voiced allophone [d̪], while in utterance-final positions it has a voiceless ejective allophone [t̪’]. In some realisations it is preceded by a period of pre-glottalisation (see 5.3.1.2). The distribution of the dental stop /d/ allophones can be stated by rule two below.

Rule 2:

/d/ → [t̪’] / __#

[d̪] elsewhere

The voiceless dental stop /t/ has two allophones. It has an aspirated [t̪ʰ] and an unaspirated [t̪]. The aspirated allophone occurs in utterance-final positions and in the onset of stressed syllables. The unaspirated [t̪] occurs elsewhere. In some realisations, it is preceded by a period of pre-aspiration (see 5.3.1.3). The distribution of the voiceless dental stop /t/ allophones can be stated by rule three below.

Rule 3:

/t/ → [t̪ʰ] / { __#

$[+stressed] __ }

[t̪] elsewhere

The final dental stop is the emphatic /tˤ/. This phoneme is an interesting one with regard to Semitic phonology, as it has ejective and ‘backed’ allophones. In terms of phonation, all the allophones of /tˤ/ are voiceless. The ejective allophone [t̪’] occurs in utterance-final positions, and the ‘backed’ [t̪ˤ] allophone occurs elsewhere. Some tokens in utterance-medial and final positions are preceded with a short period of pre-glottalisation (see 5.3.1.1). The distribution of the emphatic dental stop /tˤ/ allophones can be stated by rule four below.

Rule 4:

/tˤ/ → [t̪’] / __#

[t̪ˤ] elsewhere

The voiceless emphatic dental stop /tˤ/ and its allophones are discussed in detail in 4.3.

Other stops in Ḥarsūsi are three velars: voiced velar /g/, voiceless velar /k/, and emphatic velar /k’/. These three velars can be established as separate phonemes in Ḥarsūsi given the minimal pairs in Table 4.5 below.

Phoneme	Example
/g/	/geˈɾoːf/ - [gə.ˈɾoːf] ‘to brush out 3M.SG.PFV’
/k/	/keˈɾoːf/ - [kə.ˈɾoːf] ‘to sniff 3M.SG.PFV’ /keˈboːɾ/ - [kə.ˈboːɾ] ‘to say phrase Allah akbar 3M.SG.PFV’
/k’/	/k’eˈboːɾ/ - [k’ə.ˈboːɾ] ‘to bury 3M.SG.PFV’

Table 4.5: Minimal pairs of /g/, /k/, and /k’/.

The voiced velar stop /g/ has two allophones and undergoes utterance-final devoicing similar to other stops in this position. It has a voiceless ejective [k’] which occurs in utterance-final positions where it is released on a glottalic air stream and a voiced allophone [g] which occurs elsewhere. Similar to the voiced dental stop /d/, some tokens of the voiced velar stop /g/

are found to be preceded by a period of pre-glottalisation in utterance-final position (see 5.3.1.2). The distribution of the voiced velar stop /g/ allophones can be stated by rule five below.

Rule 5:

/g/ → [k’] / __#

[g] elsewhere

Similar to the voiceless dental stop /t/, the voiceless velar stop /k/ has two allophones. It has an aspirated allophone [k^h] and an unaspirated allophone [k]. Moreover, in some realisations, it is preceded by a period of pre-aspiration (see 5.3.1.3). In terms of phonation, all the allophones of /k/ are voiceless. The aspirated allophone [k^h] occurs in utterance-final positions and in onsets of stressed syllables. The unaspirated allophone [k] occurs elsewhere. The distribution of the voiceless velar stop /k/ allophones can be stated by rule six below.

Rule 6:

$$/k/ \rightarrow [k^h] \; / \left\{ \begin{array}{l} \_\_\# \\ \$_{[+stressed]} \_\_ \end{array} \right\}$$

[k] elsewhere

The last velar stop is the emphatic /k’/. This velar phoneme is very interesting in Ḥarsūsi as it is found to be realised as an ejective in most environments unlike the other emphatics which are ‘backed’ (discussed in detail in 4.3). It has two allophones: a ‘backed’ allophone [kˁ] which occurs in non-stressed utterance-medial positions and an ejective allophone [k’] which occurs elsewhere. Rule seven below states the distribution of the velar emphatic stop /k’/ allophones. As for the emphatic dental stop /tˤ/, some of the tokens of the emphatic velar /k’/ are found with a period of pre-glottalisation in some environments (see 5.3.1.1).

Rule 7:

$$/k'/ \rightarrow [k^{ʕ}] \;/\; \left\{\begin{array}{c} C \\ V \end{array}\right\} \_\_ \left\{\begin{array}{c} C \\ V \end{array}\right\}$$

[k’] elsewhere

The emphatic velar /k’/ is discussed in detail in section 4.3.

The final stop from Table 4.2 of Ḥarsūsi is the glottal stop /ʔ/. The glottal stop in Ḥarsūsi occurs in utterance-initial positions and rarely in utterance-medial positions. In utterance-final positions, the glottal stop has not been attested in the data. Regardless of this limited occurrence, the glottal stop /ʔ/ in Ḥarsūsi can be established as a separate phoneme based on the minimal pair in Table 4.6 below.

Phoneme	Example
/ʔ/	/ˈʔɐːm/ - [ˈʔɑːm] ‘if ’
/ħ/	/ˈħɐːm/ - [ˈħɑːm] ‘mother F.SG’

Table 4.6: Minimal pairs of /ʔ/ and /ħ/.

The glottal stop /ʔ/ is discussed in detail in section 4.2.

4.1.2. Fricatives

Ḥarsūsi has voiceless and voiced fricatives. The voiced fricatives in turn are plain and emphatic. The class of fricatives comprise the highest number of phonemes in Ḥarsūsi with a total of 16 fricatives. The voiced fricatives are: an interdental /ð/, an alveolar /z/, a post-velar /ʁ/, and a pharyngeal /ʕ/. The emphatic fricatives are: an interdental /ðˤ/, an alveolar /sˤ/, a palato-alveolar /ʃˤ/, and a lateral /ɬˤ/. The voiceless fricatives are: a labiodental /f/, an interdental /θ/, an alveolar /s/, a palato-alveolar /ʃ/, a post-velar /χ/, a pharyngeal /ħ/, a glottal /h/, and a lateral /ɬ/.Table 4.7 below shows these different phonemes in initial, medial, and final environments. The alveolar-lateral fricatives /ɬ/ and /ɬˤ/ are discussed in 4.1.3.

Phoneme	Initial	Medial	Final
/f/	/ˈfɐːm/ ‘foot M.SG’	/ˈhoːfel/ ‘stomach M.SG’	/ˈʃekf/ ‘to sleep 2M.SG.IMP’
/ð/	/ˈðɐnemeh/ ‘this M.SG.DEM’ /ˈðekmeh/ ‘that F.SG.DEM’	/ħɐjˈðiːn/ ‘ear M.SG’ /ħɐːˈðiːb/ ‘heart M.SG’ /ħɐːˈðoːbet/ ‘hearts M.PL’	
/θ/	/θeˈɾoːh/ ‘two M.PL’ /θemeˈniːt/ ‘eight F.PL’ /ˈθoːdi/ ‘breast M.SG’	/mˈθeːni/ ‘teeth M.PL’ /ʔnˈθoːk/ ‘bit 3M.SG.PFV’ /ˈʁoːθi/ ‘neck F.SG’	/ˈɬiːleθ/ ‘third M.SG’ /ˈtɐθ/ ‘woman F.SG’ /ˈħɐːnejθ/ ‘women F.PL’
ðˤ	/ðˤeˈfiːɾ/ ‘fingernail M.SG’ /ˈðˤɐɾb/ ‘twig M.SG’	/jeˈðˤoːlɐː/ ‘to limp 3M..SG.IPFV’	/ʔɐːˈɾeːðˤ/ ‘male goat M.SG’
/z/	/jezˈheːb/ ‘gets ready 3M.SG.IPFV’	/ʔeˈzeːm/ ‘to give 2M.SG.IMP’ /weˈzuːm/ ‘to give 3M.SG.PFV’	/ˈχɐbz/ ‘bread M.SG’

/s/	/ˈseh/ 'she 3F.SG' /seˈħoːb/ 'cloud M.SG' /seˈnɐt/ 'year F.SG'	/ˈmenseːl/ ~ /ˈmɐːseːl/ 'rain M.SG' /ʔesˈkeːb/ 'to pour 2M.SG.IMP' /ˈħseːb/ 'count 2M.SG.IMP'	/ʔɐːsˤeˈɾeːs/ 'to squeeze it 3M.SG.PFV'
/sˤ/	/ˈsˤɐjd/ 'fish M.SG' /sˤeˈwɐɾ/ 'stone F.SG'	/k'eˈsˤiːɾ/ 'short M.SG' /k'eˈsˤeret/ 'short F.SG'	/ˈbɐχsˤ/ 'pain M.SG'
/ʃ/	/ˈʃekf/ 'to sleep 2M.SG.IMP'	/ˈjemʃeh/ 'yesterday' /leˈʃiːn/ 'tongue M.SG'	/ˈħɐʃiːʃ/ 'grass M.SG'
/ʃˤ/	/k'eˈʃˤɐwb/ 'to cut 3M.SG.PFV' /ʃˤefeˈɾuːt/ 'bird M.SG' /ʃˤeˈɾoːm/ 'to slap 3M.SG.PFV'	/ħeˈʃˤɐːbɐː/ 'fingers F.PL'	
/ʁ/	/ˈʁajg/ 'man M.SG'	/ʔɐˈʁɐwf/ 'above LOC'	/ʔelˈtuːʁ/ 'to kill 3M.SG.PFV'
/χ/	/ˈχejbet/ 'little' /χeˈmoːh/ 'five F.PL' /χetˤˈɾɐːk'/ 'stick F.SG'	/ˈɬχoːf/ 'milk M.SG' /neχˈriːɾ/ 'nostril M.SG'	/deˈjoːχ/ 'to faint 3M.SG.PFV' /feˈtˤoːχ/ 'to blow to the head 3M.SG.PFV'
/ʕ/	/ˈʕiːd/ 'Eid M.SG' /ʕeˈnɐb/ 'grapes M.SG' /ˈʕɐjn/ 'eye F.SG'	/ʃeˈʕiːɾ/ 'barley M.SG' /meʕˈkɐːz/ 'crutch M.SG'	
/ħ/	/ħɐˈɬɐn/ 'what' /ˈħoːn/ 'where' /ˈħɐːm/ 'mother F.SG'	/nˈħɐː/ 'we 1C.PL.INCL' /jeɬˤˈħoːk/ 'to laugh 3M.SG.IPFV' /jeˈħoːfeɾ/ 'to dig 3M.SG.IPFV'	/jeˈmoːɬeħ/ 'to wipe 3M.SG.IPFV' /ˈsˤeːleħ/ 'chubby M.SG'
/h/	/ˈhoːh/ 'I 1C.SG' /ˈhiːt/ 'you 2C.SG' /ˈhoːm/ 'they 3M.PL'	/ˈħoːhi/ 'dirt M.SG' /neˈhuːren/ 'morning' /kehˈloːnɐ/ 'to know 3M.SG.FUT'	/ˈðɐnemeh/ 'this M.SG.DEM' /ˈbuːmeh/ 'here DEM.LOC' /θeˈɾoːh/ 'two M.PL'
/ɬ/	/ɬeˈweːtˤ/ 'fire M.SG'	/ˈħɐɬen/ 'what 3M.PL'	/ˈʔɐɬɬ/ 'to stand 3M.SG.PFV'
/ɬˤ/	/ˈɬˤɐjgɐ/ 'house M.SG'	/ħeɾˈlˤeːt/ '*Acacia tortilis* F.SG'	/ħeˈɾuːɬˤ/ '*Acacia tortilis* F.PL'

Table 4.7: Ḥarsūsi fricative phonemes.

The voiceless labiodental fricative /f/ in Ḥarsūsi has two allophones. It has a voiced allophone [v] that often occurs in intervocalic positions and a voiceless [f] that occurs elsewhere. The minimal pair in Table 4.8 below shows that the labiodental in Ḥarsūsi can be established as a separate phoneme since it is in contrastive distribution with the voiceless pharyngeal fricative [ħ].

Phoneme	Example
/f/	/ˈfɐːm/ - [ˈfɐːm] ‘foot M.SG’
/ħ/	/ˈħɐːm/ - [ˈħɑːm] ‘mother F.SG’

Table 4.8: Minimal pair of /f/ and /ħ/.

The distribution of the labiodental fricative /f/ allophones can be stated by rule eight below.

Rule 8:

/f/ → [v] / V__V

[f] elsewhere

In terms of interdentals, Ḥarsūsi has a voiced /ð/, an emphatic /ðˤ/, and a voiceless /θ/. The interdental trio can be established as separate phonemes based on minimal and near-minimal pairs as Table 4.9 shows below.

Phoneme	Example
/ð/	/jeðˈɾi/ - [jið.ˈɾi] ‘to bleed 3M.SG.IPFV’ /ðeˈfiːɾ/ - [ðə.ˈfiːr] ‘medicinal plant M.SG’
/θ/	/jeθˈɾi/ - [jiθ.ˈɾi] ‘to become damp 3M.SG.IPFV’
/ðˤ/	/ðˤeˈfiːɾ/ - [ðˤə.ˈfiːr] ‘fingernail M.SG’

Table 4.9: Minimal and near-minimal pairs of /ð/, /θ/, and /ðˤ/.

In terms of the allophones, the voiced interdental fricative /ð/ has two allophones. It has a voiced allophone [ð] which occurs in utterance-initial and medial positions, and a voiceless allophone which occurs in utterance-final positions. Rule nine below states the distribution of the emphatic interdental fricative /ðˤ/ allophones.

Rule 9:

/ð/ → [θ’] / __#

[ð] elsewhere

The voiceless interdental fricative /θ/ has only one allophone in all environments which is [θ]. As Table 4.7 shows, this allophone is attested in utterance-initial, medial, and final positions.

The emphatic interdental fricative /ðˤ/ has three allophones, a ‘backed’ voiceless [θˤ], an ejective [θ’], and a ‘backed’ voiced [ðˤ]. The ‘backed’ voiceless allophone occurs only in utterance-initial position in the speech of some speakers. The ejective occurs only in utterance-final position, while the ‘backed’ voiced allophone occurs elsewhere. Similar to the stop emphatics /k’/ and /tˤ/, the emphatic interdental fricative /ðˤ/ is articulated as an ejective in utterance-final position, and some tokens show it preceded with a period of pre-glottalisation (see 6.3.1.1). The emphatic interdental fricative /ðˤ/ is discussed in detail in 4.3. Rule 10 below states the distribution of the emphatic interdental fricative /ðˤ/ allophones.

Rule 10:

/ðˤ/ → [θˤ] or [ðˤ] / #__

[θ’] / __#

[ðˤ] elsewhere

Ḥarsūsi has three alveolar fricatives, which are a voiced alveolar /z/, a voiceless alveolar /s/, and an emphatic alveolar /sˤ/. The minimal and near-minimal pairs in Table 4.10 below show that these sounds are in contrastive distribution; therefore, they are separate phonemes in Ḥarsūsi.

Phoneme	Example
/z/	/zeˈɾoːnɐ/ - [zə.ˈɾoː.nɐ] ‘to visit 3M.SG.FUT’
/s/	/siːˈɾonɐ/ - [siːˈɾoː.nɐ] ‘to go 3M.SG.FUT’ /seˈboːɾ/ - [sə.ˈboːr] ‘to scout 3M.SG.PFV’
/sˤ/	/sˤeˈboːɾ/ - [sˤə.ˈboːr] ‘to wait 3M.SG.PFV’

Table 4.10: Minimal and near-minimal pairs of /z/, /s/, and /sˤ/.

The voiced alveolar fricative /z/ and the voiceless alveolar fricative /s/ can be established as separate phonemes based on the near-minimal pair /zeˈɾoːnɐ/ - [zə.ˈɾoː.nɐ] ‘to visit 3M.SG.FUT’ and /siːˈɾoːnɐ/ - [siːˈɾoː.nɐ] ‘to go 3M.SG.FUT’. The minimal pair /seˈboːɾ/ - [sə.ˈboːɾ] ‘to scout 3M.SG.PFV’ and /sˤeˈboːɾ/ - [sˤə.ˈboːɾ] ‘to wait 3M.SG.PFV’ show that the voiceless alveolar fricative [s] is in contrastive distribution with the emphatic alveolar [sˤ]. Therefore, the emphatic alveolar fricative /sˤ/ can also be established as a separate phoneme. In addition, the emphatic alveolar /sˤ/ can also be established as a separate phoneme as it affects the vowel formants of the following vowels unlike the non-emphatic counterparts. The emphatic alveolar /sˤ/ is discussed in detail in 4.3.

The voiced alveolar fricative /z/ has two allophones that occur in different environments. In utterance-initial and medial positions, it is realised as a voiced fricative [z]. However, in utterance-final positions, it undergoes devoicing and is realised as an ejective fricative [s’], as in the word /ˈχɐbz/ - [ˈχɐ̥bs’] ‘bread M.SG’. Heselwood & Watson (2018) mentioned that in Mehri final voiced fricatives are articulated as unaspirated devoiced pulmonics. Watson thought that if

/z/ in Ḥarsūsi patterned like /z/ in Mehri, then it will be distinguishable from /s/ in utterance-final positions as it will look more like /sˤ/ in this position (Personal Communication). Further investigations relied on systematic elicited data using wordlists revealed that was the case in Ḥarsūsi as well. In utterance-final positions the voiced alveolar fricative /z/ is realised as a voiceless ejective fricative [s’] in the majority of tokens in the data which follows the same pattern of other voiced stops in this position. The utterance-final realisation of this segment is discussed in detail under 6.3.1.2. Rule 11 below states the distribution of the voiced alveolar fricative /z/ allophones.

Rule 11:

/z/ → [s’] / __#

[z] elsewhere

The voiceless alveolar fricative /s/ has only one voiceless allophone [s] which occurs in all environments. Among the alveolar fricatives in Ḥarsūsi, the voiceless alveolar /s/ is the most widespread. The voiceless alveolar fricative /s/ is discussed in more detail in 6.3.1.3.2.

The emphatic alveolar fricative /sˤ/ has one voiceless ‘backed’ allophone [sˤ] which occurs in all environments. In one token by a single speaker, it is voiced inter-vocalically, however, in the majority of the data, it occurs as a voiceless [sˤ]. Similar to the other emphatics, the voiceless alveolar fricative /sˤ/ affects the formants of the following vowels and it is discussed in detail in 4.3.

The palato-alveolars in Ḥarsūsi are: a voiceless palato-alveolar fricative /ʃ/ and an emphatic palato-alveolar fricative /ʃˤ/. The minimal and near-minimal pairs in Table 4.11 below shows these sounds in contrastive distribution with other sounds and, therefore, they are separate phonemes in Ḥarsūsi.

Phoneme	Example
/ʃ/	/ˈʃeh/ - [ˈʃeh] 'with him 3M.SG.'
/s/	/ˈseh/ - [ˈseh] 'she 3F.SG.'
/ʃˤ/	/ʃˤeˈɾoːm/ - [ʃˤə.ˈɾoːm] 'to slap 3M.SG.PFV'
/sˤ/	/sˤeˈɾoːmeh/ - [sˤə.ˈɾoː.məh] 'now ADV'

Table 4.11: Minimal and near-minimal pairs of /ʃ/ and /ʃˤ/.

Table 4.11 shows that the voiceless palato-alveolar fricative [ʃ] is in contrastive distribution with the voiceless alveolar fricative [s] given the minimal pair of the words /ˈʃeh/ - [ˈʃeh] 'with him 3M.SG.' and /ˈseh/ - [ˈseh] 'she 3F.SG.'. Similarly, the emphatic palato-alveolar [ʃˤ] is in contrastive distribution with the emphatic alveolar fricative [sˤ] in the near-minimal pair /ʃˤeˈɾoːm/ - [ʃˤə.ˈɾoːm] 'to slap 3M.SG.PFV' and /sˤeˈɾoːmeh/ - [sˤə.ˈɾoː.məh] 'now ADV'. Therefore, the voiceless palato-alveolar fricative /ʃ/ and the emphatic palato-alveolar /ʃˤ/ are separate phonemes In Ḥarsūsi.

The voiceless palato-alveolar fricative /ʃ/ has only one allophone [ʃ] which occurs in all environments. It is attested in utterance-initial, medial, and final positions as seen in Table 4.11 above.

The emphatic palato-alveolar fricative /ʃˤ/ also has one 'backed' allophone [ʃˤ] which occurs in all environments. It can be voiced sometimes inter-vocalically; however, voicing is not seen in all intervocalic tokens in the data. It should be noted here that this phoneme is one of the rarest phonemes in Ḥarsūsi, as it is in the other MSAL, and occurs only in a handful of words in the language. As for the other emphatics, it has an effect on the formants of adjacent vowels. The articulation of the emphatic palato-alveolar fricative is discussed in 4.3.

There are two post-velar phonemes in Ḥarsūsi: a voiced /ʁ/ and a voiceless /χ/. These sounds can be established as separate phonemes based on the minimal pair in Table 4.12 below.

Phoneme	Example
/ʁ/	/ʁeˈboːɾ/ - [ʁə.ˈboːr] 'to meet 3M.SG.PFV'
/χ/	/χeˈboːɾ/ - [χə.ˈboːr] 'to know/ask for news 3M.SG.PFV'

Table 4.12: /ʁ/ and /χ/ minimal pair.

The voiced post-velar fricative /ʁ/ has two allophones: a voiced [ʁ] and a voiceless [χ] allophone. The latter occurs only in utterance-final position, consistent with the devoicing process. Rule 12 below states the distribution of the voiced post-velar fricative /ʁ/ allophones.

Rule 12:

/ʁ/ → [χ] / __#

[ʁ] elsewhere

The voiceless post-velar fricative /χ/ has one allophone. It occurs as a voiceless allophone [χ] in all positions investigated in this study.

The voiced pharyngeal /ʕ/ is a separate phoneme in Ḥarsūsi, however, its occurrence is limited to certain words and positions. It is discussed in detail in 4.2 below.

The voiceless pharyngeal fricative /ħ/ is attested in utterance-initial, medial, and final positions as seen in Table 4.7 above. It can be established as a separate phoneme given the minimal pair in Table 4.13 below. As for the allophones, it has one voiceless allophone [ħ] which occurs in all contexts.

Phoneme	Example
/ħ/	/ħeˈɾoːm/ - [ħə.ˈɾoːm] ‘forbidden ADJ’
/h/	/heˈɾoːm/ - [hə.ˈɾoːm] ‘plant M.SG’

Table 4.13: /ħ/ and /h/ minimal pair.

The voiced glottal fricative /h/ is also an established separate phoneme in Ḥarsūsi based on the data in Table 4.13 above. It has a voiced allophone [ɦ] and a voiceless allophone [h]. The voiced [ɦ] occurs in intervocalic positions, while the voiceless [h] occurs elsewhere. The distribution of the voiced glottal fricative /h/ allophones can be stated by rule 13 below.

Rule 13:

/h/ → [ɦ] / V__V

[h] elsewhere

Since the voiced allophone [ɦ] of the voiced glottal fricative /h/ occurs as a result of voicing assimilation in intervocalic position, a voicing rule in Ḥarsūsi can be formulated for the voicing of the voiced glottal fricative /h/ as Rule 14 below.

Rule 14:

/h/ [-Voice] → [+Voice] / V__V

4.1.3. Laterals

The laterals in Ḥarsūsi have a 3-way distinction. The laterals are: a voiced alveolar-lateral /l/, a voiceless alveolar-lateral fricative /ɬ/, and an emphatic alveolar-lateral fricative /ɬˤ/. All the laterals are attested in utterance-initial, medial, and final positions. Table 4.14 below shows the laterals in all three environments.

Phoneme	Initial	Medial	Final
/l/	/leˈʃiːn/ 'tongue M.SG' /leˈbuːn/ 'white M.SG'	/ˈkɐllen/ 'all of' /ˈhoːleh/ 'big M.SG' /ˈkoːb/ 'dog/wolf M.SG'	/ˈmoːl/ 'wealth M.SG' /ˈhoːfel/ 'belly M.SG'
/ɬ/	/ˈɬɐbeħ/ 'fat M.SG' /ˈɬeːf/ 'hair M.SG'	/ħɐˈɬɐn/ 'what'	/ˈɾeːɬ/ 'snakes M.PL' /ʔeɾˈħɐːɬ/ 'to wipe 2M.SG.IMP'
/ɬˤ/	/ˈɬˤɐ.heɾ/ 'back M.SG'	/heˈɬˤoːɾ/ 'green M.SG' /ˈnɬˤeːf/ 'mattress M.SG'	/ˈʔɐːreɬˤ/ 'wide ADJ'

Table 4.14: Ḥarsūsi lateral phonemes.

The voiced alveolar lateral /l/ has one voiced allophone [l] which occurs in all environments. It can be established as a separate phoneme in Ḥarsūsi given the minimal pair in Table 4.15 below.

Phoneme	Example
/l/	/jelˈħoːkʼ/ - [jil.ˈħoːkʼ] 'to catch up/help 3M.SG.IPFV'
/ɾ/	/jeɾˈħoːkʼ/ - [jiɾ.ˈħoːkʼ] 'to be distant 3M.SG.IPFV'

Table 4.15: Minimal pair of /l/ and /ɾ/.

The data in Table 4.15 above show that the voiced alveolar lateral [l] is in contrastive distribution with the voiced alveolar tap [ɾ], and therefore, it can be established as a separate phoneme. An interesting point about the voiced alveolar lateral /l/ is that it is vocalised in certain contexts. In mono-syllabic words, the /l/ is vocalised when it occurs before a consonant in coda position. Table 4.16 below shows two tokens from the data where the alveolar lateral /l/ is deleted.

Phoneme	Mono-syllabic	Di-syllabic
/l/	/ˈkoːb/ - [ˈkʰoːpʼ] or [ˈkʰɐwpʼ] ‘dog/wolf M.SG’	/keˈloːb/ - [kʰə.ˈloːpʼ] ‘dogs/wolves M.PL’
	/ˈgoːd/ - [ˈgoːt̪ʼ] ‘skin M.SG’	/geˈleːd/ - [gə.ˈleːt̪ʼ] ‘skins M.PL’

Table 4.16: /l/ deletion data.

As seen in Table 4.16 above, in the monosyllabic singular forms of the words ‘dog/wolf’ and ‘skin’, the voiced alveolar lateral /l/ is vocalised before a stop. However, in the plural forms of the same words, the /l/ surfaces to show that it is part of the root of these words. Watson (2012) found a similar process in Mehri and termed it as ‘/l/ vocalization’. She found the process to be more common in the Mehreyyet dialect of Mehri than in Mahriyōt (Watson, 2012).

Both the voiceless alveolar-lateral fricative /ɬ/ and the emphatic alveolar-lateral fricative /ɬˤ/ can be established as separate phonemes based on the minimal pair in Table 4.17 below which shows the sounds in contrastive distribution.

Phoneme	Example
/ɬ/	/jeɬˈboːb/ - [jiɬ.ˈboːpʼ] ‘to climb 3M.SG.IPFV’
/ɬˤ/	/jeɬˤˈboːb/ - [jiɬˤ.ˈboːpʼ] ‘to chat 3M.SG.IPFV’

Table 4.17: Minimal pair of /ɬ/ and /ɬˤ/.

The voiceless alveolar-lateral fricative /ɬ/ has only one voiceless allophone [ɬ] which occurs in all environments. As seen in Table 4.14 above, the same allophone [ɬ] has been attested in utterance-initial, medial, and final positions. The voiceless alveolar-lateral fricative /ɬ/ is discussed in more detail in 6.3.1.3.4.

The emphatic alveolar-lateral fricative /ɬˤ/ has two allophones that occur in different environments. It has a voiced 'backed' allophone [ɮˤ] which occurs intervocalically and a voiceless 'backed' allophone [ɬˤ] which occurs elsewhere. The word /heˈɬˤoːɾ/ - [hə.ˈɮˤo̹ːr] 'green M.SG' in Table 4.14 shows the context for /ɬˤ/ voicing. Rule 15 below states the distribution of the emphatic alveolar-lateral fricative /ɬˤ/ allophones.

Rule 15:

/ɬˤ/ → [ɮˤ] / V__V

[ɬˤ] elsewhere

Since the voiced 'backed' allophone [ɮˤ] occurs as a result of voicing assimilation in intervocalic positions, a voicing rule in Ḥarsūsi can be formulated for the voicing of the emphatic alveolar-lateral fricative /ɬˤ/ as Rule 16 below.

Rule 16:

/ɬˤ/ [-Voice] → [+Voice] / V__V

The articulation of the emphatic alveolar-lateral fricative /ɬˤ/ is discussed in 4.3.

4.1.4. Nasals

The nasals in Ḥarsūsi are: a labial /m/ and an alveolar /n/. Both nasals are attested in utterance-initial, medial, and final positions. Table 4.18 below shows the nasals and their allophones in different environments.

Phoneme	Initial	Medial	Final
/m/	/ˈmɐken/ 'a lot ADJ' /meθeˈneːt/ 'tooth F.SG' /ˈmoːh/ 'water M.SG'	/kenˈmuːt/ 'louse F.SG' /keɾˈmeːm/ 'mountain M.SG' /jemˈʃeːh/ 'yesterday ADV'	/ʔaˈtoːm/ 'you 2M.PL' /ˈfɐːm/ 'foot M.SG' /ħeˈjuːm/ 'sun F.SG'
/n/	/ˈnoːsˤereh/ 'now ADV' /nˈdɐχ/ 'smoke M.SG' /neˈhuːren/ 'morning ADV'	/ðeˈneːb/ 'tail M.SG' /ðenˈbuːten/ 'tails M.PL' /ʔenˈkoːnɐː/ 'to come 1C.SG.FUT'	/ˈseːn/ 'they 3F.PL' /ˈħoːn/ 'where ADV' /ʁeˈgeːn/ 'male-child M.SG'

Table 4.18: Ḥarsūsi nasal phonemes.

The nasals in Ḥarsūsi can be established as separate phonemes based on the minimal pair in Table 4.19 below. The possessive marker for plural masculine subjects is /-kem/ - [kəm] 'your M.PL' and the possessive marker for plural feminine subjects is /-ken/ - [kən] 'your F.PL'.

Phoneme	Example
/m/	/ħɐjˈbiːt-kem/ [ħɐi.ˈbit.kəm̥] 'your camel 2M.PL'
/n/	/ħɐjˈbiːt-ken/ [ħɐi.ˈbit.kən̥] 'your camel 2F.PL'

Table 4.19: Minimal pair of /m/ and /n/.

The results based on visual observations of spectrograms and waveforms show both nasals to be devoiced in utterance-final positions as seen in Figure 4.3 below.

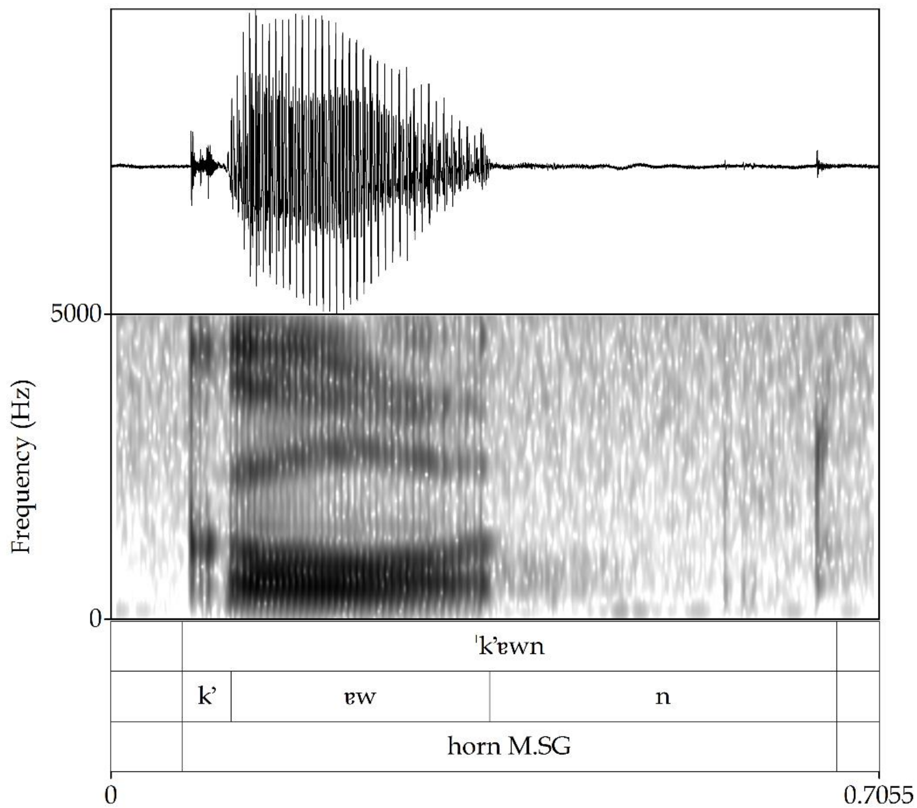

Figure 4.3: Spectrogram and Waveform showing devoiced /n/ in /k'ɐwːn/ 'horn M.SG'.

In many of the tokens in the data, vocal folds pulses cease to exist after a short period into the nasal in utterance-final positions. In addition, the spectrograms show very low energy during the articulation of both nasals in utterance-final positions. Heselwood & Watson (2018) mentioned that Mehri sonorants which include the nasals /m, n/ are silently articulated in utterance final positions. Their definition of silent articulation was that it is an articulatory movement that is suitable to realise a phoneme without acoustic output (Heselwood & Watson, 2018).

The labial nasal /m/ has two allophones that occur in different environments. It has a voiced allophone [m] which occurs utterance-initially and medially, and a voiceless allophone [m̥] that occurs utterance-finally. Rule 17 below states the distribution of the labial nasal /m/ allophones.

Rule 17:

/m/ → [m̥] / __#

[m] elsewhere

The alveolar nasal /n/ has five allophones that occur in different environments. It has a voiced labial [m] which occurs utterance-medially when followed by a labial, a voiced velar /ŋ/ which occurs when followed by a velar, a voiced labio-dental [ɱ] which occurs when followed by a labio-dental, a voiceless /n̥/ which occurs utterance-finally, and a voiced alveolar [n] which occurs elsewhere. Rule 18 below states the distribution of the alveolar nasal /n/ allophones.

Rule 18:

/n/ → [m] / __ [+labial]

[ŋ] / __ [+velar]

[ɱ] / __ [+labio-dental]

[n̥] / __ #

[n] elsewhere

As seen in rule 17, the nasal /n/ assimilates to the place of the following labial, velar, or labio-dental. The place assimilation of nasals is also found in dialects of Arabic (Watson, 2007).

4.1.5. Tap

Ḥarsūsi has one alveolar tap /ɾ/. The alveolar tap /ɾ/ can be established as a separate phoneme based on the minimal pair in Table 4.15 above. Table 4.20 below shows /ɾ/ in different environments.

Phoneme	Initial	Medial	Final
/ɾ/	/ɾeˈmoːdet/ ‘ashes F.PL’ /ˈɾeħekʼ/ ‘far M.SG’ /ɾeˈjɐħ/ ‘wind F.SG’	/ħeˈɾuːɬˤ/ ‘acacia tree F.SG’ /ˈbɐɾek/ ‘knee F.SG’ /feˈɾɾoːnɐ/ ‘to fly 1C.SG.FUT’	/deˈfeːɾ/ ‘to push 3.M.SG.PFV’ /heˈɬˤoːɾ/ ‘green M.SG’ /ˈfeɾɾ/ ‘feather F.SG’

Table 4.20: Ḥarsūsi tap phoneme.

The alveolar tap /ɾ/ has two allophones: a voiced trill [r] and a voiced tap [ɾ]. The voiced trill [r] occurs when geminate and in utterance-final positions, while the voiced tap [ɾ] occurs elsewhere. Rule 19 below states the distribution of /r/ allophones.

Rule 19:

/ɾ/ → [r] / { C_1C_1__ ; __ # }

[ɾ] elsewhere

4.1.6. Glides

There are two phonemic glides in Ḥarsūsi, a voiced labial velar /w/ and a voiced palatal /j/. Table 4.21 below shows these phonemes in different environments.

Phoneme	Initial	Medial	Final
/w/	/weˈɾeːkʼ/ ‘leaves F.PL’ /ˈwoːɾeχ/ ‘month M.SG’ /ˈwɐː/ ‘and’	/beɾˈwoːt/ ‘to give birth 3F.SG.PFV’ /jeˈteːwem/ ‘to eat 3M.PL.IPFV’ /jeˈkʼeːwiː/ ‘to vomit 3M.SG.IPFV’	/ˈbiːɾw/ ‘to give birth 3F.PL.PFV’ /jeˈteːw/ ‘to eat 3M.SG.IPFV’ /mekʼeˈneːw/ ‘male child M.SG’
/j/	/jeˈtiːt/ ‘six F.PL’ /jeˈnɐːħ/ ‘wing M.SG’ /ˈjuːmet/ ‘day F.SG’	/ħelˈleːjo/ ‘night M.SG’ /ʔɐːˈjoːnten/ ‘eyes F.PL’	/be-heˈllɐj/ ‘at night/tonight’

Table 4.21: Ḥarsūsi glide phonemes.

Both of the glides can be established as separate phonemes based on the minimal and near-minimal pairs in Table 4.22 below.

Phoneme	Example
/w/	/ˈwɐː/ [ˈwɐ] ‘and’
/k/	/ˈkɐː/ [ˈkɐ] ‘with’
/j/	/ħeˈjuːm/ [ħi.ˈjuːm] ‘sun F.SG’
/g/	/ħeˈgoːm/ [ħə.ˈgoːm] ‘to leave camels in safe place and return home 3M.SG.PFV’

Table 4.22: Minimal and near-minimal pairs of /w/ and /j/.

The data in Table 4.22 above show that the labial velar [w] is in contrastive distribution with the voiceless velar stop [k]; therefore, it is a separate phoneme in Ḥarsūsi. Similarly, the palatal [j] is in contrastive distribution with the voiced velar stop [g]; therefore, it is also a separate phoneme.

Both glides have two separate allophones for each which occur in different environments. The data in Table 4.21 above show both glides in various environments. The labial velar /w/ has a high-mid back rounded allophone [o] which occurs in utterance-final positions and a labial velar [w] which occurs elsewhere. Similarly, the palatal /j/ has a high front unrounded allophone [i] which occurs in utterance-final positions and a palatal [j] which occurs elsewhere. Rules 20 and 21 below state the distribution of the labial velar /w/ and the palatal /j/ allophones, respectively.

Rule 20:

/w/ → [o] / __#

[w] elsewhere

Rule 21:

/j/ → [i] / __#

[j] elsewhere

It can be seen that both of the glides surface as short vowels in utterance-final position and as glides in other environments. Therefore, a general rule for Ḥarsūsi glide realisation in utterance-final positions can be formulated as Rule 22 below.

Rule 22:

/C/ [-Consonantal , -Syllabic] → [V] [-Consonantal , +Syllabic] / __#

Apart from these two phonemic glides, Ḥarsūsi also has some allophonic diphthongs as a result of long vowel diphthongisation in certain contexts which are discussed in detail in 4.4.2. As a result of this diphthongisation process, distinguishing the (vowel + glide) clusters from diphthongised vowels is not straightforward and especially in utterance-final positions where the glides surface as vowels themselves. Nonetheless, the consonantal root of the words can be taken as a distinguishing criterion for (vowel + glide) clusters in Ḥarsūsi. The data in Table 4.23 below show how the consonantal root helps in distinguishing the (vowel + glide) clusters.

Root	Example 1	Example 2
/b-r-w/	/ˈbiːɾw/ - [ˈbiː.ɾo] ‘to give birth 3F.PL.PFV’	/beɾˈwoːt/ - [bəɾ.ˈwoːt̪] ‘to give birth 3F.SG.PFV’
/l-l-j/	/be-heˈllɐj/ - [bə-ħə.ˈlːɐi] ‘at night/tonight’	/ħelˈleːjo/ - [ħə.ˈliː.jo] ‘night M.SG’
/g-n-ʔ/	/geˈnoː/ - [gə.ˈno] ‘to sit 3F.PL.PFV’	/geˈnoːt/ [gə.ˈnoːt̪] ‘to sit 3F.SG.PFV’

Table 4.23: Examples of Vowel + Glide clusters.

By looking at the data in Table 4.23, it can be seen that the word for ‘to give birth’ has the consonantal root /b-ɾ-w/ in Ḥarsūsi. The labial velar /w/ which is part of the consonantal root surfaces as a high-mid back rounded vowel [o] when the word is in perfective aspect for plural subjects as in /ˈbiːɾw/ - [ˈbiː.ɾo] ‘to give birth 3F.PL.PFV’. However, in the perfective aspect for singular subjects, the labial velar /w/ of the consonantal root surfaces as a glide [w] as in the word /beɾˈwoːt/ - [bəɾ.ˈwoːt̪] ‘to give birth 3F.SG.PFV’. In comparison, the word for ‘to sit’ has the consonantal root /g-n-ʔ/ in Ḥarsūsi. In the perfective aspect for plural subjects it surfaces as /geˈnoː/ - [gə.ˈno] ‘to sit 3F.PL.PFV’ which is similar to the form for the word ‘to give birth’ as seen previously. However, in the perfective aspect for singular subjects the word for ‘to sit’ surfaces as /geˈnoːt/ - [gə.ˈnoːt̪] ‘to sit 3F.SG.PFV’ with no glide as was the case for the word ‘to give birth’. These previous examples show that the consonantal root can be taken as a criterion to distinguish the (vowel + glide) clusters from diphthongised vowels.

In the case of the voiced palatal /j/, data in Table 4.23 above show that the word for ‘night’ has the consonantal root /l-l-j/ in Ḥarsūsi which gets the definite marker /ħ-/ in these examples. The voiced palatal /j/ shows up as a high front unrounded vowel [i] when it is in utterance-final position as in the word /be-ħeˈllɐj/ - [bə-ħə.ˈlːɐi] ‘at night/tonight’. In non-final positions, however, the palatal /j/ surfaces as a glide [j] as in the word /ħelˈleːjo/ - [ħə.ˈliː.jo] ‘night M.SG’.

4.2. The Glottal /ʔ/ and the Pharyngeal /ʕ/

The glottal stop /ʔ/ and the voiced pharyngeal /ʕ/ are interesting and complicated in Ḥarsūsi. They are both realised differently in different environments. The voiced pharyngeal /ʕ/ has been attested utterance-initially and medially in a handful of Ḥarsūsi words in addition to some Arabic words borrowed into Ḥarsūsi, but the glottal stop /ʔ/ has been attested only utterance-initially.

From a historical point of view, the Proto-Semitic voiced pharyngeal /ʕ/ has changed into a glottal stop /ʔ/ (Kogan, 2011). In the reconstruction of the Proto-Semitic word for ‘bone’, Kogan (2011) showed that the etymological *ʕ has changed into a glottal /ʔ/ in Mehri as in the word /ʔāðˤəmēt/ (p. 58). This change is also seen in Ḥarsūsi in the elicitation of the same word as it is given as /ʔɐðˤemet/ - [ʔɑ.ðˤe.met] ‘back F.SG’. This change can be further proven from the fact that certain words in Ḥarsūsi are attested with either a voiced pharyngeal /ʕ/ or a glottal stop /ʔ/ as in the word /sɐːˈʕiːt/ - [sɐː.ˈʔɐit̪] or [sɐː.ˈʕait̪] ‘nine F.SG’. Therefore, it can be said that the low attestation of the voiced pharyngeal /ʕ/ in Ḥarsūsi is due to the fact that it underwent diachronic change into a glottal stop /ʔ/.

A similar change of the voiced pharyngeal is also found in Mehri. Rubin (2018) stated that in Omani Mehri, the voiced pharyngeal /ʕ/ is lost in most positions except in some environments. It is retained when followed by stressed /ə/ in a closed syllable or diphthong /ɐj/ in an initial syllable, in a stressed open syllable, or in a stressed final open or closed syllable. In addition, it is retained in “the sequence Vʿy which we find in D/L-Stem forms of I-ʿ, II-y verbs” (Rubin, 2018, p. 25). On the other hand, Watson et al. (2020) said that the voiced pharyngeal /ʕ/ is realised as /ʕ/ when it precedes /j/, /i/, unstressed /ī/ or stressed /ə/ (p. 18). Moreover, they showed that etymological *ʕ when not realised as [ʕ] causes the realisation of back vowels and diphthongisation of following long high vowels (Watson et al., 2020, p. 18).

In the Ḥarsūsi data, the voiced pharyngeal /ʕ/ occurs in a few environments only utterance-initially and medially. It occurs as onset to stressed syllable with /e/ as in /beˈʕeli/ - [bə.ˈʕeli] ‘owners of C.PL’. Moreover, it occurs before the glide /j/ or vowel /iː/ as in /beʕˈjoːr/ - [bəʕ.ˈjoːr] ‘male-camel M.SG’ and /ˈʕiːd/ - [ˈʕiː t̪ʼ] ‘Eid festival M.SG’. Table 4.24 below shows some of the Ḥarsūsi words where the voiced pharyngeal is realised as /ʕ/.

Phoneme	Initial	Medial	Final
/ʕ/	/ˈʕejnuːnet/ - [ˈʕej.nuː.nət̪] ‘little ADJ’ /ˈʕedd/ - [ˈʕedː] ‘to count 2M.SG.IMP’ /ˈʕiːd/ - [ˈʕiː t̪ʼ] ‘Eid festival M.SG’	/sˤɐːˈʕiːt/ - [sˤɑː.ˈʕait̪] ~ [sˤɑː.ˈʔait̪] ‘nine F.SG’ /meʕˈjoːn/ - [məʕ.ˈjoːn] or [mə.ʔ.ˈjoːn] ‘intestines F.PL’ /beʕˈjoːr/ - [bəʕ.ˈjoːɾ] ‘male-camel M.PL’ /kʼeʕˈjoːt/ - [kʼəʕ.ˈjoːt̪] ‘female-spirit F.SG’ /kʼeːˈʕj/ - [kʼeː.ˈʕi] ‘male-spirit M.SG’ /beˈʕeli/ - [bə.ˈʕeli] ‘owners of C.PL’	Not Attested

Table 4.24: Voiced pharyngeal /ʕ/.

An interesting point about the attestation of the voiced pharyngeal /ʕ/ in the few examples in Ḥarsūsi is that they are mostly either nouns or adjectives. It should be noted here, however, that the occurrence of the pharyngeal /ʕ/ is more frequent in the speech of the younger generation and in words borrowed from or having a similar form in Arabic as in the words /ˈʕiːd/ - [ˈʕiːt̪ʼ] ‘Eid occasion M.SG’ and /ˈʕajn/ - [ˈʕain] ~ [ˈʔain] ‘eye F.SG’.

As for the glottal stop, it has not been attested in Ḥarsūsi except word-initially and in the few instances where it alternates with the voiced pharyngeal /ʕ/ as seen in Table 4.24 above. Table 4.25 below shows the glottal stop word-initially in Ḥarsūsi.

Phoneme	Initial
/ʔ/	/ˈʔɐjn/ - [ˈʔɑin] ‘eye F.SG’ /ˈʔɐːm/ - [ˈʔɑːm] ‘if’ /ʔɐːˈmuːɾ/ - [ʔɑː.ˈmuːr] ‘to say 3M.SG.PFV’ /ʔɐˈtoːm/ - [ʔɑ.ˈt̪oːm] ‘you 2M.PL’ /ʔɐˈteːn/ - [ʔɑ.ˈt̪eːn] ‘you 2F.PL’ /ʔɐˈffɐɾ/ - [ʔɑ.ˈfːɐr] ‘red M.SG’ /ʔɐħˈfeːɾ/ - [ʔɑħ.’feːr] ‘to dig 1C.SG.IPFV’ /ʔɐˈzeːm/ - [ʔɑ.’zeːm] ‘to give 1C.SG.IPFV’ /ʔɐlˈbeːd/ - [ʔɑl.ˈbeːt̪ʼ] ‘to hit 1C.SG.IPFV’

Table 4.25: Glottal stop /ʔ/.

In utterance-medial positions, the glottal stop /ʔ/ in Ḥarsūsi is dropped. This drop can be proven by looking at the consonantal roots of Ḥarsūsi words including the glottal /ʔ/ and how they are realised in different environments. For instance, the consonantal root for the word ‘say’ is /ʕ-m-ɾ/ and, as seen in Table 4.25, it is realised with the glottal stop as /ʔɐːˈmuːɾ/ - [ʔɑː.ˈmuːr] ‘to say 3M.SG.PFV’ word-initially. However, word-medially, the glottal stop /ʔ/, which is substituting the voiced pharyngeal in this word, is dropped and the word is realised as /ˈjɐwmeɾ/ - [ˈjɐu.məɾ] ‘to say 3M.SG.IPFV’.

In utterance-final positions, the- glottal stop /ʔ/ is dropped completely, but sometimes creaky voice is seen on the final vowel. For instance, the word with the consonantal root /b-tˤ-ʔ/ is realised in Ḥarsūsi as /jeˈboːtˤɐ/ - [ji.ˈboː.tˤɑ̰] 'to slow 3M.SG.IPFV'. Similarly, the word for 'come' with the consonantal root /n-k-ʕ/ is realised as /ˈnkaː/ - [ˈn.ka̰ː] 'to come 2M.SG.IMP' where the glottal stop substituting the voiced pharyngeal /ʕ/ is dropped as seen in Figure 4.4 below.

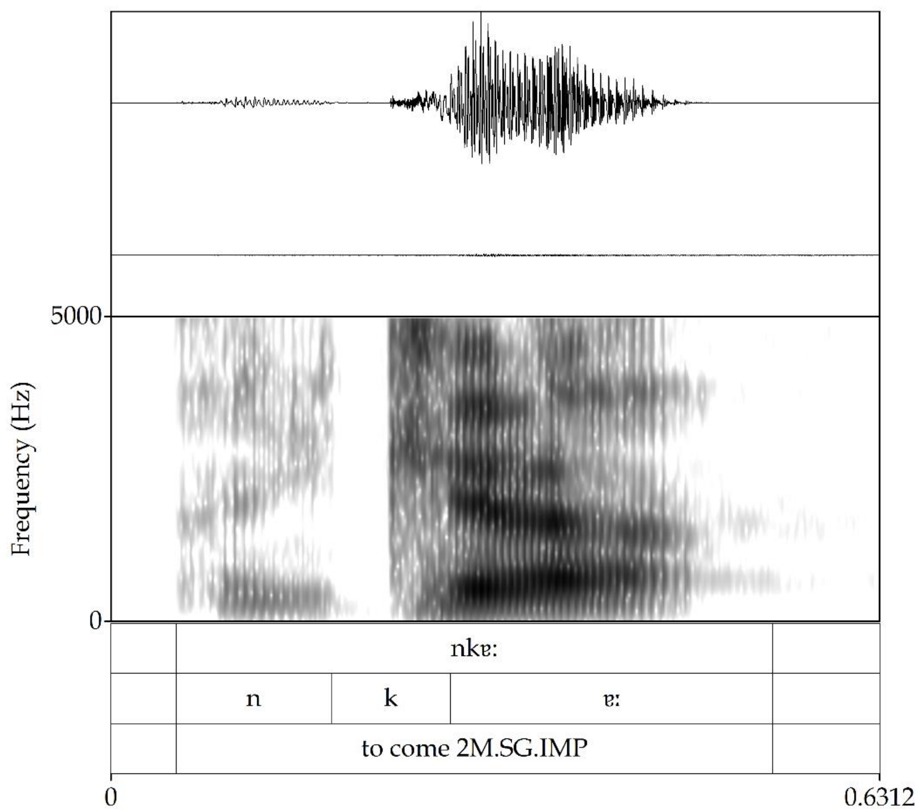

Figure 4.4. Spectrogram and waveform showing the drop of the glottal /ʔ/.

In conclusion, data show that the historical voiced pharyngeal /ʕ/ has changed into a glottal stop /ʔ/ which is dropped utterance-medially and finally in Ḥarsūsi. This explains the low occurrence of the pharyngeal /ʕ/ in Ḥarsūsi words. Nonetheless, there are a few phonological environments and a few Ḥarsūsi words where the historical voiced pharyngeal /ʕ/ is still retained as seen in Table 4.24. It should be also noted here that the voiced pharyngeal /ʕ/ always occurs in words borrowed from Arabic into Ḥarsūsi. The glottal stop /ʔ/ is attested only in utterance-initial positions and does not occur in utterance-medial and final positions.

4.3. THE EMPHATICS

As mentioned in 2.4, similar to other Semitic languages, Ḥarsūsi includes a class of consonants which act as a phonological category generally known by the term emphatics. Interestingly, the emphatics in Ḥarsūsi include both ejectives and 'backed' consonants.

In the following sections 4.3.1 and 4.3.2 each type of Ḥarsūsi emphatics, ejective and 'backed', will be investigated and discussed in detail based on the visual examination of the waveforms and spectrograms.

It should be noted here that the illustrative images in the following sections below are transcribed phonemically and broad phonetically in case of some long vowels. In addition, only the segment in focus is segmented in detail for illustrative purposes.

4.3.1. The Emphatic Stops

Visual examination of the spectrograms and waveforms show that the articulation of emphatic stops is context dependent. Each emphatic stop is articulated differently in different environments.

The emphatic dental stop /tˤ/ occurs in utterance-initial, medial, and final positions and is articulated differently in these environments. Visual inspections show that it is realised as an ejective only in utterance-final positions. As seen in Figure 4.5 below, a spike can be seen in the waveform which is suggestive of glottalic release after the initial oral release in the word /jemˈtˤawtˤ/ - [jim.ˈt̪ˤawt̪’] ‘to pull 3M.SG.IPFV’. In addition, the spectrogram also shows a silent period suggestive of glottal closure after the initial oral burst. The secondary burst is brief, which suggests a weak glottal release in this token.

By contrast, in utterance-initial and medial positions, the emphatic alveolar /tˤ/ is not realised as an ejective, as the glottalic spike or burst cannot be seen in the waveforms and spectrograms in Figure 4.6 and Figure 4.7 below.

It should be noted, however, that few tokens in the data also showed a short period of irregular cycles in the waveform preceding the oral closure of the emphatic dental stop /tˤ/ in utterance-final position mainly, but sometimes in utterance-medial as well. Such a short period is seen in Figure 4.5 below which is suggestive of pre-glottalisation in these realisations. In addition, creaky voice can also be seen on the vowel preceding the emphatic dental stop /tˤ/; nonetheless, other non-emphatic segments also showed sometimes creaky voice on preceding vowels.

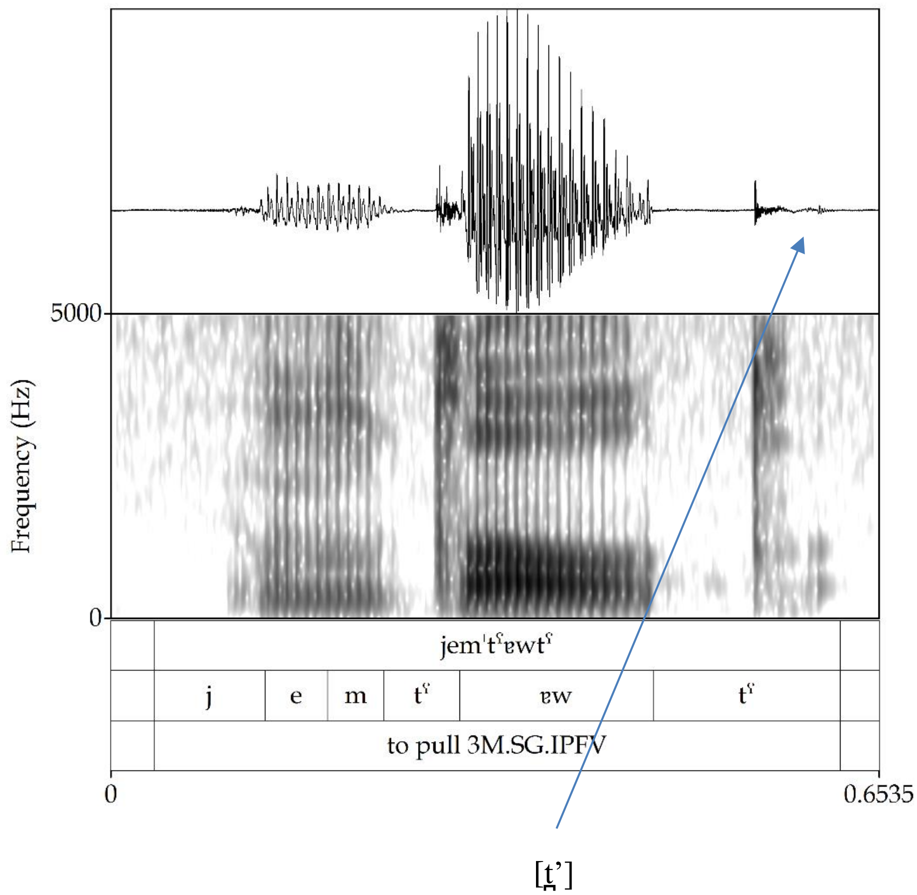

Figure 4.5: Spectrogram and waveform showing the glottal release spike and burst in the emphatic /tˤ/ in /jemˈtˤɐwtˤ/ - [jim.ˈt̪ˤɑwt̪’] ‘to pull 3M.SG.IPFV’.

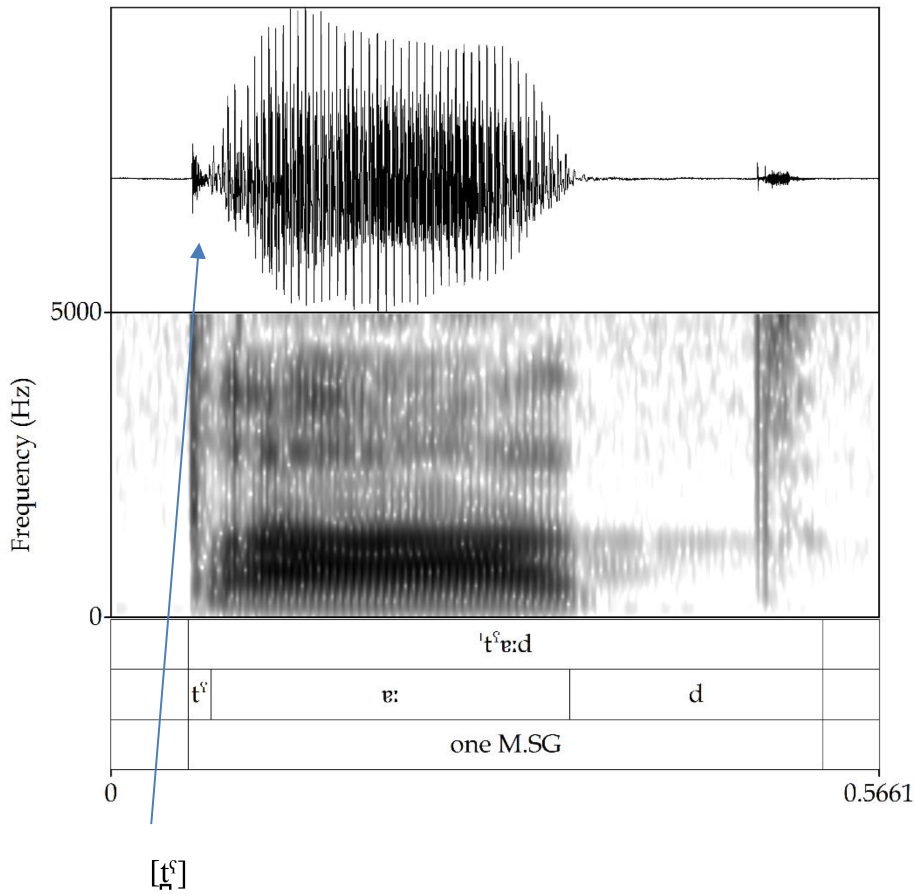

Figure 4.6: Spectrogram and waveform lacking the glottal release spike and burst in the emphatic /tˤ/ in /ˈtˤɐːd/ - [ˈt̪ˤɑːt̪ʼ] ‘one M.SG’.

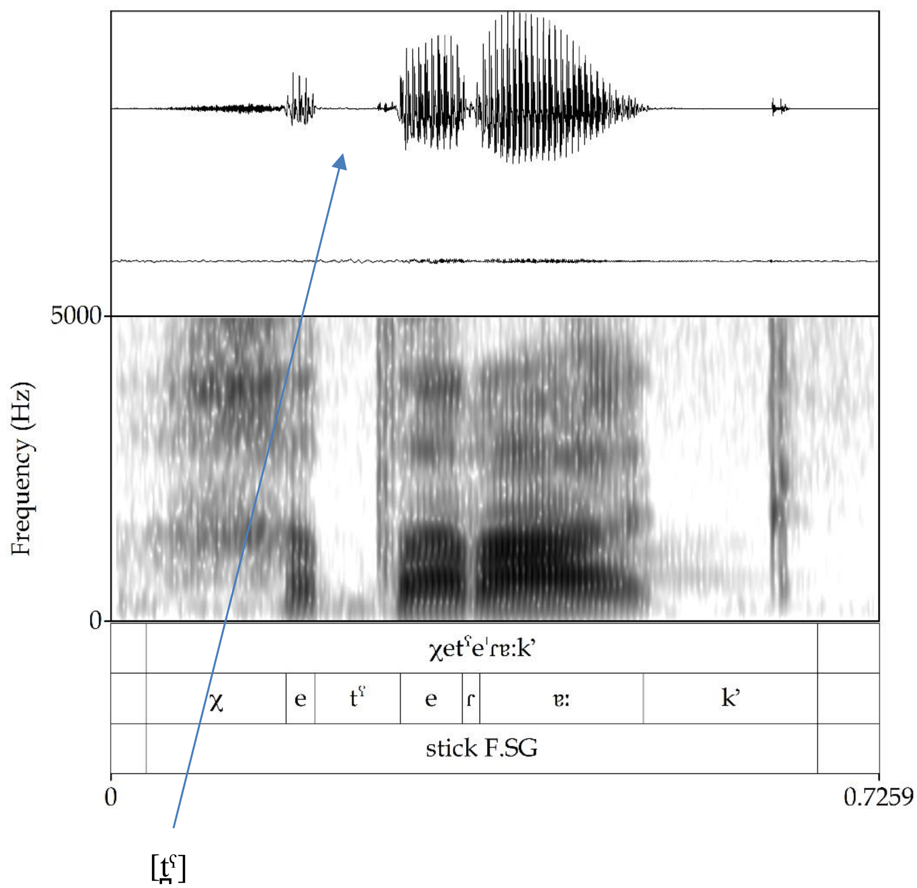

Figure 4.7: Spectrogram and waveform lacking the glottal release spike and burst in the emphatic /tˤ/ in /χetˤeˈɾaːk’/ - [χətˤə.ˈɾɐːk’] ‘stick F.SG’.

As for the velar emphatic stop /k’/, it also occurs in utterance-initial, medial, and final positions and is realised differently in each environment. It is realised as an ejective in utterance-initial and final positions more commonly. In utterance-medial positions it is realised as an ejective in a few tokens only. Figure 4.8 below clearly shows a second burst in the waveform after the oral burst which is typical of glottalic release in the word /ˈk'ɐːl/ - [ˈk'ɐ̰ːl̥] 'to pour 3M.SG.PFV'. Moreover, the spectrogram also shows a glottal burst after the initial oral burst which shows that the velar emphatic /k'/ is realised as an ejective in this environment.

Similarly, in utterance-final positions the emphatic velar stop /k'/ is realised as an ejective consonant. Figure 4.9 below shows the glottal release spike and burst in the velar emphatic /k'/ in the word /teˈbuːɾek'/ - [t̪ə.ˈbuː.ɾək'] 'to flash, lighten 3F.SG.IPFV'.

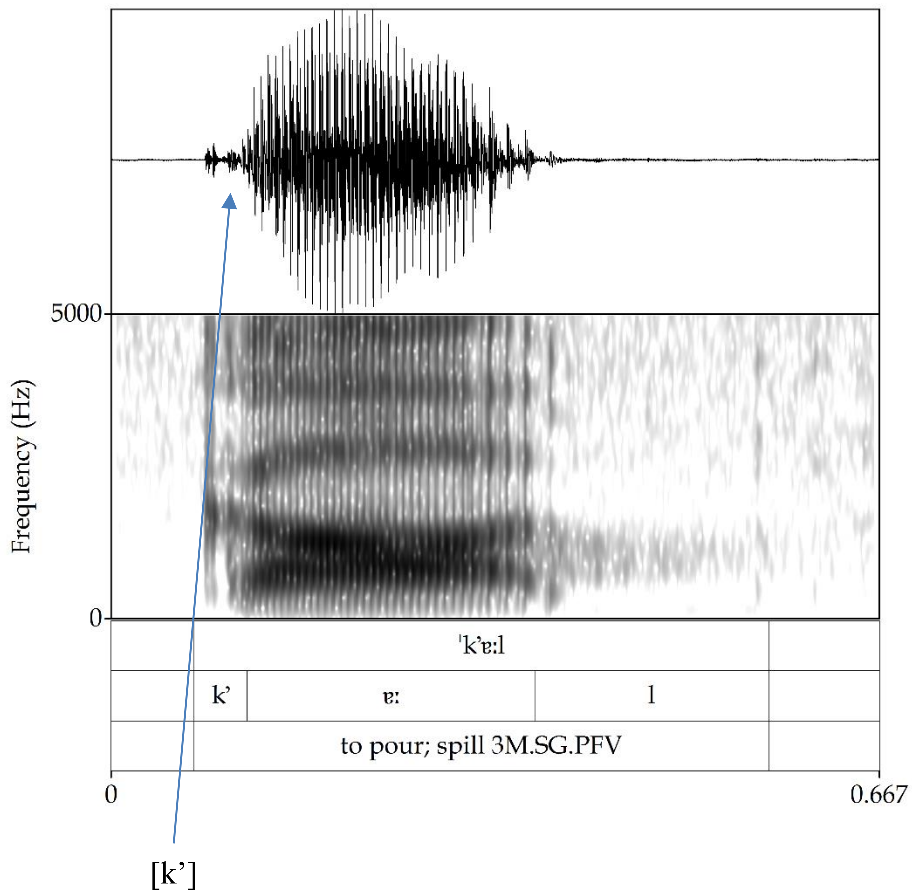

Figure 4.8: Spectrogram and waveform showing the glottal release spike and burst in the emphatic /k’/ in /k’ɐːl/ - [ˈk’ɐ̰ːl̥] ‘to pour 3M.SG.PFV’.

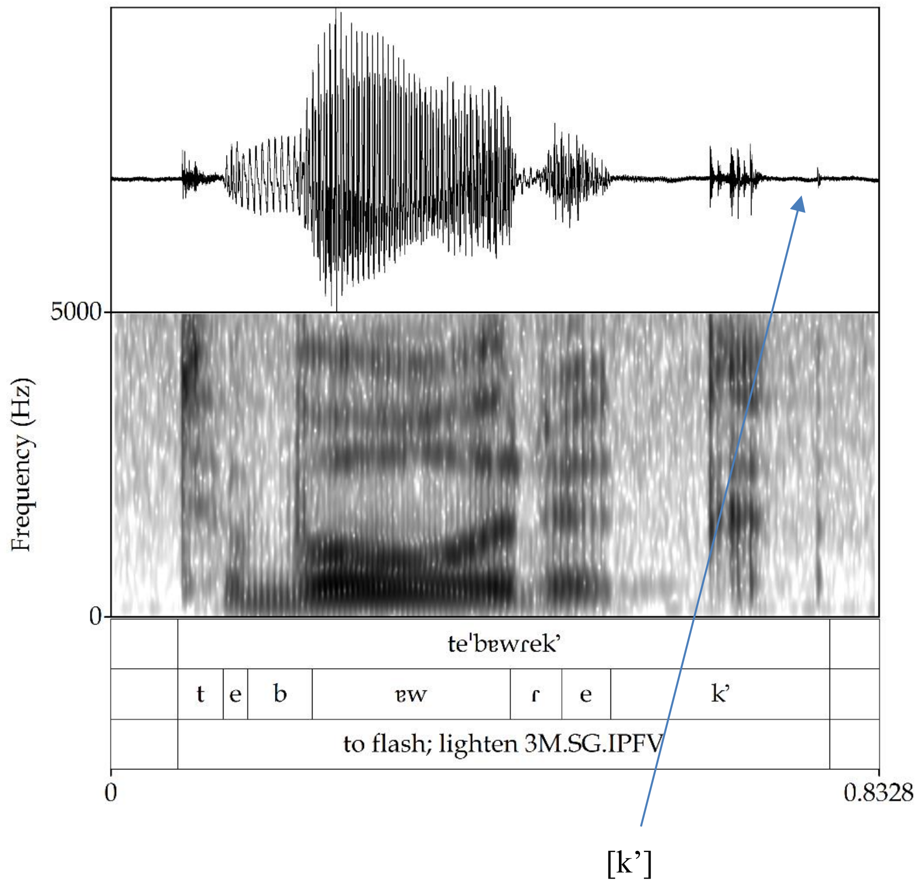

Figure 4.9: Spectrogram and waveform showing the glottal release spike and burst in the emphatic /k’/ in /teˈbɐwɾek’/ - [t̪ə.ˈbɐw.ɾək’] ‘to flash; lighten 3F.SG.IPFV’.

On the other hand, in utterance-medial positions, the emphatic velar stop /k’/ is less commonly realised as a glottalised. Figure 4.10 and Figure 4.11 show the emphatic velar stop /k’/ being realised in two different ways in utterance-medial position.

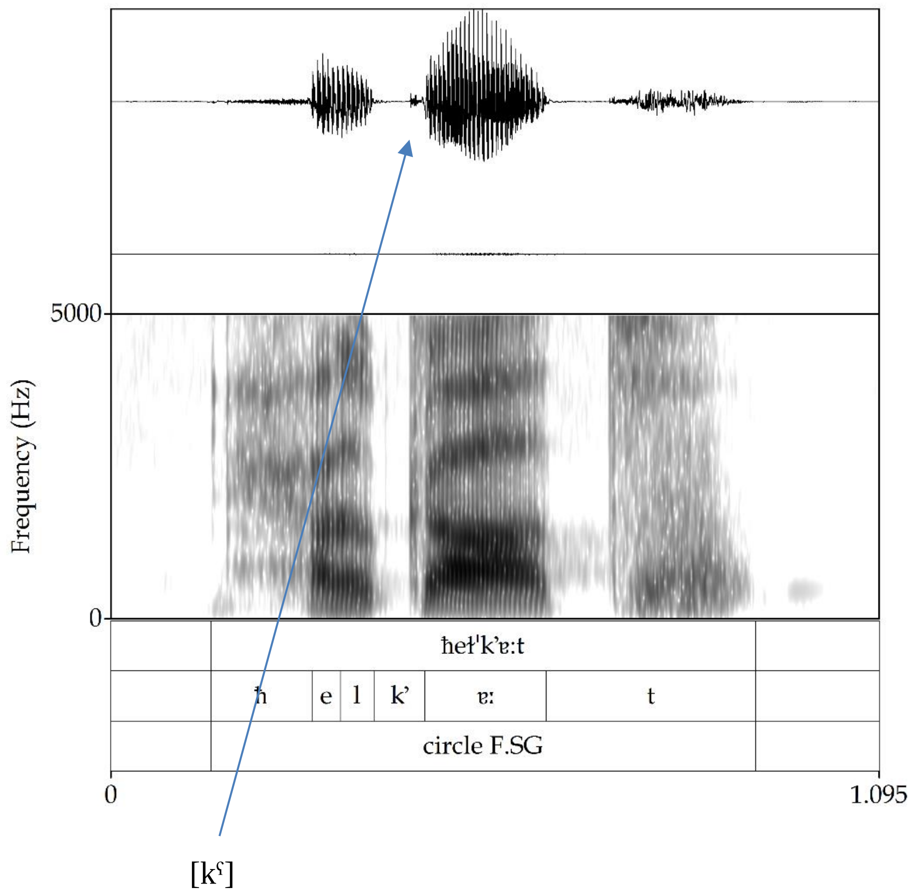

Figure 4.10: Spectrogram and waveform lacking the glottal release spike and burst in the emphatic /k'/ in /ħelˈk'ɐːt/ - [ħəɫːˈkˤɐːt̪ʰ] 'circle F.SG'.

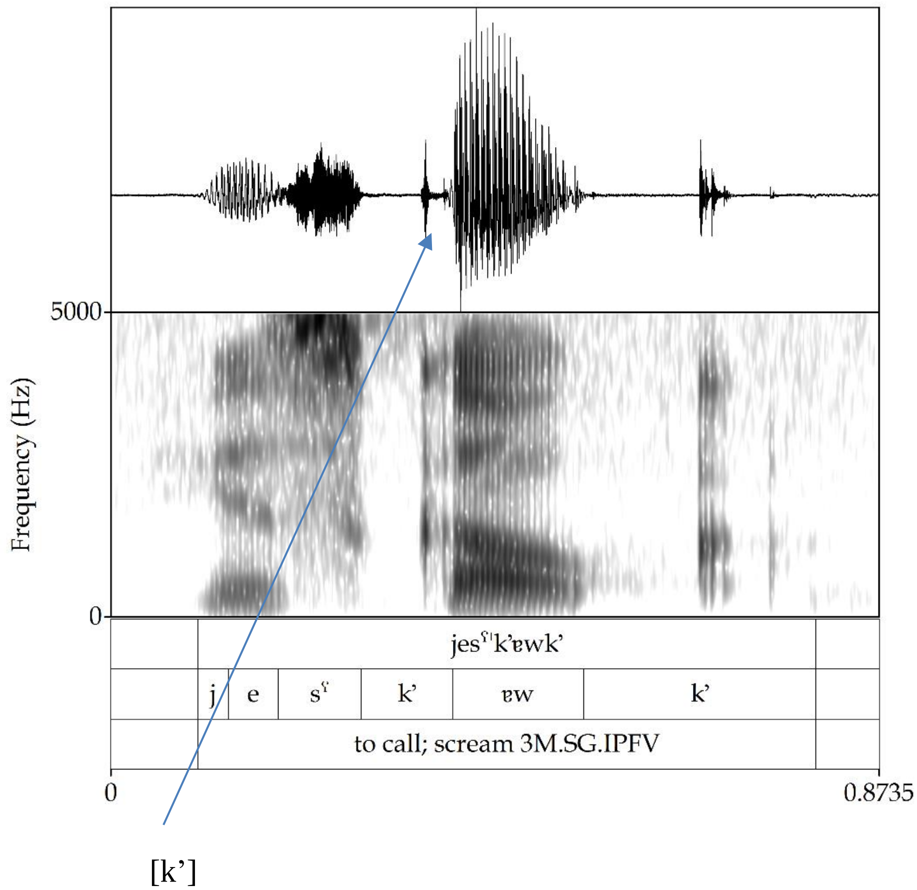

Figure 4.11: Spectrogram and waveform showing the glottal release spike and burst in the emphatic /k'/ in /jesˤˈk'ɐwk'/ - [jisˤ.ˈk'ɑwk'] 'to call; scream 3M.SG.IPFV'.

It is worth mentioning here that some tokens in the data also showed a short period of irregular cycles in the waveform preceding the oral closure of the emphatic velar stop /k'/ in utterance-medial and final positions. Such a short period is seen in Figure 4.9 above which is suggestive of pre-glottalisation in these realisations. In addition, creaky voice can also be seen on the vowel preceding the emphatic velar stop /k’/; however, other non-emphatic segments also showed sometimes creaky voice on preceding vowels

Given the previous results and following the convention of naming phonemes according to their principal allophones, the emphatic velar stop phoneme is best labelled as ‘ejective’ /k’/, while the emphatic dental stop phoneme is best labelled as ‘backed’ /tˤ/. The emphatic velar stop phoneme is realised as an ejective in both utterance-initial and final positions, but not in all medial positions, while the emphatic alveolar /tˤ/ is only realised as an ejective in utterance-final position (see rules 4 and 7 in 4.1.1).

4.3.2. The Emphatic Fricatives

The emphatic interdental fricative /ðˤ/ is realised differently in different environments as was mentioned above in 4.1.2. It is realised as a devoiced ‘backed’ fricative [θˤ] in some tokens of utterance-initial position by some speakers, as an ejective [θ’] in utterance-final position, and as a fully voiced fricative [ðˤ] in other positions. Ejectivity affects other voiced consonants as well and is not exclusive to the emphatic interdental fricative /ðˤ/. As seen in Figure 4.12 below, in utterance-initial position, the spectrogram for the interdental /ðˤ/ is aperiodic with energy showing at higher frequencies which is typical of continuant frication. Moreover, the emphatic interdental fricative /ðˤ/ in this token is articulated as a voiceless [θˤ] which is clear in the fact of having low energy in lower formants and lacking the blue lines of glottal pulses in the waveform. On the other hand, in utterance-final position, as can be seen in Figure 4.13 below, the emphatic interdental /ðˤ/ is articulated with a post-frication silent lag which can be translated as a glottal closure suggesting an ejective realisation in this position. It should be noted that pre- and post-frication silent lags were found in some tokens of Mehri emphatic fricatives (Ridouane & Gendrot, 2017).

In addition, some tokens in utterance-final position were preceded by a short period of pre-glottalisation (PG) (see 6.3.1.1.1).

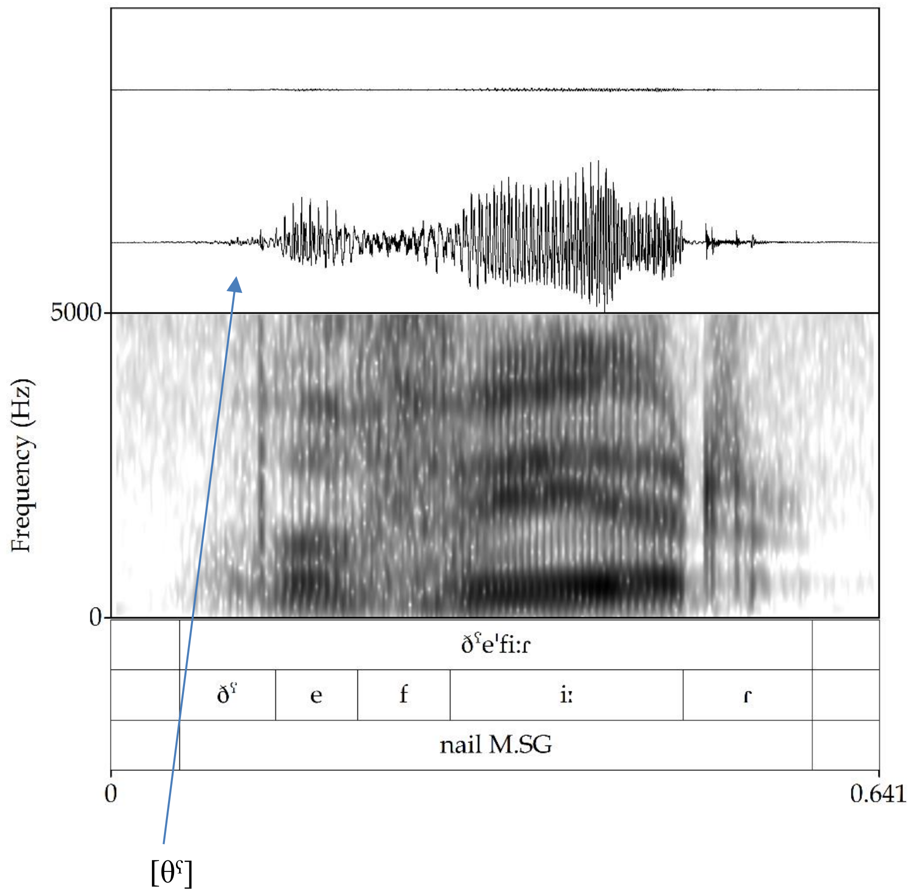

Figure 4.12: Spectrogram and waveform lacking the silent lag in the emphatic /ðˤ/ in /ðˤe'fːɾ/ - [θˤə.'fiːr] 'nail M.SG'.

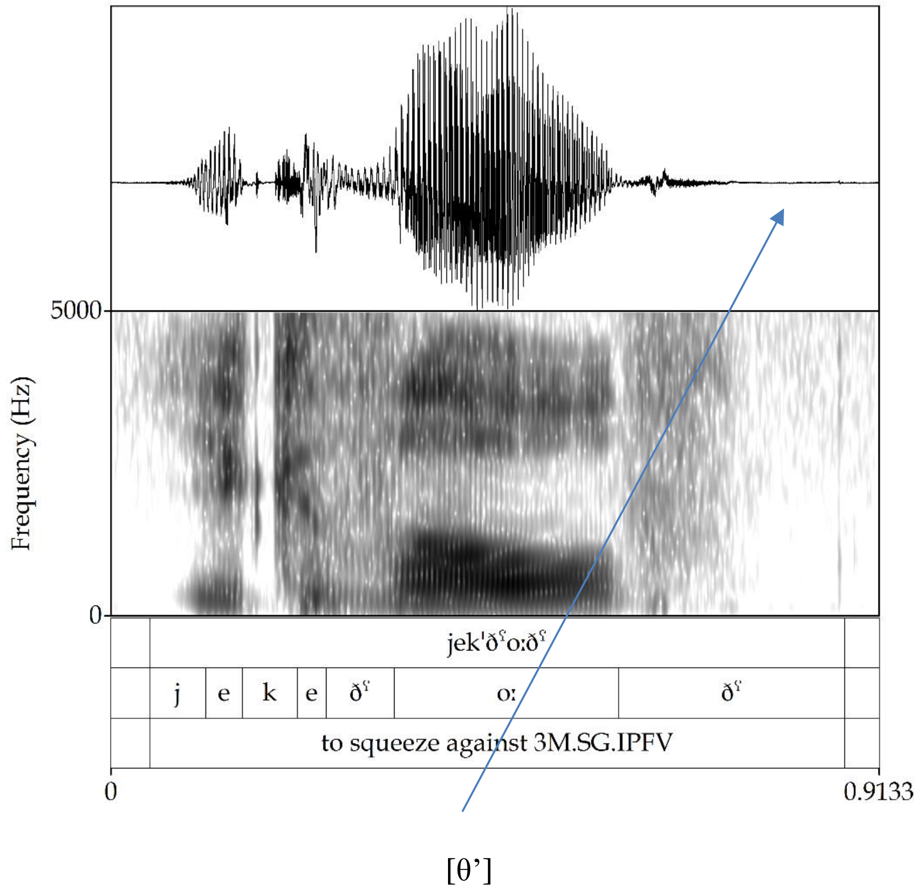

Figure 4.13: Spectrogram and waveform showing the post-frication silent lag in the emphatic /ðˤ/ in /jekˈðˤoːðˤ/ - [jikˈðˤo̞ːθ’] ‘to squeeze against 3M.SG.IPFV’.

The emphatic alveolar fricative /sˤ/ is realised differently according to environment. It occurs utterance-initially and medially as a voiceless ‘backed’ [sˤ], while utterance-finally it is realised as an ejective [s’] where some of its tokens are preceded by a period of pre-glottalisation (PG) (see 6.3.1.1.2). Figure 4.14, Figure 4.15, and Figure 4.16 show the emphatic alveolar fricative /sˤ/ in different positions. The spectrograms show no closures of bursts typical of glottal release in utterance-initial and medial positions, but rather high energy at higher frequencies where the waveforms become aperiodic which is typical of non-voiced fricatives. However, in utterance-final position, a post-frication silent lag typical of emphatic fricatives in Mehri (Ridouane & Gendrot, 2017) is seen in Figure 4.16.

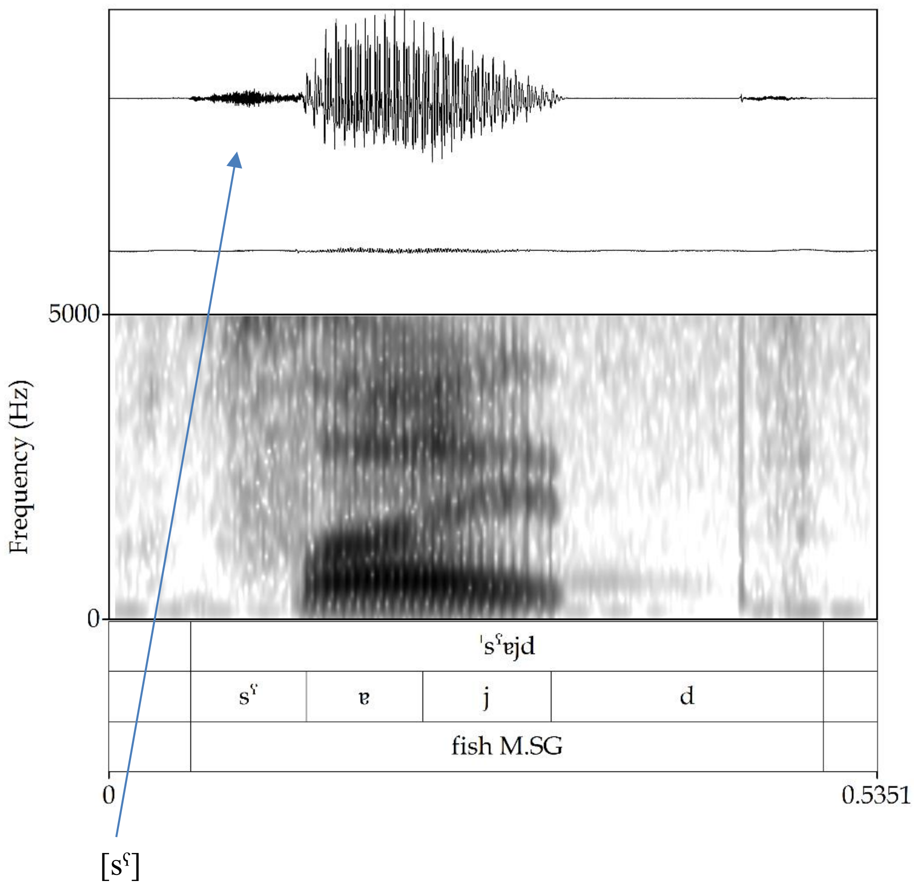

Figure 4.14: Spectrogram and waveform lacking the silent lag in the emphatic /sˤ/ in /ˈsˤɐjd/ - [ˈsˤɑit̪ʼ] ‘fish M.SG’.

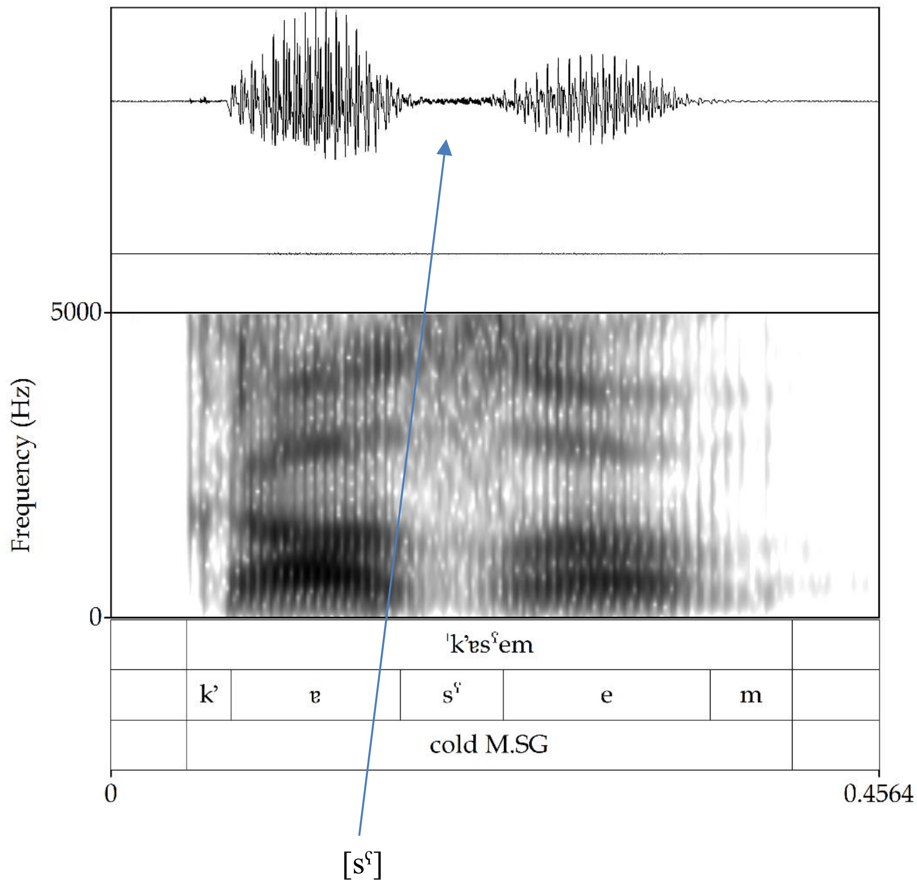

Figure 4.15: Spectrogram and waveform lacking the silent lag in the emphatic /sˁ/ in /ˈk'ɐsˁem/ - ['k'ɑ.sˁəm] 'cold M.SG'.

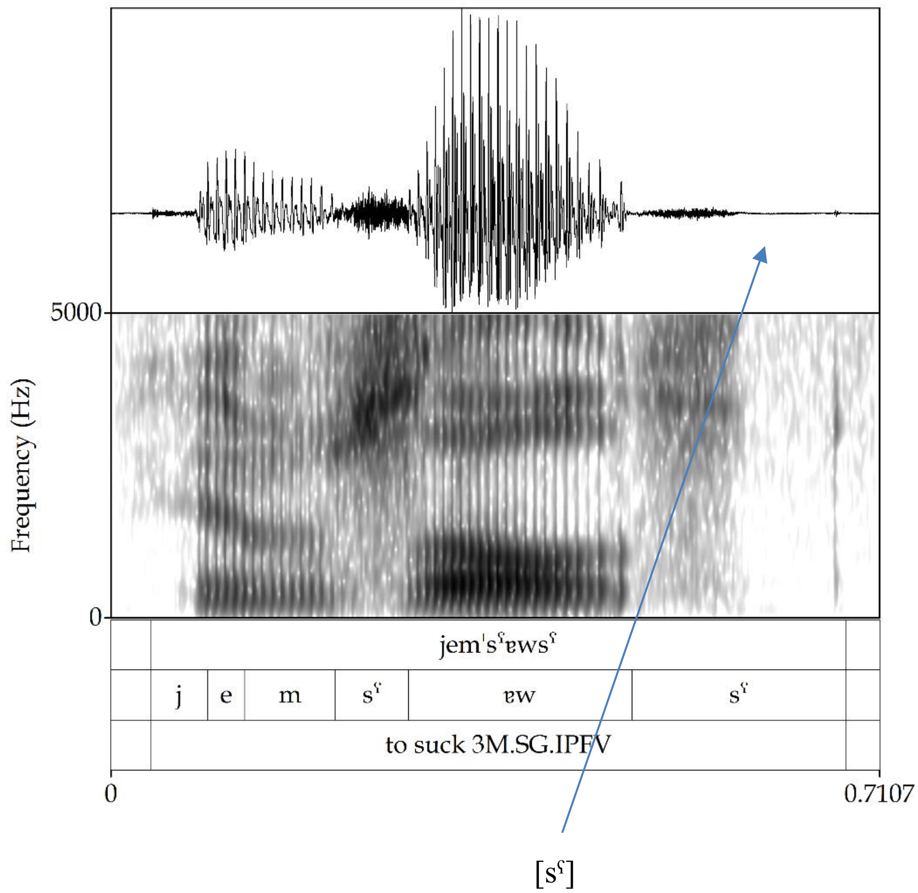

Figure 4.16: Spectrogram and waveform showing the post-frication silent lag in the emphatic /sˤ/ in /jemˈsˤɐwsˤ/ - [jim.'sˤɑws'] 'to suck 3M.SG.IPFV'.

The emphatic palato-alveolar fricative /ʃˤ/ is the least common consonant in Ḥarsūsi, as it is in the other MSAL. It has been attested only in a handful of words in the data in word-initial and medial positions, but not in word-final position. It is not realised as an ejective in Ḥarsūsi. The waveforms in Figure 4.17 and Figure 4.18 below lack pre- or post-frication silent lags.

Moreover, the spectrograms do not include any occlusions or bursts and energy at higher frequencies is seen throughout the duration of the consonant indicating a frication continuation. Pre- or post-frication silent lags were found in a few tokens of the emphatic palato-alveolar fricative /ʃˤ/ in the data; however, these lags were not complete silences and their occurrence was limited. In addition, a number of the tokens in utterance-medial position were preceded by a short period of pre-glottalisation (PG) (see 6.3.1.1.3).

In terms of voicing, some tokens do show voicing assimilation in utterance-medial positions; however, this voicing is not consistent and other tokens are predominantly voiceless. The emphatic palato-alveolar fricative /ʃˤ/ will be discussed in detail in chapter 6.

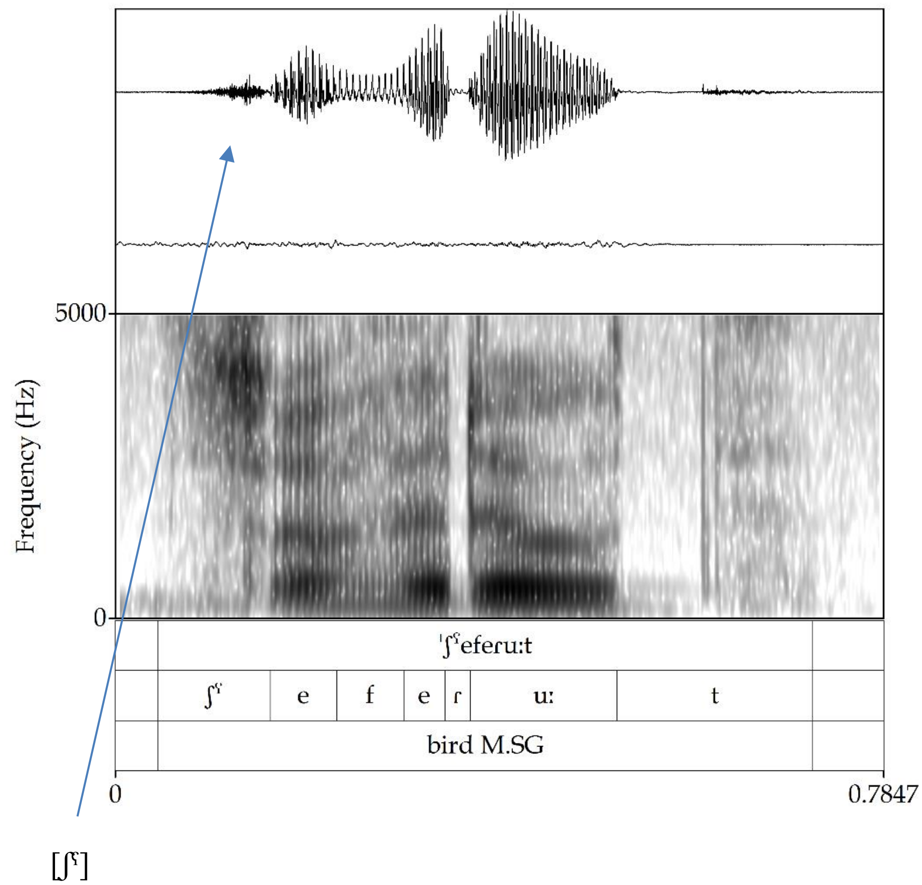

Figure 4.17: Spectrogram and waveform lacking the silent lag in the emphatic /ʃˤ/ in /ʃˤefeɾu:t/ - [ʃˤə.fə.ˈɾu:t̪ʰ] ‘bird M.SG’.

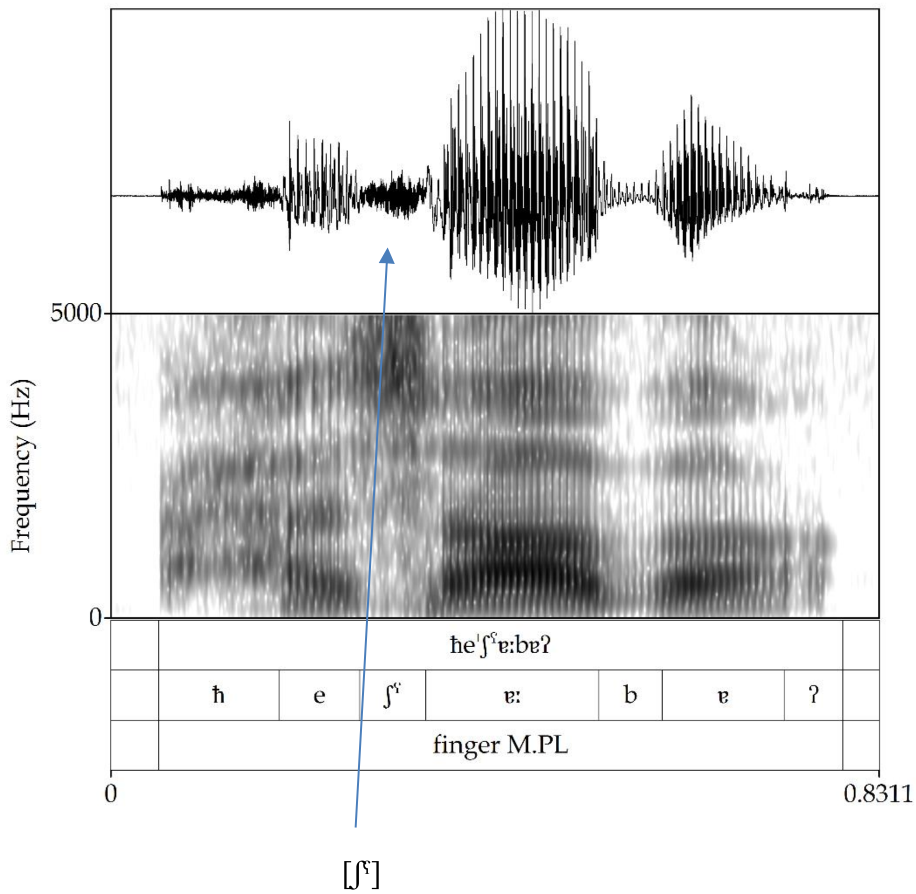

Figure 4.18: Spectrogram and waveform lacking the silent lag in the emphatic /ʃˤ/ in /ħeʃˤɐːbɐ/ - [ħə.ˈʃˤɑː.bɐ] ‘fingers F.PL’.

The emphatic alveolar-lateral fricative /ɬˤ/ has three allophones. It is typically realised as a voiceless [ɬˤ] utterance-initially and medially, as a voiced [ɮˤ] intervocalically, and as an ejective [ɬ’] utterance-finally. The visual inspection of waveforms and spectrograms lack systematic pre- or post-frication silent lags except in utterance-final position. The majority of the tokens in utterance-initial and medial positions lack pre- or post-frication silent lags. In terms of voicing, glottalic pulses as blue lines do show up in the spectrogram throughout the fricative in intervocalic positions suggesting voicing assimilation. In other contexts, however, the fricative stays predominantly voiceless. Figure 4.19, Figure 4.20, Figure 4.21, and Figure 4.22 below show the emphatic alveolar-lateral fricative in utterance-initial, medial, and final positions.

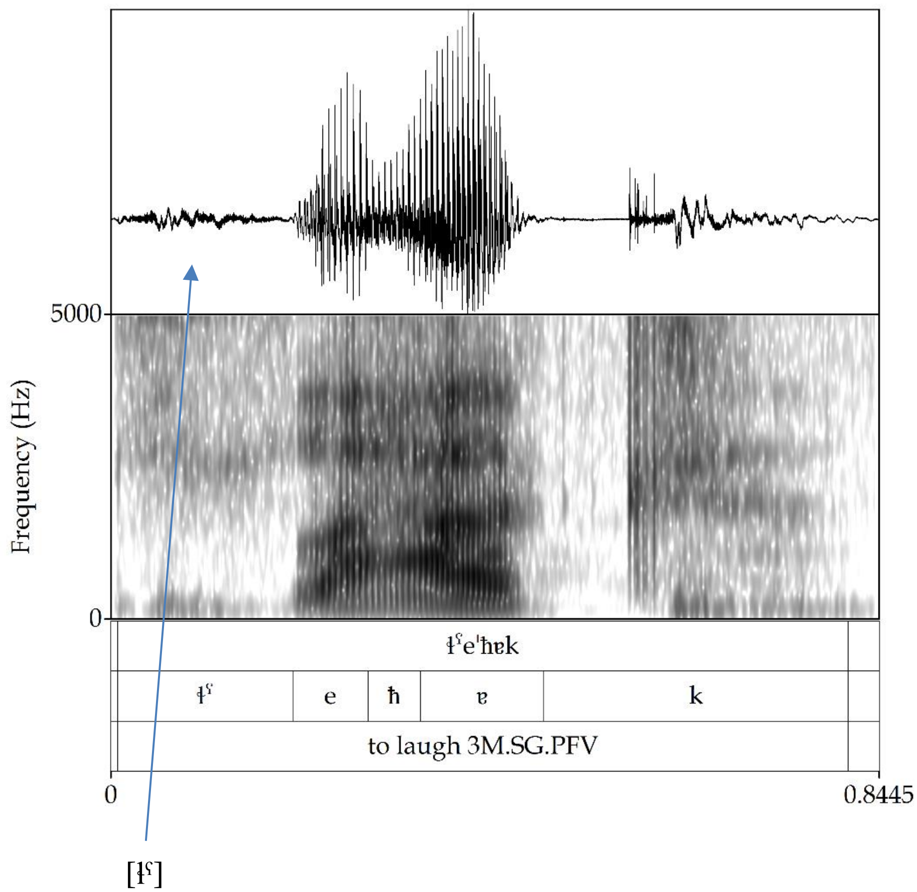

Figure 4.19: Spectrogram and waveform lacking the silent lag in the emphatic /ɬˤ/ in /ˈɬˤħɐk/ - [ˈɬˤħɑkʰ] ‘to laugh 3M.SG.PFV’.

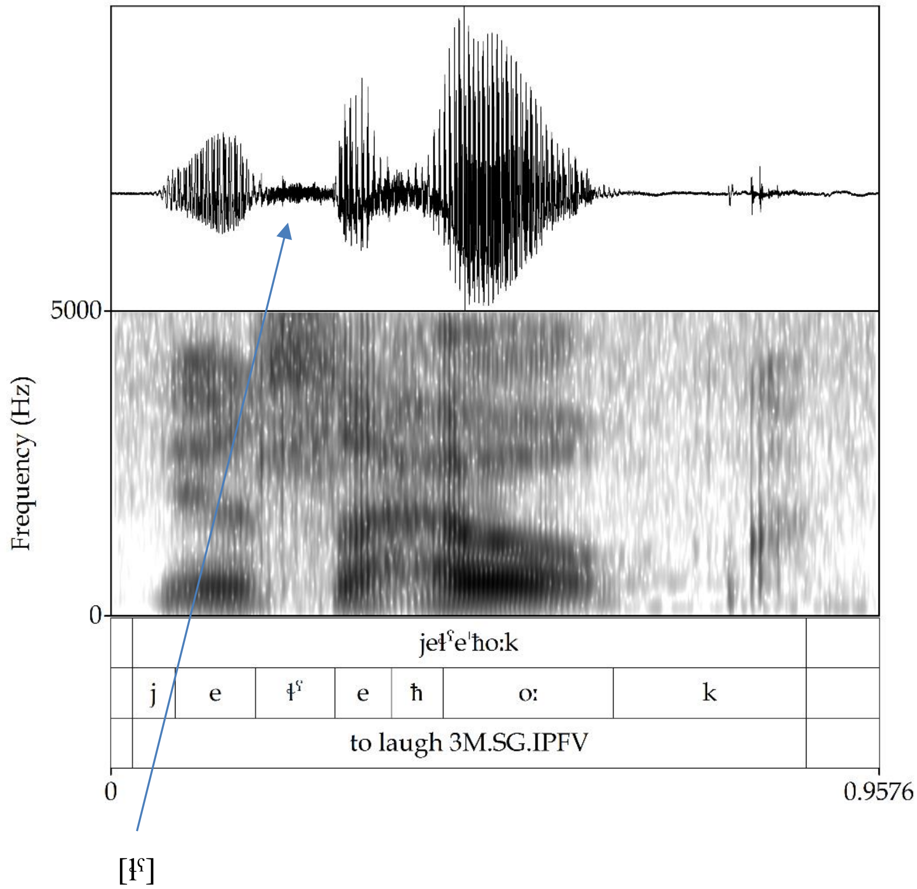

Figure 4.20: Spectrogram and waveform lacking the silent lag in the emphatic /ɬˤ/ in /jeɬˤeˈhoːk/ - [jiɬˤə.ˈħo̱ːkʰ] ‘to laugh 3M.SG.IPFV’.

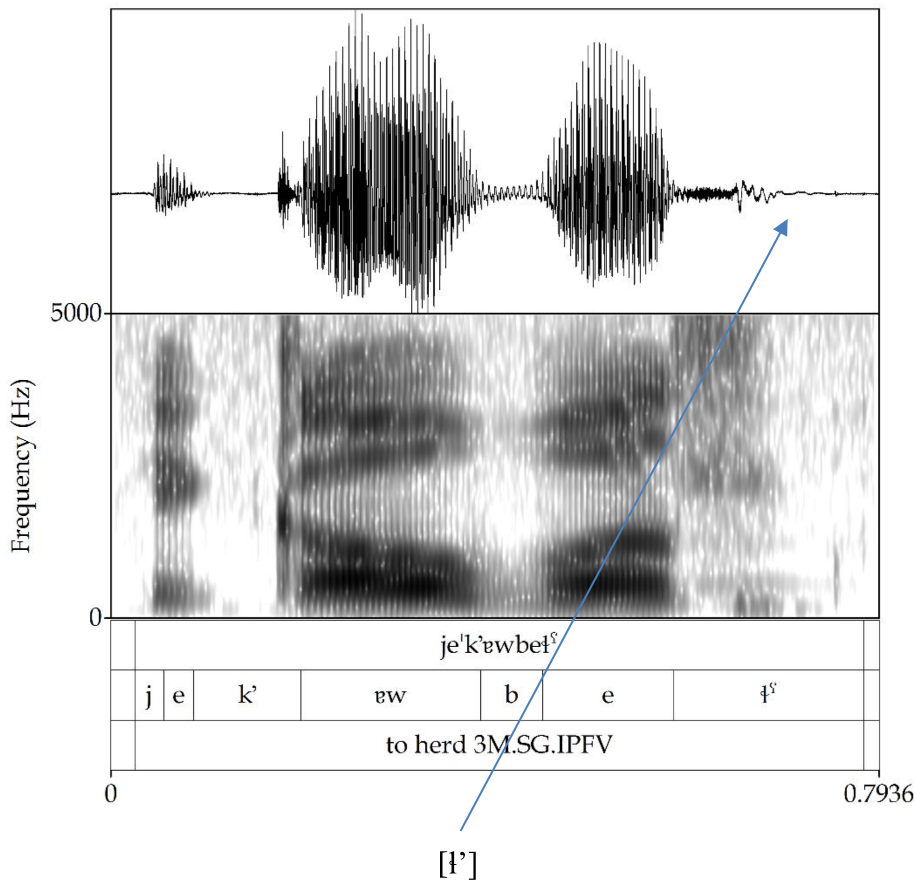

Figure 4.21: Spectrogram and waveform showing the post-frication silent lag in the emphatic /ɬˤ/ in /jeˈk’ɐwbeːɬˤ/ - [ji.ˈkˤɐwbəɬ’] ‘to herd 3M.SG.IPFV’.

It is clear in the previous figures that the emphatic alveolar-lateral fricative /ɬˤ/ is neither a voiced nor an ejective fricative. The high energy showing up at higher frequencies where the waveform becomes aperiodic suggest a continuation of frication throughout the sound in Figure 4.19 and Figure 4.20. In utterance-final position, a silent lag is seen after the frication in Figure 4.21 which is followed by burst release suggesting ejective realisation.

In terms of voicing, no glottalic pulses or energy in the voicing bar can be seen except at the very start of the frication in Figure 4.20, which suggests that the emphatic fricative /ɬˤ/ is predominantly voiceless in Ḥarsūsi. However, in medial positions between two voiced segments, as in Figure 4.22 below, it can become fully voiced as a result of voicing assimilation. The lateral emphatic /ɬˤ/ in Figure 4.22 is preceded by the voiced post-velar /ʁ/ and followed by the long back vowel /oː/. The blue lines of glottalic pulses in the waveform and the energy in the voicing bar in spectrogram clearly show voicing throughout the emphatic fricative /ɬˤ/ which is realised as a voiced lateral emphatic fricative [ɮˤ].

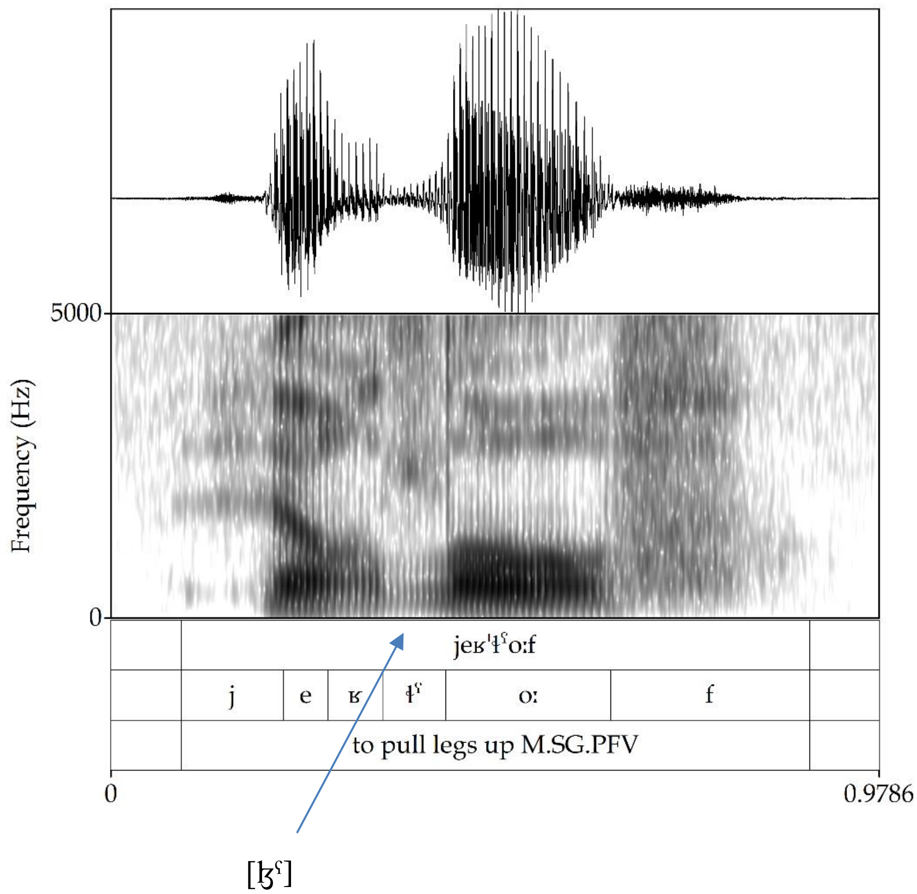

Figure 4.22: Spectrogram and waveform showing energy in voicing bar in the emphatic /ɬˤ/ in /jeʁˈɬˤoːf/ - [jiʁ.ˈɮˤo̰ːf] ‘to pull legs up 3M.SG.IPFV’.

It should be noted here that in utterance-final position, a number of emphatic alveolar-lateral fricative /ɬˤ/ tokens were preceded by a short period of pre-glottalisation (PG) (see 6.3.1.1.4).

4.4. VOWEL PHONEMES

Ḥarsūsi has seven vowels, two short and five long. The short vowels are /ɐ/ and /e/. The long vowels are /ɐː/, /eː/, /iː/, /oː/, and /uː/. In certain environments such as utterance-finally, the long vowels are shortened into corresponding short vowels. In addition, in the context of an emphatic sound, the Ḥarsūsi vowels become lower and more back compared to other contexts as a result of the emphatic effect on vowel formants.

The vowel chart below in Figure 4.23 shows all the distinct Ḥarsūsi vowel phonemes plotted in neutral contexts to avoid the emphatic effect on vowel formants. It should be noted here, however, the plot below is shown for illustration purposes only and is based on vowel formant measurements taken from three tokens of each vowel in neutral contexts preceded by coronals and produced by five young speakers from the participants (see 3.3). Seven items (see Vowel Plotting Items) each including one vowel, were repeated three times by each participant. The measurements were extracted at the vowel midpoint using PRAAT (Boersma & Weenink, 2020) following the same settings mentioned in 3.5.

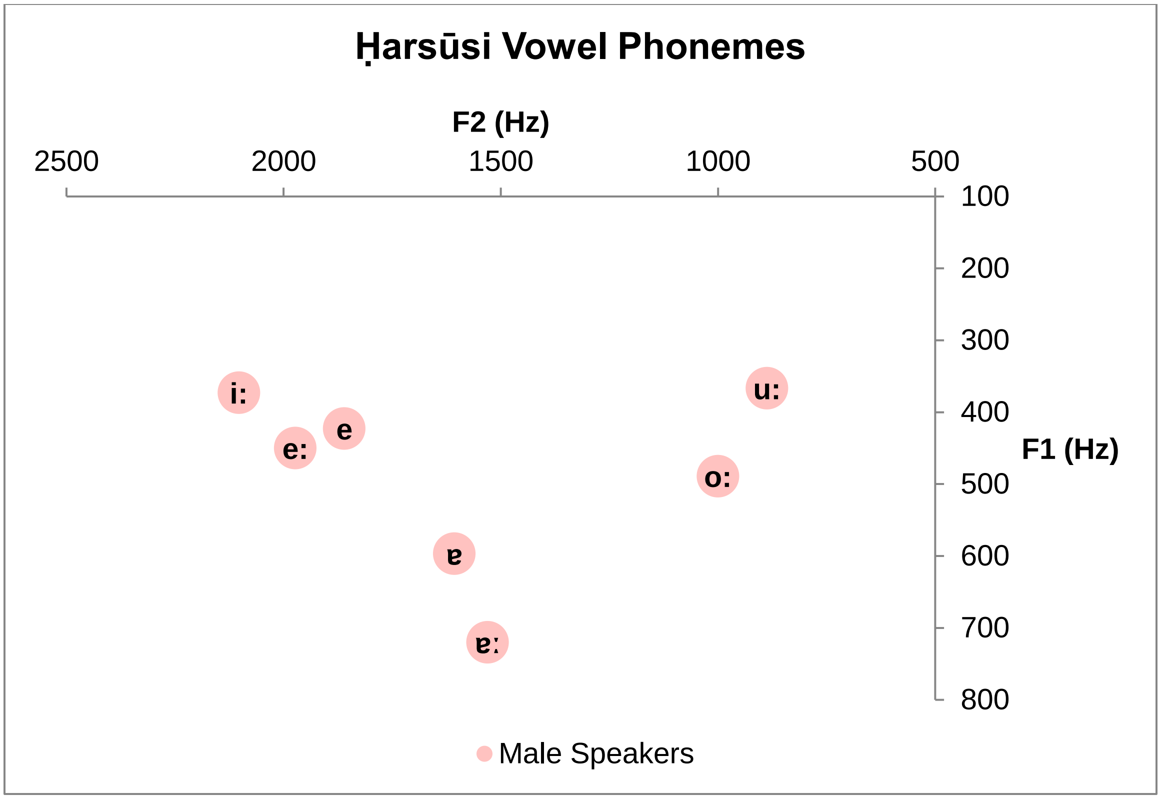

Figure 4.23: Vowel chart of Ḥarsūsi vowel phonemes

4.4.1. The Short Vowels

The phonemic short vowels of Ḥarsūsi are only 2: /ɐ/ and /e/. Both of these vowels are unrounded and realised differently in different environments as will be discussed below. Other short vowels found in Ḥarsūsi are not phonemic, but rather allophonic variations as a result of long vowel shortening.

The /ɐ/ vowel is a short central front vowel which occurs in stressed open or closed, and unstressed open or closed syllables. It has two allophones which are a lower and more backed [ɑ] and [ɐ]. The [ɑ] allophone with a more lowered and back quality occurs after emphatic, post-velar, and pharyngeal sounds, while the [ɐ] allophone occurs elsewhere. Rule 23 below states the distribution of the short vowel /ɐ/ allophones. The feature 'retracted tongue root' is being used here to denote the backing effect of emphatics, post-velars, and pharyngeals which involve tongue dorsum retraction (see 2.4.6).

Rule 23:

/ɐ/ → [ɑ] / /C/[+RTR] ___

[ɐ] elsewhere

The examples in Table 4.26 below show the short central front vowel /ɐ/ in various environments.

Environment	Example
Closed Stressed	/ˈħɐɾk'/ - [ˈħɑɾk'] 'hot M.SG'
Open Stressed	/ˈʔɐfeɾ/ - [ˈʔɑ.vəɾ] 'red M.PL'
Closed Unstressed	/ʔɐɾˈboːt/ - [ʔɑɾ.ˈboːt̪ʰ] 'four F.PL'
Open Unstressed	/ʔɐfeˈɾoːt/ - [ʔɑ.və.ˈɾoːt̪ʰ] 'red F.SG'
After Emphatic	/ˈðˤɐɾb/ - [ˈðˤɑɾp'] 'twig/firewood M.SG'

Table 4.26: Examples of vowel /ɐ/ in various environments.

The other phonemic short vowel of Ḥarsūsi is /e/, a high-mid front unrounded vowel. Similar to the previous short vowel /ɐ/, the high-mid front vowel /e/ occurs in both stressed open or closed syllables, and unstressed open or closed syllables. The realisation of the high-mid front vowel /e/ differs based on the environment in which it occurs. Some of the environments depend on whether the syllable is stressed or unstressed and whether closed or opened, while others depend on the type of surrounding consonants. The examples in Table 4.27 below show the short high-mid front vowel /e/ in various environments.

Environment	Example
Closed Stressed	/ˈtek’/ - [ˈt̪ʰek’] ‘drink 2M.SG.IMP’
Open Stressed	/ˈkellen/ - [ˈkʰʌ.lən] ‘all’
Closed Unstressed	/ˈmɐken/ - [ˈmɐ.kən] ‘a lot ADV’
Open Unstressed	/θeˈɾoːh/ - [θə.ˈɾoːh] ‘two M.PL’
After Emphatic	/ðˤeˈɾeːb/ - [ðˤe̠.ˈɾeːp’] ‘twigs/firewood M.PL’
Before /w/	/teˈwoːh/ - [t̪u.ˈwoːh] ‘to eat 3M.SG.PFV’
After /w/	/weɾˈk’ɐːt/ - [wuɾ.ˈk’ɑːt̪ʰ] ‘leaf F.SG’
Before /j/	/ħeˈjuːm/ - [ħi.ˈjuːm] ‘sun F.SG’
After /j/	/jemˈʃeːh/ - [jim.ˈʃeːh] ‘yesterday ADV’

Table 4.27: Examples of vowel /e/ in various environments.

It is realised as a fronter and higher variant [e] in closed stressed syllables, and a backer and lower [ʌ] in open stressed syllables. In unstressed syllables, it is realised as a more mid-central schwa [ə].

In terms of surrounding sounds, it is realised as lower and more back [e̠] after emphatics. In the presence of the glides /w/ and /j/, it is realised as a short vowel that assimilates into the features of the corresponding glide. Before or after the glide /w/, it is realised as a high back rounded vowel [u]. Similarly, before or after the glide /j/, it is realised as a high front unrounded vowel [i]. Johnstone (1977) noted that the vowel /e/ assimilates to surrounding glide features, however, no examples were given to explicitly show the assimilation.

The distribution of the short high-mid vowel /e/ allophones can be stated by the following rules below.

Rule 24:

/e/ → [e] / $[+Stressed] CØ ___ CØ

Rule 24 states that the allophone [e] of the short mid-high front vowel /e/ occurs only in stressed closed syllables.

Rule 25:

/e/ → [ʌ] / $[+Stressed] CØ ___

Rule 25 states that the allophone [ʌ] of the short mid-high front vowel /e/ occurs only in stressed open syllables.

Rule 26:

/e/ → [ə] / $[-Stressed] CØ ___ (CØ)

Rule 26 states that the allophone [ə] of the short mid-high front vowel /e/ occurs in both closed and open unstressed syllables.

Rule 27:

/e/ → [e̠] / /C/[+RTR] ___

Rule 27 states that the marked lower and more back allophone [e̠] of the short mid-high front vowel /e/ occurs only when following either an emphatic, post-velar, or pharyngeal consonant involving a retracted tongue dorsum.

Rule 28:

$$/e/ \rightarrow [@back\ ,\ @round\ ,\ +high]\ /\ \left\{ \begin{array}{l} /C/\ [@round\ ,\ @back\ ,\ -consonant\ ,\ +syllabic\ ,\ +high]\ \_\_ \\ \_\_\ /C/\ [@round\ ,\ @back\ ,\ -consonant\ ,\ +syllabic\ ,\ +high] \end{array} \right\}$$

Rule 28 states that the short high-mid vowel /e/ assimilates to the preceding or following glides features and is realised either as [u] or [i] in the presence of the glides /w/ and /j/, respectively.

4.4.2. The Long Vowels

There are five long vowels in Ḥarsūsi: two rounded vowels and three unrounded vowels. The rounded vowels are a high back /uː/ and a high-mid back /oː/. The unrounded vowels are a high front /iː/, a high-mid front /eː/, and a low central /ɐː/. Each of these vowels has more than one allophone which occur in different environments. As mentioned in 4.4.1 above, the emphatics, post-velars, and pharyngeals affect the vowels and result in a lowered and more back variant of the vowel. Similarly, all the long vowels are affected by the emphatics, post-velars, and pharyngeals and are realised as lowered and more back compared to their realisations in other contexts. Table 4.28 below shows the long vowels in Ḥarsūsi in various environments.

Phoneme	Medial	Final	After Emphatic
/ɐː/	/ˈbɐːɬˤ/ - [ˈbɐːɬ’] ‘some ADV’	/kelˈθoːnɐ/ - [kəl.ˈθoːnɐ] ‘to talk/chat 1C.SG.FUT’	/ˈtˤɐːd/ - [ˈt̪ˤɑːt̪’] ‘one M.SG’
/eː/	/weˈɾeːk’/ - [wu.ˈɾeːk’] ‘leaves M.PL’	Not attested	/weɾˈk’ɐːt/ - [wuɾ.ˈk’ɑːt̪ʰ] ‘leaf F.SG’
/iː/	/θemeˈniːt/ - [θə.mə.ˈniːt̪ʰ] ‘eight M.PL’	/ˈðiːɾi/ - [ˈðiː.ɾi] ‘bloods F.PL’	/θeˈk’iːl/ - [θe.ˈkˤi̞ːl] ‘heavy M.SG’ /ˈsˤiːleħ/ - [ˈsˤɐ̞i̞.ləħ] ‘fat M.SG’
/oː/	/ˈhoːm/ - [ˈhoːm̥] ‘they M.PL’	Not attested	/jeˈtˤoːn/ - [ji.ˈt̪ˤo̞ːn̥] ‘to stab 3M.SG.IPFV’ /ʁelˈk’oːnɐ/ - [ʁəl.ˈk’o̞ː.nɐ] ‘to see/look 1C.SG.FUT’
/uː/	/ˈħɐːbuːb/ - [ˈħɑː.buːp’] ‘people M.PL’	/teˈħɐːɾbuː/ - [t̪ə.ˈħɑːɾ.bu] ‘to fight 3M.PL.PFV’	/k’eˈʃˤuːb/ - [k’ə.ˈʃˤu̞ːp’] ~ [k’ə.ˈʃˤauːp’] ‘to cut 3M.SG.PFV’ /jeˈk’uːdeɾ/ - [ji.ˈk’ɐ̞u̞.d̪eɾ] ‘to be able/can 3M.SG.IPFV’

Table 4.28: Ḥarsūsi long vowels and their allophones.

4.4.2.1. Vowels /ɐː/ and /eː/

The low central and high-mid front unrounded vowels /ɐː/ and /eː/ are separate phonemes in Ḥarsūsi even though they rarely contrast. The minimal pair and the near-minimal pairs in Table 4.29 below where the Arabic word /ˈsaːħel/ - [ˈsaː.ħəl] ‘coast M.SG’ is adopted into Ḥarsūsi below show that both vowels are in contrastive distribution and are phonemic.

Phoneme	Example
/ɐː/	/ʃeˈnɐːt/ - [ʃə.ˈnɐːt̪] ‘type of plant M.SG’ /ˈsɐːħel/ - [ˈsɐː.ħe̠l] ‘coast M.SG’
/eː/	/ʃeˈneːt/ - [ʃə.ˈneːt̪] ‘sleep F.SG’ /ˈseːhel/ - [ˈseː.həl] ‘easy ADJ’

Table 4.29: Minimal and near-minimal pairs of /ɐː/ and /eː/.

The low central front long vowel /ɐː/ has two allophones which occur in different environments. It has a low central front [ɐː] and a lower more back front [ɑː]. As mentioned earlier, the lower and more back allophone [ɑː] of the vowel /ɐː/ occurs after emphatic, post-velar, and pharyngeal consonants. The low central [ɐː] allophone occurs elsewhere. Rule 29 below states the distribution of the long vowel /ɐː/ allophones.

Rule 29:

/ɐː/ → [ɑː] / /C/[+RTR] ___

[ɐː] elsewhere

The high-mid front long vowel /eː/ has two allophones also. As is seen in Table 4.28 above, it has a low central allophone [ɑː] and a high-mid front [eː]. The allophone [ɑː] occurs after emphatic, post-velar, and pharyngeal sounds (see 2.4.6), while the allophone [eː] occurs elsewhere. Johnstone (1977) stated that after gutturals, which include post-velar and pharyngeal sounds, [ɑː] occurs as an allophone of /eː/. Moreover, he stated that after glottalic sounds either [ɑː] or [ɑi] occur as allophones of /eː/. Our data only confirmed the occurrence of [ɑː] as an allophone of /eː/ after the emphatics and the pharyngeal /ħ/. The allophone [ɑi] has not been attested in the data as an allophone of /eː/. Table 4.30 below shows examples of both of the allophones [ɐ̞ː] and [eː] of the high-mid front long vowel /eː/ in some feminine singular nouns.

Phoneme	After Emphatics and Post-velars	Elsewhere
/eː/	/weɾˈk’eːt/ - [wuɾ.ˈk’ɑːt̪ʰ] ‘leaf F.SG’ /ħelˈk’eːt/ - [ħəɫ.ˈkˤɑːt̪ʰ] ‘circle F.SG’ /melˈħeːt/ - [məl.ˈħɑːt̪ʰ] ‘salt F.SG’	/ħɐˈbeːt/ - [ħɑ.ˈbeːt̪ʰ] ‘seed F.SG’ /k’elˈfeːt/ - [k’əl.ˈfeːt̪ʰ] ‘bark F.SG’ /bek’eˈleːt/ - [bə.kˤə.ˈleːt̪ʰ] ‘egg F.SG’

Table 4.30: Allophones of /eː/ in singular feminine nouns.

As is seen in Table 4.30 above, after emphatics and pharyngeal /ħ/, the /eː/ vowel is realised as [ɑː], while elsewhere it is realised as [eː]. Rule 30 below states the distribution of the vowel /eː/ allophones.

Rule 30:

/eː/ → [ɑː] / /C/[+RTR] ___

[eː] elsewhere

From the previous examples it is clear that although there are very few near-minimal pairs, /eː/ and /ɐː/ are separate phonemes in Ḥarsūsi; however, after the emphatics, /tˤ/, /k’/, /ðˤ/, /sˤ/, /ʃˤ/, the pharyngeals, /ʕ/ and /ħ/, and post-velars, /χ/ and /ʁ/, there is neutralisation and both vowels surface as [ɑː].

*4.4.2.2. Vowel /*i*:/*

The high front long vowel /iː/ can be established as a separate phoneme based on the minimal pair in Table 4.31 below.

Phoneme	Example
/oː/	/ˈθoːdiː/ - [ˈθoː.di] 'breast M.SG'
/iː/	/θiːˈdiː/ - [θiː.ˈdi] 'breasts M.PL'

Table 4.31: Minimal pair of /oː/ and /iː/.

As is seen in Table 4.31 above, the vowels [oː] and [iː] are in contrastive distribution given the minimal pair. Therefore, the vowel /iː/ is a separate phoneme in Ḥarsūsi. The high front long vowel /iː/ has four different allophones. Table 4.32 below shows the allophones of the vowel /iː/.

Phoneme	After Emphatics and Post-velars	Final	Elsewhere
/iː/	/ˈtˤiːn/ - [ˈt̪ˤi̠ːn̥] 'mud M.SG' /k'eˈtˤiːn/ - [k'ə.ˈtˤi̠ːn̥] or [k'ə.ˈtˤajn̥] 'slim M.SG' /ˈʁiːrek'/ - [ˈʁai.ɾek'] 'to drown 3M.SG.PFV' /ˈħiːrek'/ - [ˈħɑi.ɾek'] 'to burn 3M.SG.PFV'	/ˈðiːriː/ - [ˈðiː.ɾi] 'bloods F.PL'	/leˈʃiːn/ - [lə.ˈʃiːn̥] 'tongue M.SG' /ħɐˈʃiːʃ/ - [ħɑ.ˈʃiːʃ] 'grass M.PL'

Table 4.32: Allophones of vowel /iː/.

As is seen in Table 4.32 above, after emphatics, post-velars, and pharyngeals, the /iː/ vowel occurs either as a lower and backer [i̠ː] or as a diphthong [ɑi]. In utterance-final positions, it occurs as a short high front vowel [i]. In all other environments, it occurs as a high front long [iː].

Johnstone (1977) mentioned that it is rather difficult to distinguish the high front long vowel /iː/ from the high-mid front long vowel /eː/ as their qualities overlap in certain positions. Indeed, as is the case of all vowels that occur after emphatics, post-velars, and pharyngeals, the high front long vowel /iː/ is lower and more back when it occurs after emphatics, post-velars, and pharyngeals and its qualities get closer to the qualities of /eː/. However, the data shows that the vowel /eː/ after emphatics is realised as [ɑː] as seen above, therefore, the vowel /iː/ can be more easily distinguished in this environment. Moreover, the high front long vowel /iː/ is diphthongised in some cases after emphatics and post-velars as seen in Table 4.32 above which also helps in distinguishing it from /eː/.

The second allophone of the high front long vowel as is seen in Table 4.32 is a diphthong [ɑi]. As mentioned earlier, after emphatics, post-velars and pharyngeals, either a more centralised and backed allophone [i̠ː] or a diphthong [ɑi] occurs which is seen in the example /k’e.ˈtˤiːn/ - [k’ə.ˈt̪ˤi̠ːn̥] ~ [k’ə.ˈt̪ˤɑin̥] ‘slim M.SG’. However, there are many examples in the data where only one allophone is given in this environment. Table 4.33 shows more examples of vowel /iː/ allophones after emphatics, post-velars, and pharyngeals.

Phoneme	[i̠ː]	[ɑi]
/iː/	/menɐːˈk’iːb/ - [mə.nɐː.ˈk’i̠ːp’] ‘beaks M.PL’ /ħɐːˈtˤiːb/ - [ħɑː.ˈtˤi̠ːp’] ‘teat M.SG’ /neˈðˤiːf/ - [nə.ˈðˤi̠ːf] ‘clean M.SG’	/ˈxiːmeh/ - [ˈxɑi.məh] ‘five F.PL’ /ˈħiːbeɾ/ - [ˈħɑi.bər] ‘to get cold 3M.SG.PFV’ /lebeˈniːt/ - [lə.bə.ˈnɑit̪ʰ] ‘white F.SG’ /ɬaˈfiːt/ - [ɬa.ˈfɑit̪ʰ] ‘three F.SG’

Table 4.33: Vowel /iː/ after emphatics and post-velars.

The data in Table 4.33 show that the diphthongisation process of the vowel /iː/ is not straightforward. In all the previous examples, the long vowel /iː/ occurs in stressed syllables. However, it undergoes diphthongisation when in second syllable, while it surfaces as a lower and more back allophone [i̠ː] when in the first syllable. Moreover, there are also examples of diphthongisation where the vowel /iː/ is not preceded by an emphatic, post-velar, or pharyngeal sound. For example, the word for ‘white’ was given as /lebeˈniːt/ - [lə.bə.ˈnɑit̪ʰ] ‘white F.SG’, where its consonantal root is /l-b-n/. Given the high number of examples, diphthongisation is consistently observed in the context of emphatic, post-velar, or pharyngeal sounds, but sporadically also in other contexts.

The third allophone of the long vowel /iː/ is a high short front allophone [i] which occurs in utterance-final positions.

The fourth allophone of the high front vowel /iː/ is a high front long allophone [iː] which occurs in most of the contexts in the data. Since the allophone [iː] occurs in the majority of contexts, it can be taken as the underlying representation and the distribution of the different allophones of the long vowel /iː/ can be stated by Rule 31 below.

Rule 31:

/iː/ → [i] / __#

[i̠ː] / $/C/ [+RTR] __

[ɑi] / /C/ [+RTR] __$

[iː] elsewhere

4.4.2.3. Vowels /oː/ *and* /uː/

The back vowels in Ḥarsūsi are two rounded long vowels: high-mid back /oː/ and high back /uː/. The data in Table 4.31 above show the high-mid long vowel [oː] in contrastive distribution with the high front long vowel [iː]. Therefore, the high-mid long vowel /oː/ is a separate phoneme. There are some near-minimal pairs showing that both of the back rounded vowels are separate phonemes. Moreover, each of the back rounded vowels is realised differently in certain environments, which also shows their phonemic status. Table 4.34 below shows some of the near-minimal pairs for the vowels /oː/ and /uː/.

Phoneme	Example
/oː/	/jeˈdoːnten/ - [ji.ˈdoːn.t̪ən̥] ‘new M.PL’ /ʔɐɾˈboːt/ - [ʔɑɾ.ˈboːt̪ʰ] ‘four F.PL’
/uː/	/ħɐːˈduːten/ - [ħɑː.ˈduː.t̪ən̥] ‘hands F.PL’ /ʔɐɾˈsˤuːn/ - [ʔɐɾ.ˈsˤu̠ːn̥] ‘to tie 1C.SG.IPFV’

Table 4.34: Near-minimal pairs of /oː/ and /uː/.

The high-mid back rounded vowel /oː/ has two allophones which occur in different environments. After emphatics, post-velars, and pharyngeals, it has a lower and more back [o̞ː], while in other environments it is a high-mid [oː]. Rule 32 below states the distribution of the vowel /oː/ allophones.

Rule 32:

/oː/ → [o̞ː] / /C/$_{[+RTR]}$ ___

[oː] elsewhere

The high back long rounded vowel /uː/ has two allophones. It has a marked diphthongised allophone [ɑu] which occurs after emphatics, post-velars, or pharyngeals and an unmarked high back [uː] which occurs elsewhere. Rule 33 below states the distribution of the vowel /uː/ allophones.

Rule 33:

/uː/ → [ɑu] / /C/$_{[+RTR]}$ ___

[uː] elsewhere

Johnstone (1977) mentioned that similar to the front high and high-mid vowels /iː/ and /eː/, it is difficult to distinguish the high back vowel /uː/ from the high-mid back vowel /oː/ as their qualities overlap in certain environments. However, current data shows that these vowels behave differently in the environments where their qualities are expected to overlap. For instance, after emphatics, post-velars, and pharyngeals where the vowels get lowered and more back, the data shows that the high back vowel /uː/ is diphthongised to [ɑu] regularly and there is only one example where it does not. On the other hand, the high-mid back vowel in this environment is realised as a lowered and more back vowel. Table 4.35 below shows more examples of the vowels /oː/ and /uː/ after emphatics, post-velars, and pharyngeals.

Phoneme	Example
/oː/	/jeˈtˤoːn/ - [ji.ˈt̪ˤo̞ːn̥] 'to stab 3M.SG.IPFV' /ˈsˤoːɾ/ - [ˈsˤo̞ːr] 'to stand up/stop 3M.SG.PFV' /ˈxoːtˤeɾ/ - [ˈxo̞ː.t̪ˤər] 'below LOC' But, /ˈhoːmɐː/ - [ˈhɑu.mɐ] ~ [ˈhoː.mɐ] 'to hear 3M.SG.PFV' /ˈmoːnɐː/ - [ˈmɑu.nɐ] ~ [ˈmoː.nɐ] 'to hold 3M.SG.PFV'
/uː/	/jeˈħuːfeɾ/ - [ji.ˈħɑu.fər] 'to dig 3M.SG.IPFV' /ʔɐˈk'uːdeɾ/ - [ʔɑ.ˈk'ɑu.dər] 'to be able/can 1C.SG.IPFV' /jeˈʁuːbeɾ/ - [ji.ˈʁɑu.bər] 'to meet 3M.SG.IPFV' But, /jeˈluːbed/ - [ji.ˈluː.bət̪'] 'to hit 3M.SG.IPFV' /k'eˈʃˤuːb/ - [k'ə.ˈʃˤu̞ːp'] 'to cut 3M.SG.PFV'

Table 4.35: /oː/ and /uː/ allophones.

The examples in Table 4.35 show that the vowel /oː/ occurs as a lower and more back [o̞ː] when following the emphatics and post-velars. However, there are two examples where /oː/ is diphthongised even though it is not preceded by an emphatic, post-velar, or pharyngeal. For instance, in the words; /ˈhoːmɐː/ - [ˈhɑu.mɐ] ~ [ˈhoː.mɐ] 'to hear 3M.SG.PFV' and /ˈmoːnɐː/ - [ˈmɑu.nɐ] ~ [ˈmoː.nɐ] 'to hold 3M.SG.PFV' the vowel /oː/ is preceded by a glottal and a nasal soundm, however, the speaker provided diphthongised examples as possible forms in this environment. Nonetheless, these examples can be an idiosyncratic over-generalisation in these examples provided by the speaker since in other examples diphthongisation was not given as in;

/jeˈhoːmɐː/ - [ji.ˈhoː.mɐ] ‘to hear 3M.SG.IPFV’ and /jeˈmoːnɐː/ - [ji.ˈmoː.nɐ] ‘to hold 3M.SG.IPFV’.

In case of the high back long vowel /uː/, the examples in Table 4.35 above show that it is diphthongised to [ɑu] only when it is preceded by emphatics, post-velars, and pharyngeals. For example, both of the words; /jeˈʁuːbeɾ/ - [ji.ˈʁɑu.bər] ‘to meet 3M.SG.IPFV’ and /jeˈluːbed/ - [ji.ˈluː.bət̪’] ‘to hit 3M.SG.IPFV’ are in the same paradigm for third person masculine singular imperfective. In addition, none of them has a glide in its consonantal root, but in one the vowel /uː/ is diphthongised into [ɑu], while in the other it is not. It is worth noting that only in one example, /k’eˈʃˤuːb/ - [k’ə.ˈʃˤu̠ːp’] ‘to cut 3M.SG.PFV’, the vowel /uː/ was not diphthongised. However, in other paradigms the same word is found with a diphthongised /uː/ as in /jeˈk’uːʃˤeb/ - [ji.ˈkˤɑu.ʃˤəp’] ‘to cut 3M.SG.IPFV’. Therefore, it can be suggested that in the example where /uː/ is found as lower and more back /u̠ː/, the speaker is not applying the diphthongisation rule where it should be applied.

4.4.3. Diphthongs

Johnstone (1977) mentioned eight diphthongs in Ḥarsūsi: /aw, aj, ew, ej, eːw, iːw, oːj and uːj/ (adapted from Johnstone (1977, p. xiii). Current data includes no minimal pairs to establish these as separate diphthong phonemes. The examples found in the data suggest that there are no phonemic diphthongs in Ḥarsūsi. The diphthongs found in Ḥarsūsi are either allophonic variants of long vowels (as discussed in 4.4.2), or vowel + glide clusters where the glide is part of the consonantal root of the words. Table 4.36 shows some of the examples where these diphthongs are found and the consonantal roots of these words.

Vowel + Glide	Consonantal root	Example
aj	ʔ - j – n kʼ - j – d d – j – n d – n – j	/ˈʔɐjn/ - [ˈˈʔɑin̥] ‘eye F.SG’ /ˈkʼɐjd/ - [ˈkʼɑit̪ʼ] ‘rope M.SG’ /ˈdɐjn/ - [ˈdɐin̥] ‘debt M.SG’ /teˈdɐjn/ - [tə.ˈdɑin̥] ‘to become pregnant 3F.SG.IPFV’
aw	g – w – f	/ˈgɐwf/ - [ˈgɐwf] ‘chest M.SG’
ew	ħ – w – r	/ħewˈɾoːt/ - [ħuw.ˈɾoːt̪ʰ] ‘black F.SG’
eːw	kʼ - n – w d – w – j	/mekʼeˈneːw/ - [mɐ.kˤə.ˈneːw] ‘child M.SG’ /ʔɐˈdeːw/ - [ʔɑ.ˈdeːw] ‘to give medicine 1M.SG.IPFV’

Table 4.36: Vowel + glide cluster examples.

As is seen in Table 4.36 above, the diphthongs in Ḥarsūsi are not phonemic and can be analysed as vowel + glide clusters by looking at the consonantal roots of the words where these clusters are found. There are only two allophonic diphthongs found in the data, [ɑu] and [ɑi], which are allophonic variants of the long high vowels /uː/ and /iː/ which occur in certain environments unlike Mehri, where phonemic diphthongs are found (Watson et al., 2020).

5. Chapter Five: The Phonetic Realisation of Ḥarsūsi Stops

5.1. Research Questions and Hypotheses

Given the scholarly debate about the nature of the group of emphatics in Semitic languages and the recent developments on this group in the MSAL, it seemed crucial to investigate this group of sounds in Ḥarsūsi in depth in order to understand their nature and behaviour in this language.

The study investigated the acoustic characteristics of Ḥarsūsi stops to tackle three issues. First, to establish whether the class of emphatic stops were articulated as ejectives as in Ethio-Semitic languages (Demolin, 2004; Shosted & Rose, 2011) for example, or pharyngealised/uvularised as in most documented varieties of Arabic (Laufer & Baer, 1988; Embarki et al., 2007; Jongman et al., 2011; Al-Solami, 2017) based on quantitative analysis. Secondly, to check whether the emphatics were distinguishable from their plain counterparts based on certain acoustic parameters such as VOT and oral closure duration. Thirdly, to examine if the voiced stops patterned with the emphatic stops in any position, and whether such patterning could be acoustically supported in Ḥarsūsi.

In trying to establish the nature of emphatic stops in Ḥarsūsi quantitatively, this study investigated the parameters of visible oral and glottal release and the presence of glottal closure. In addition, glottal closure was also investigated as an acoustic parameter in investigating the patterning of voiced stops with the emphatics in various positions. No study up to date has looked into this issue in detail in Ḥarsūsi and there are no studies based on statistical evidence that can give a clear assumption about the nature of emphatic stops in Ḥarsūsi.

In addition, the study also examined some other acoustic parameters that might help in distinguishing the group of emphatic stops from their plain counterparts in this language. It investigated the acoustic parameters of VOT and oral closure duration of Ḥarsūsi emphatic stops to see if they were distinguishable from their voiced and voiceless plain counterparts.

With regard to phonological patterning of emphatic and voiced stops, the study investigated VOT and the presence or absence of glottal closure and release in both voiced and emphatic stops in the positions investigated in this study. These acoustic parameters were investigated to see whether the phonological patterning of these two types of sounds can be supported based on phonetic acoustic parameters.

The research questions are the following:

1. Do the emphatic stops in Ḥarsūsi display any known acoustic characteristics of ejective stops?
2. Do the emphatic stops differ from their plain counterparts in terms of their VOT, oral closure duration, presence or absence of glottal closure and release?
3. Do the emphatic stops and their plain voiced counterparts pattern together in any position based on acoustic characteristics?

As reported in 4, during the manual segmentation process of tokens, it was observed that not all the emphatic stops in Ḥarsūsi displayed known characteristics of ejective stops in all positions investigated. For instance, a clear glottal closure and release was seen in tokens of the velar emphatic stop /k'/ in various environments which was not the case with the alveolar emphatic stop /tˤ/. In addition, previous studies on other MSAL such as Mehri and Baṭḥari showed that the emphatic velar /ḳ/ was glottalised. For instance, it was found to be glottalised in all contexts of both Mehri dialects, Mahriyōt and Mehreyyet, except for some intervocalic tokens of Mehreyyet (Bellem & Watson, 2014). Similar patterns were also observed in Baṭḥari as Gasparini (2017) found that it showed signs of glottalisation in initial and intervocalic positions. However, the emphatic alveolar /tˤ/ was glottalised word-initially, before non-back vowels, and pre-pausally in Mehreyyet and Mahriyōt (Bellem & Watson, 2014). Hence, it was expected in this study that the emphatic velar /k'/ will be glottalised and realised as an ejective in most contexts in Ḥarsūsi, while the emphatic alveolar /tˤ/ will be glottalised in utterance-final positions only.

In terms of emphatic and voiced stops patterning, the study expected both of these types of segments to pattern together in utterance-final position, where they are expected to be realised as glottalised segments.

As discussed in 2.4.3, the VOT of emphatic sounds was found to be longer than their voiceless plain counterparts in Baṭḥari (Gasparini, 2017). Thus, this study hypothesised a similar pattern in Ḥarsūsi and expected the emphatic stops to have a longer VOT than their voiceless plain counterparts. It also hypothesised the voiced stops to have a negative VOT, and the voiceless stops to have an intermediate VOT between the voiced and the emphatic. Apart from differences in VOT based on laryngeal category, the study also hypothesised a difference in VOT durations based on place of articulation. It was expected that the consonants articulated at a back place of articulation, velars, will have a longer VOT compared to consonants articulated at a more front place of articulation, alveolars in this case.

Similar to VOT, previous studies found different results for ejectives' oral closure durations in different languages (see 2.4.3). The oral closure of ejective stops in Amharic was significantly longer than that of their plain counterparts (Seid et al., 2009, p. 2289). Therefore, and based on inferences from the visual inspection of some tokens, the study expected the oral closure duration for the emphatic segments to be the longest among the stops overall. Moreover, it expected the emphatic stops to have the longest oral closure duration in utterance-final positions. It also expected the voiced stops to have an intermediate oral closure duration, and the voiceless stops to have the shortest oral closure duration.

5.2. METHODOLOGY

Ḥarsūsi words including the emphatic stops and their plain counterparts, voiced and voiceless, were recorded from 10 speakers in isolation for this study (see 3.2 for data sources). The target consonants were in utterance-initial, medial, and final positions in both stressed and unstressed syllable structures. The measurements of temporal parameters of VOT and oral closure were taken for the stops. In addition, emphatic stops were checked for the presence of glottal closure and release in all positions. Linear mixed model and logistic regression tests were run to check the significance of different factors such as segment type, segment position, place of articulation, and syllable structure.

5.2.1. Stimulus Material

Each target consonant was recorded in four different words and was found in two stressed and two unstressed syllable structures in utterance-initial, medial, and final positions (see 3.2 for details on word list preparation). Therefore, a total of 12 different words were recorded for each target consonant. Each word was repeated three times which resulted in 36 tokens for each target consonant from each participant. So, the total number of tokens for each target consonant was 360 produced by 10 participants and the total number of tokens used in this study is 2160 (360 tokens * six target consonants).

The words used have the following syllable structures given below, and the target consonants occur in stressed and unstressed syllables in these words.

***Utterance-initial*:**

Stressed **C**VVC

Unstressed **C**V.CVVC

Utterance-medial:

Stressed CVC.**C**VVC

Unstressed CV**C**.CVVC (and one word in CVC**C**.CVVC)

Utterance-final:

Stressed CV**CC** and CVC.CVV**C**

Unstressed CV.CVV.CV**C**

Table 5.1 below shows the Ḥarsūsi words including the target consonants in different positions.

Phoneme	Stress	Initial	Medial	Final
t	**S**	/ˈtɐːb/ ‘to weary, become tired 3M.SG.PFV’ /ˈtoːb/ ‘to repent 3M.SG.PFV’	/jefˈtuːt/ ‘to crumble 3M.SG.IPFV’ /jefˈtuːk/ ‘to come out; take out; escape 3M.SG.IPFV’	/ˈfett/ ‘to crumble 3M.SG.PFV’ /jefˈtuːt/ ‘to crumble 3M.SG.IPFV’
	US	/teˈroːb/ ‘to do ablution with sand 3M.SG.PFV’ /teˈhoːm/ ‘to accuse 3M.SG.PFV’	/jetˈheːm/ ‘to accuse 3M.SG.IPFV’ /jɐwtˈkʼoːðˤ/ ‘to awaken 3M.SG.IPFV’	/ħeˈɾɐwhet/ ‘head M.PL’ /ħeˈdɐwdet/ ‘iron F.SG’
tˤ	**S**	/ˈtˤɐːd/ ‘one M.SG’ /ˈtˤoːb/ ‘kind of plant M.SG’	/jemˈtˤɐwtˤ/ ‘to pull 3M.SG.IPFV’ /jefˈtˤoːn/ ‘to think 3M.SG.IPFV’	/ˈmetˤtˤ/ ‘to pull 3M.SG.PFV’ /jemˈtˤɐwtˤ/ ‘to pull 3M.SG.IPFV’
	US	/tˤeˈboːx/ ‘to cook 3M.SG.PFV’ /tˤeˈhɐːs/ ‘to slip 3M.SG.PFV’	/jetˤˈboːkʼ/ ‘to be tame 3M.SG.IPFV’ /jetˤˈfoːf/ ‘to float 3M.SG.IPFV’	/jeˈkʼɐwɾetˤ/ ‘to bite 3M.SG.IPFV’ /jeˈbuːsˤetˤ/ ‘to breakfast 3M.SG.IPFV’
d	**S**	/ˈdoːɾ/ ‘to go round 3M.SG.PFV’ /ˈdoːs/ ‘to tread, step on 3M.SG.PFV’	/jehˈduːd/ ‘to choke/close 3M.SG.IPFV’ /jeħˈduːd/ ‘to turn away; pull away 3M.SG.IPFV’	/ˈhedd/ ‘to close, shut, block 3M.SG.PFV’ /jehˈduːd/ ‘to choke 3M.SG.IPFV’
	US	/deˈfuːɾ/ ‘to push 3M.SG.PFV’ /deˈwiːl/ ‘old; ancient M.ADJ’	/jedeˈluːl/ ‘to know 3M.SG.IPFV’ /jedeˈfeːɾ/ ‘to push 3M.SG.IPFV’	/jeˈmuːsed/ ‘to rub, twist 3M.SG.IPFV’ /jeˈluːbed/ ‘to hit 3M.SG.IPFV’
k	**S**	/ˈkɐwb/ ‘wolf, dog M.SG’	/jeħˈkuːk/ ‘to scratch 3M.SG.IPFV’	/ˈħekk/ ‘to scratch 3M.SG.PFV’

		/ˈkoːb/ ‘cup M.SG’	/jerˈkoːb/ ‘to mount; ride 3M.SG.IPFV’	/jeħˈkuːk/ ‘to scratch 3M.SG.IPFV’
	US	/keˈluːθ/ ‘to talk 3M.SG.PFV’ /keˈloːn/ ‘bridegroom M.SG’	/jɐkˈfuːf/ ‘to stop; shut/discovers the area where it rained 3M.SG.IPFV’ /jekˈhoːl/ ‘to be able; can 3M.SG.IPFV’	/seˈjoːrek/ ‘to go 1C.SG.PFV’ /ʔɐːˈmuːrek/ ‘to say 1C.SG.PFV’
k’	S	/ˈk’ɐwn/ ‘horn M.SG’ /ˈk’ɐːl/ ‘to pour; spill 3M.SG.PFV’	/jesˤˈk’ɐwk’/ ‘to call; scream 3M.SG.IPFV’ /jeɬˈk’ɐwk’/ ‘to slit 3M.SG.IPFV’	/ˈsˤek’k’/ ‘to call; scream 3M.SG.PFV’ /jesˤˈk’ɐwk’/ ‘to call; scream 3M.SG.IPFV’
	US	/k’ɐˈnɐwn/ ‘small M.SG’ /k’eˈjoːd/ ‘rope M.PL’	/jek’eˈbɐwl/ ‘to accept 3M.SG.IPFV’ /jak’ˈfuːd/ ‘to put down; lower 3M.SG.IPFV’	/teˈbuːrek’/ ‘to flash; lighten 3M.SG.PFV’ /jeˈhuːrek’/ ‘to steal 3M.SG.IPFV’
g	S	/ˈgoːd/ ‘leather M.SG’ /ˈgɐːr/ ‘to fall, stumble 3M.SG.PFV’	/jesˈguːg/ ‘to daydream 3M.SG.IPFV’ /ʔerˈgeːm/ ‘to cover 3M.SG.IMP’	/ˈsegg/ ‘to daydream 3M.SG.PFV’ /jesˈguːg/ ‘to daydream 3M.SG.IPFV’
	US	/geˈleːd/ ‘leather M.PL’ /geˈheːm/ ‘to go in morning 3M.SG.IMP’	/jegˈhoːm/ ‘to go in morning 3M.SG.IPFV’ /jɐgˈluːl/ ‘to light 3M.SG.IPFV’	/jeˈnuːħeg/ ‘to play 3M.SG.IPFV’ /jeˈnuːfeg/ ‘to look for, seek 3M.SG.IPFV’

Table 5.1: List of elicited words including target stops in various positions.

5.2.2. Recording Procedure

Before the start of the recording session, the list of target words was reviewed with the participants to familiarise them with the intended words for recording. When recording started, the participants were given the meaning of the word in Arabic and were asked to provide the

Ḥarsūsi equivalent word. Participants were asked to repeat the word three times after getting the meaning of each word in Arabic (see 3.4 for recording equipment and data handling procedures).

Recording sessions took place in the main consultant's quiet guest room (Majlis) in the village of Abu Mudhabi near Haima minimising external noise to almost none. Recordings for one participant, however, were done in his own personal room at Al-Wusta Wildlife Reserve as it was not possible for him to leave the Reserve during the data collection period. The participants had a break of five minutes after recording each target consonant. Most recordings were done in two one-hour sessions for each participant. Due to various reasons, a few sessions took longer than one hour and one participant had to come for recording on two different occasions.

5.2.3. Measurements

As illustrated in Figure 5.1 below, VOT, oral closure duration, and presence or absence of glottal closure were annotated in tier 4. In addition, short periods of irregular glottal cycles and "glottal friction" (Hejná, 2023, p. 1876) which are expected to be Pre-glottalisation (PG) and Pre-aspiration (PA), respectively, were marked in tier 4. In certain tokens, irregular glottal cycles following the oral burst of the segment which showed as striations pulling apart from each other in the spectrogram were marked as creaky voice (CV). Oral release and glottal release, if any, were marked in tier six which was a point tier (see Segmentation Protocol).

All data in the illustrative images below are phonemically transcribed. Broad phonetic transcriptions are given in case of some long vowels. The phonetic transcriptions are given in the text only (see 3.5 for segmentation procedures). In addition, only the segment in focus is segmented in detail in the image for illustrative purposes.

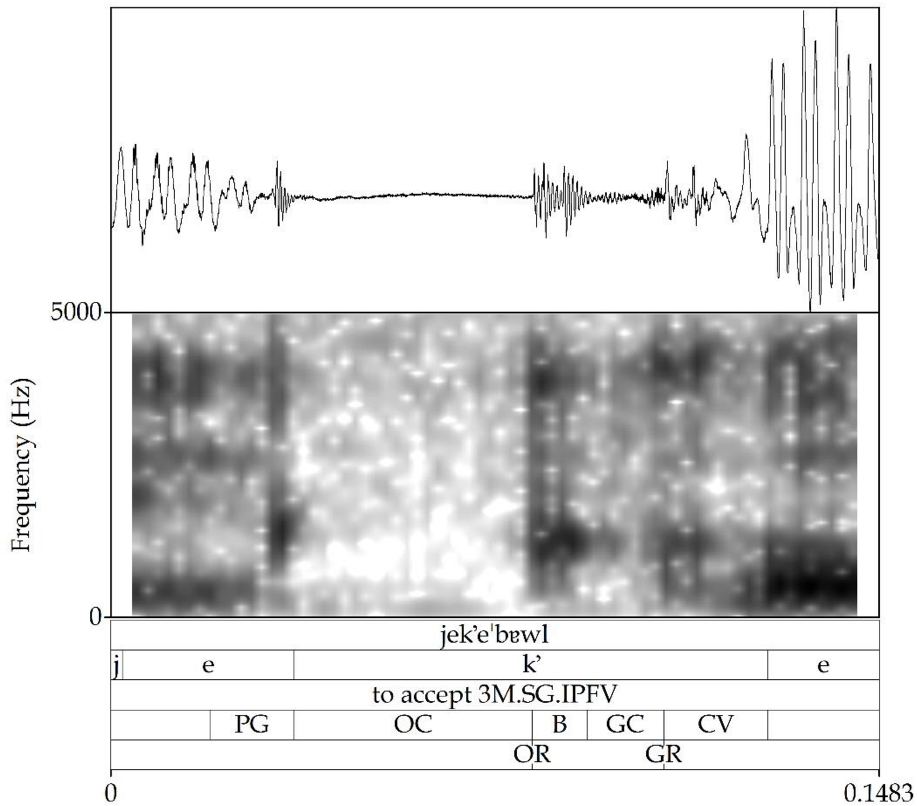

Figure 5.1: An emphatic stop token showing the tiers and segmentation style.

Table 5.2 below shows the meanings of abbreviations used in segmenting the data.

Abbreviation	Meaning
OC	Oral Closure
GC	Glottal Closure
B	Burst
N	Noise
OR	Oral Release
GR	Glottal Release
S	Stressed
US	Unstressed
PA	Pre-aspiration
PG	Pre-glottalisation
CV	Creaky Voice

Table 5.2: List of segmentation abbreviations and their meanings.

In utterance-initial position, the initial point of oral closure for the stops was set at the point where the waveform crossed the zero line and energy started showing up in the spectrogram, as is seen in Figure 5.2 below. Since it is difficult to exactly pinpoint the oral closure in initial position, the analyses only took into consideration oral closures in utterance-medial and final positions. In other positions, the occlusion point of the stop was set where the homogenous F1-F4 formant structure (J. Al-Tamimi & Khattab, 2018, p. 310)disappeared indicating oral closure as is seen in Figure 5.3 below. The burst point was set at the burst of noise in both waveform and spectrogram where there was visible energy in formants and a high spike in the signal in the waveform where the waveform crossed the zero line. The stop offset was set at the point where the sine line crossed the zero line in the waveform at the first periodic glottal cycle of the following segment, as is seen in Figure 5.3 below. In case of following fricatives in some items, stop offset was set at the end of the burst noise where aperiodicity started in the waveform and a change appeared the structure and intensity in the spectrogram as is seen in Figure 5.4 below.

See Segmentation Protocol in Appendices for detailed segmenting criteria followed in segmenting the stops.

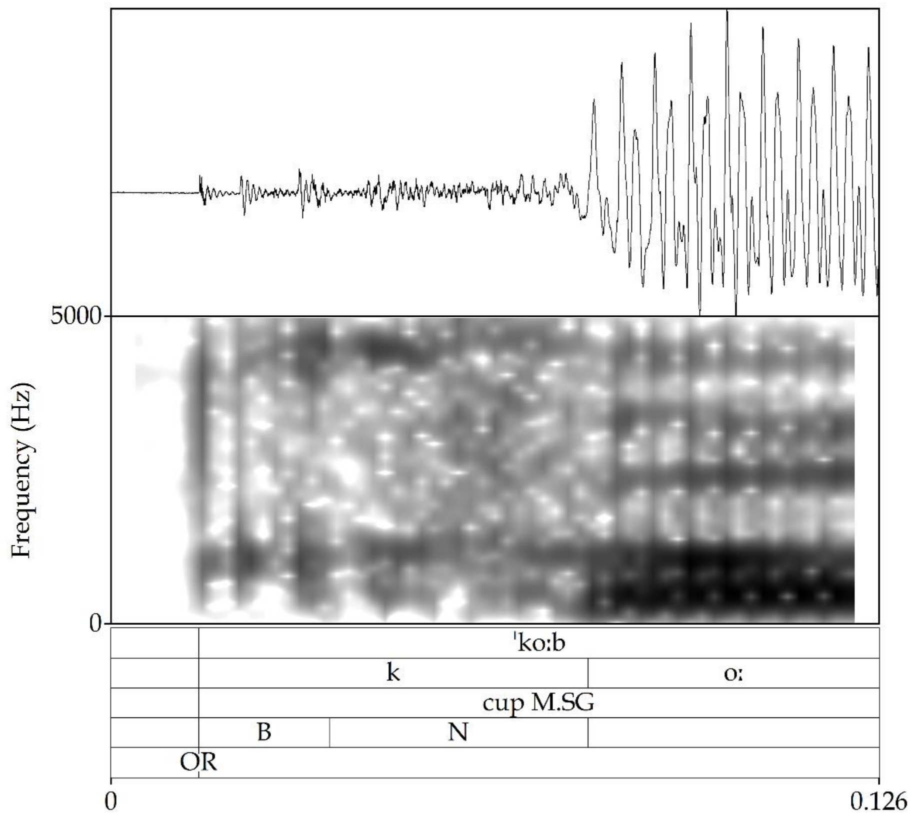

Figure 5.2: Stop in initial position.

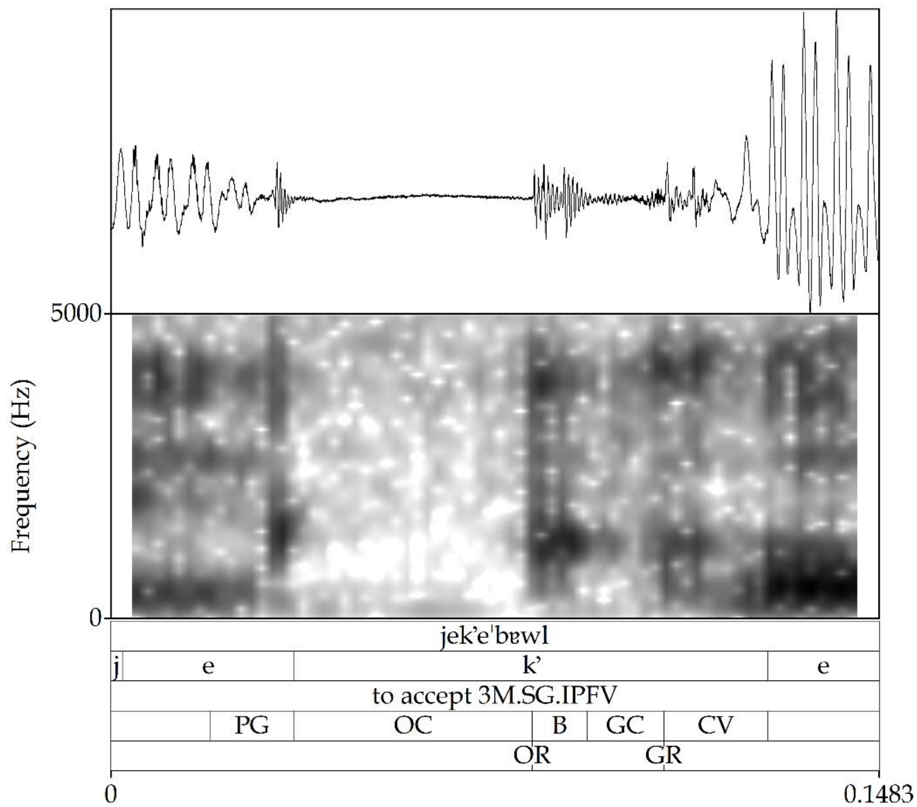

Figure 5.3: Stop in medial position.

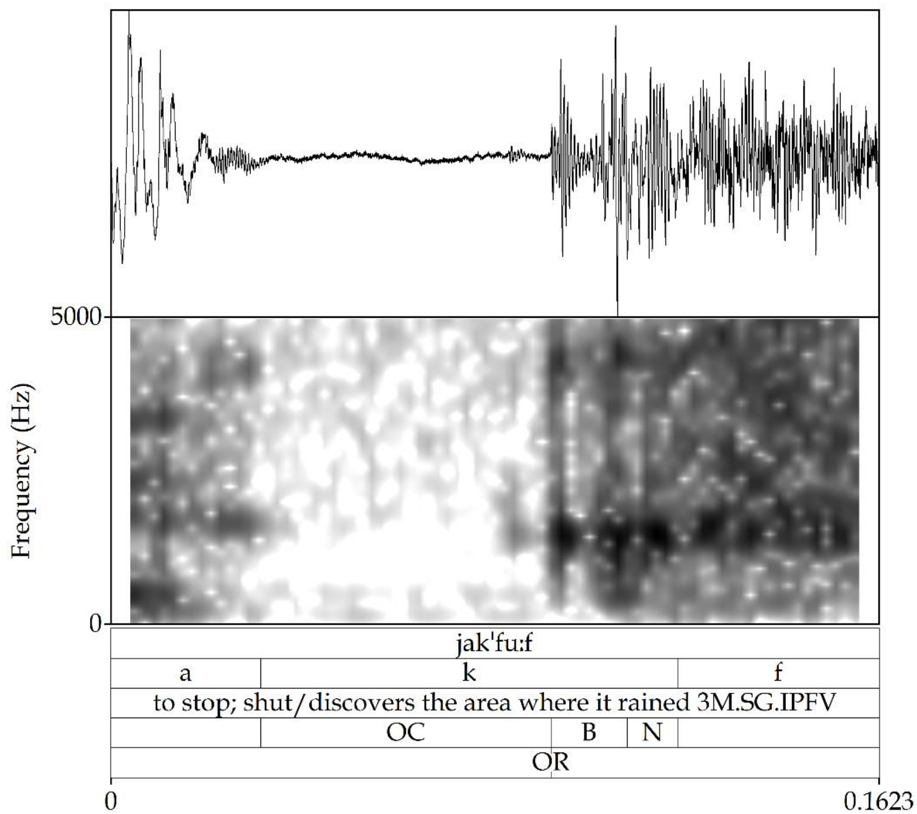

Figure 5.4: Stop followed by fricative.

VOT was measured for utterance-initial and medial stops only. It was measured from the start of the oral release burst to the first glottal pulse of the following vowel (Hajek & Stevens, 2005; Gallagher & Whang, 2014). In voiced stops, it was measured from the start of voicing in the pre-voicing duration until the release burst of the segment.

Closure duration was measured only for utterance-medial and utterance-final stops and the utterance-initial stops were not taken into consideration. It was not possible to accurately pinpoint the oral closure point in utterance initial positions since they were not recorded in carrier sentences, and therefore, they were not taken into consideration in the analyses. The closure duration was measured from the stop occlusion point until its burst point.

5.2.4. Analyses

The first part of the analyses included visual inspection of target consonants' spectrograms and waveforms to examine the presence of glottal closure and glottal burst release which are associated with ejective consonants. Moreover, the quality of the onset of the following vowel was also checked since creaky voice has been found to occur after ejective consonants in some languages. The second part of the analyses included running a PRAAT speech analysis software (Boersma & Weenink, 2020) script to measure the acoustic parameters of VOT, oral closure duration, and presence or absence of glottal closure. After getting the needed measurements, data were analysed using the statistical programmes R (R Core Team, 2019) and R studio (RStudio Team, 2020). Details on the procedures and use of these programmes are given above in 3.5.

Separate linear mixed-effects models were run for the dependent variables of VOT and oral duration, and a logistic regression model was run for glottal closure.

A post hoc omnibus test was run for all models in emmeans (Russell, 2022) to see if there were significant effects in each position, and a pairwise comparison with a Tukey adjustment decomposed the interactions within each position.

The linear mixed-effects models were reached after simplifying more complicated models step by step as suggested by Winter (2020, p. 266) to get the best fit possible. The models with the best overall fit results of AIC and BIC as suggested by Field, Miles, and Field (2012, pp. 867-868) were chosen in this study. The models with the best fit were checked for (anova) to make sure that all the included variables were significant in the model.

The main effects in the linear mixed-effects models were kept constant as segment type (voiced, voiceless, or emphatic), segment position (utterance-initial, medial, or final), syllable type (stressed or unstressed), and place of articulation (alveolar or velar). It was not possible to add varying random slope of segment type by participant in all the models due to fit being singular.

The linear mixed-effects models were run on raw data as well as log transformed data to account for any skewness in data. The results obtained from log transformed data were similar to results of raw data with the same significant variables. Therefore, only raw data models' results are reported, and main data patterns are illustrated using the raw values. In addition, a Pearson correlation test was run for dependent durational variables to see the correlation coefficient between the variables. The result of correlation coefficient is given in 5.3.2.

For the VOT linear mixed-effects model, the main effects were kept constant. It was not possible to add varying random slope of segment to this model as it resulted in fit being singular. Thus, only random intercepts by participant and item were added to the model. This model was chosen as it had the best overall fit results of AIC and BIC as suggested by Field et al. (2012, pp. 867-868). The model was reached after simplifying a number of more complicated models as suggested by Winter (2020, p. 266) which included random slopes of segment position, syllable type, and place of articulation by participant and random intercepts by participant and by item which either did not converge or their fits were singular.

Similar for the VOT linear mixed-effects model, the main effects for oral closure model were kept constant. The model included varying random slope of segment type by participant, which included the random intercept by participant and a random intercept by item. The model was reached after simplifying other models which included random slopes of other dependent variables and random intercepts by participant and item. The chosen model had the best overall fit results of AIC and BIC.

The logistic regression model for glottal closure had the presence (1) or absence (0) of glottal closure as the dependent variable. The independent variables were similar to the previous models as segment type (voiced, voiceless, or emphatic), segment position (utterance-initial, medial, or final), syllable type (stressed or unstressed), and place of articulation (alveolar or velar).

5.3. Results

In case of the voiced dental stop /d/, three tokens in initial position were not voiced and had a positive VOT. These tokens were produced by three different participants. Similarly, two tokens of the voiced velar stop /g/ had a negative VOT produced by two different participants. One of these tokens was in initial position and one in medial position. None of these negative VOT tokens were excluded, however, and were added into the analyses with their negative VOT measurements.

The results are presented in two different sections to deal with visual inspections of waveforms and spectrograms and statistical analyses separately.

5.3.1. Visual Inspection of Waveforms and Spectrograms

The visual inspection of waveforms and spectrograms during manual segmentation confirmed that the patterns of allophony described in 4 are also evident in this more controlled set of recordings. It should be noted here that the results in this section are based on the carefully elicited data (see 5.2.1) and not the natural speech data presented under 4.3. Various stops were articulated differently in the various contexts recorded in the data. Results of each type of stops are presented separately in the following sections.

The results in the following section mainly focus on the ejective realisation in the different positions studied in this research.

5.3.1.1. Emphatic Stops

Ḥarsūsi has two emphatic stops which are an alveolar /tˤ/ and a velar /k'/. Each one of these stops has two allophones, which are context dependent as mentioned earlier. In the sections below, the alveolar /tˤ/ and the velar /k'/ are examined in turn.

5.3.1.1.1. Alveolar /tˤ/

The emphatic dental stop /tˤ/ can be realised as a backed [t̪ˤ] and an ejective [t̪'] depending on the context. Visual inspections of the waveforms and spectrograms showed it is most commonly realised as a [t̪ˤ] without a clear glottal release; however, in utterance final positions it is realised as an ejective [t̪'] with a clear glottal closure and release.

Figure 5.5 and Figure 5.6 below show the emphatic dental stop /tˤ/ in utterance-initial and medial positions, respectively. Here the emphatic alveolar /tˤ/ is not realised as an ejective since the glottalic spike or burst cannot be seen in the waveforms and spectrograms. The waveforms and spectrograms show no signs of a glottal closure or release either which are associated with ejective emphatics. However, there were few instances where glottal closure and release could be seen in utterance-initial emphatic dental /tˤ/, as can be seen in Figure 5.7 below. Nonetheless, such instances were very limited and were not consistent in terms of the environment or position of occurrence. It should be noted here, however, that a few tokens in the data did show a period of irregular glottal cycles in the waveform preceding the oral closure for the emphatic dental in utterance-medial and final positions which is suggestive of pre-glottalisation. As can be seen in Figure 5.6 below, the oral closure of the emphatic dental /tˤ/ is preceded by a period of irregular cycles marked as PG in the textgrid.

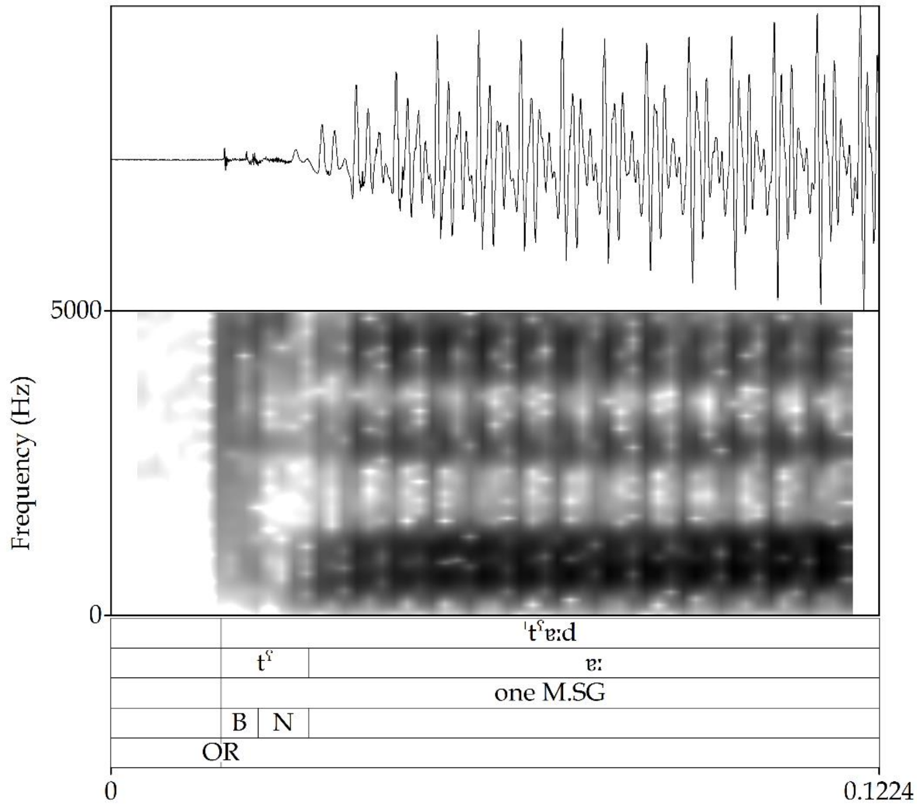

Figure 5.5: Spectrogram and waveform lacking the glottal release spike and burst in the emphatic /tˤ/ in /ˈtˤɐːd/ - [ˈt̪ˤɑːt̪ʼ] ‘one M.SG’.

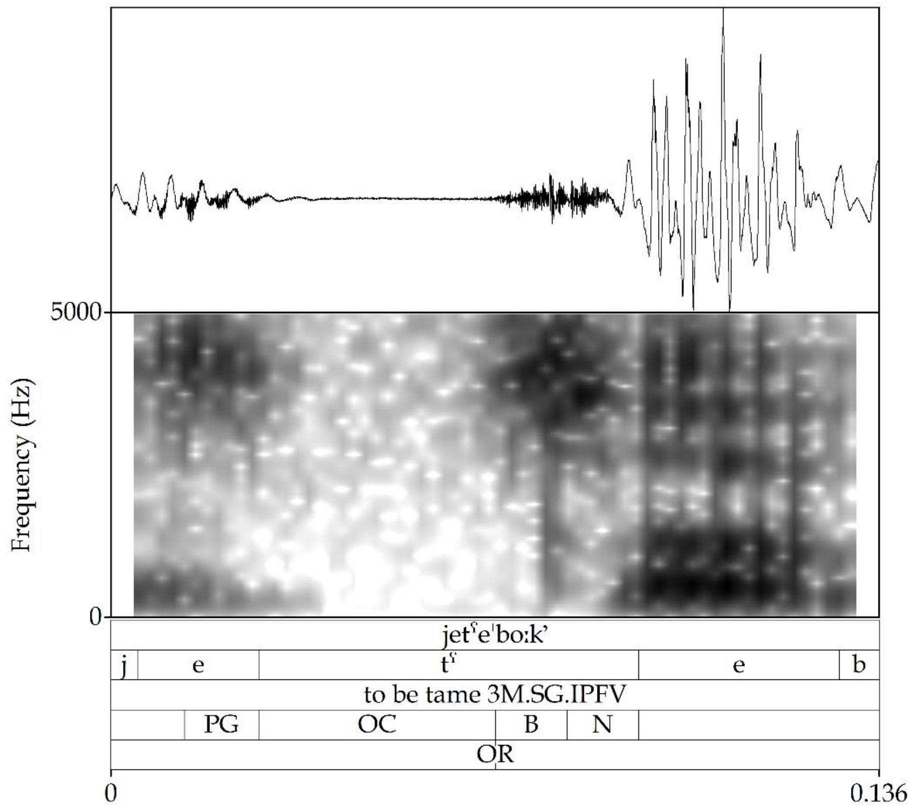

Figure 5.6: Spectrogram and waveform lacking the glottal release spike and burst in the emphatic /tˤ/ in /jetˤˈboːk'/ - [jet̪ˤ.ˈboːk'] 'to be tame 3M.SG.IPFV'.

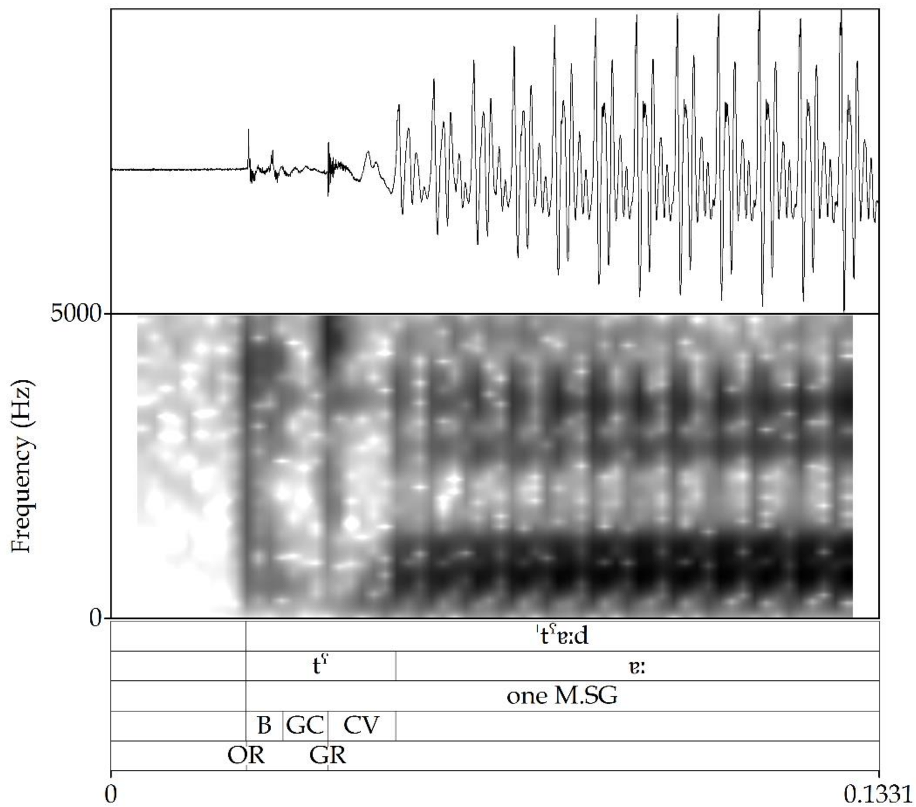

Figure 5.7: Spectrogram and waveform showing the glottal release spike and burst in the emphatic /tˤ/ in /ˈtˤɐːd/ - [ˈt̪’ɑːt̪’] ‘one M.SG’.

In utterance-final positions, the emphatic alveolar /tˤ/ is most commonly produced as an ejective [t̪’] with a clear glottal closure and release following the oral burst. As can be seen in Figure 5.8 below, the emphatic alveolar /tˤ/ shows two closures and two bursts in utterance-final position. The first closure is followed by a sharp spike, typical of glottalised consonants, in the waveform which indicates oral release. The sharp spike is followed by another closure which indicates glottal closure which in turn is followed by another shorter spike indicating glottal release. It is also worth noting here the short period of irregular glottal cycles in the waveform preceding the oral closure which is marked as PG in the textgrid.

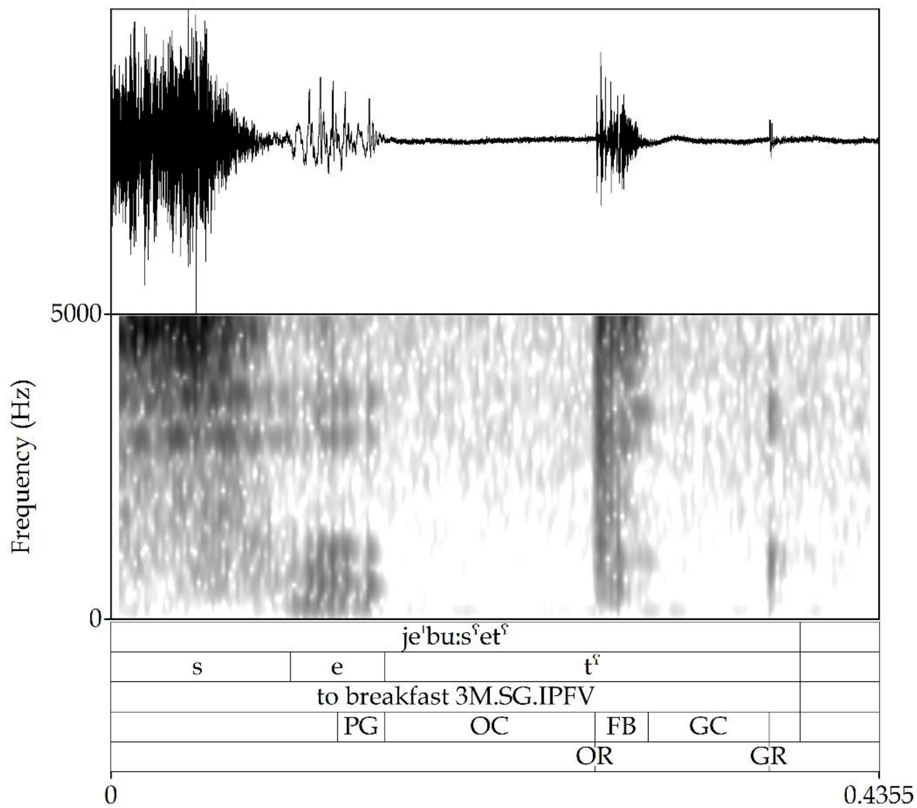

Figure 5.8: Spectrogram and waveform showing the glottal release spike and burst in the emphatic /tˤ/ in /jebˈuːsˤetˤ/ - [jib.ˈuːsˤət̪ʼ] ‘to breakfast 3M.SG.IPFV’.

5.3.1.1.2. Velar /k’/

The velar emphatic, /k’/, also has two allophones. It can be realised as a backed [$k^ʕ$] and an ejective [k’] depending on context. It is found to be commonly realised as an ejective in utterance-initial and final positions, both in stressed and unstressed syllables. In utterance-medial positions, it can be realised both as an ejective [k’] or a backed [$k^ʕ$] with varying degrees (see 5.3.2.1).

Figure 5.9 below shows the emphatic velar /k’/ in utterance-initial position. The oral burst with a sharp spike is followed by a closure which is glottal closure in this position. After the second closure, another sharp spike is seen indicating glottal release and burst after the initial oral burst which shows that the velar emphatic /k’/ is ejective in this position.

Similarly, in utterance-final positions the velar emphatic /k’/ is found to be realised as an ejective [k’]. The glottal release spike and burst in the velar emphatic /k’/ can be clearly seen in Figure 5.10 below. Two bursts can be seen after the initial oral closure which are the oral burst and the glottal burst, respectively. It can be seen after the initial burst the waveform shows a second closure which is the glottal closure which in turn is followed by a sharp spike indicating glottal release and burst.

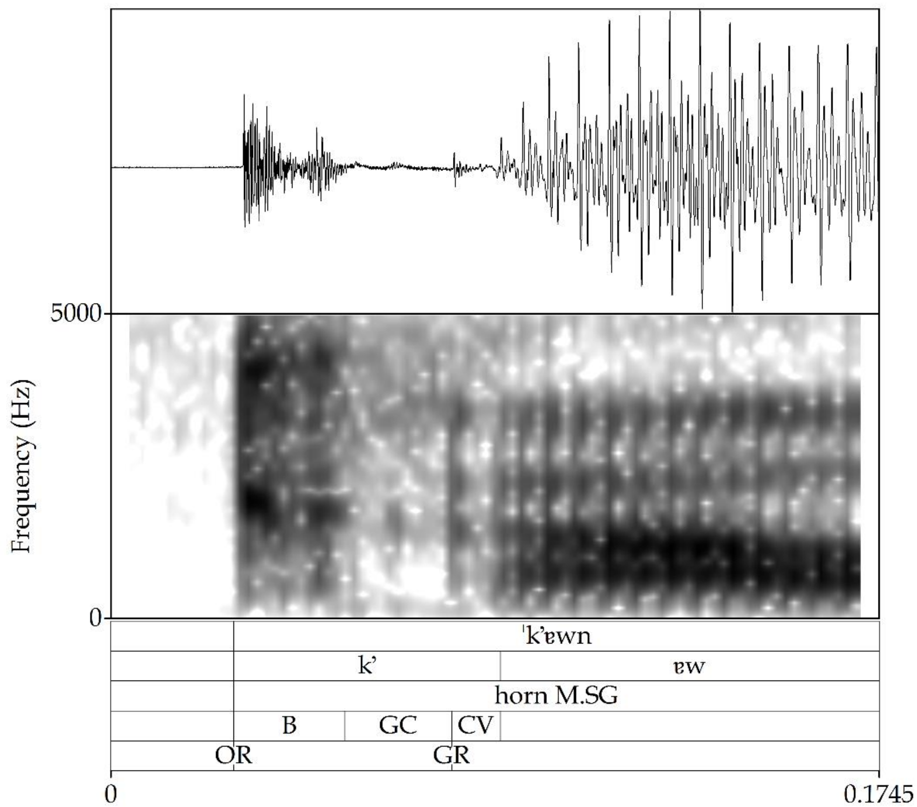

Figure 5.9: Spectrogram and waveform showing the glottal release spike and burst in the emphatic /k'/ in /k'ɐwn/ - [ˈk'ɑun] 'horn M.SG'.

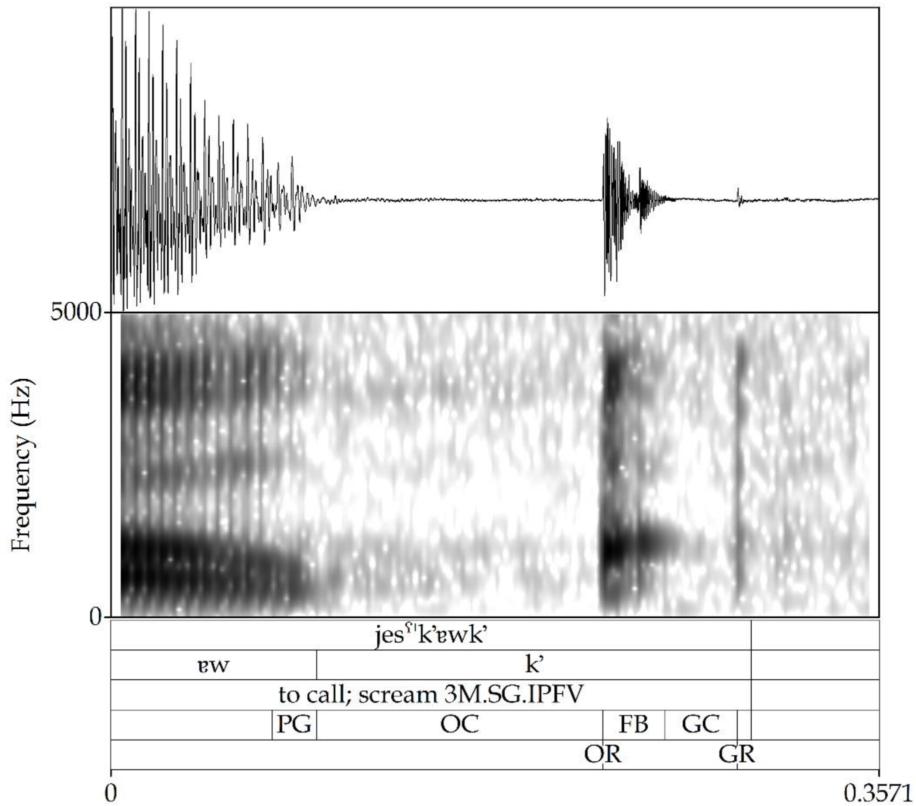

Figure 5.10: Spectrogram and waveform showing the glottal release spike and burst in the emphatic /k'/ in /jesˤˈk'ɐwk'/ - [jəsˤ.kˤɑuk'] 'to call; scream 3M.SG.IPFV'.

In utterance-medial positions, the voiceless velar emphatic /k'/ is found to be realised both as a backed [kˤ] and an ejective [k'] by different participants. Given the visual inspection of the waveforms and spectrograms of the current data, the occurrence of each allophone is not predictable as both were found in similar positions. Figure 5.11 and Figure 5.12 below show the emphatic velar /k'/ in the same context. As is seen in Figure 5.11 below, the velar emphatic / k'/ do not show the glottal closure or release. On the other hand, Figure 5.12 below shows the emphatic velar /k’/ being realised with two bursts which are an oral burst followed by a glottal burst. Moreover, the initial burst is followed by a second closure indicating glottal closure. Such realisations were found in various tokens of different participants making it difficult to infer specific conditions for each realisation.

As for the emphatic dental /tˤ/, some tokens of the emphatic velar /k’/ also exhibited irregular glottal cycles in the waveform preceding the oral closure in utterance-medial and final position. As seen in Figure 5.10 and Figure 5.12, such periods, marked as PG in the textgrid, are suggestive of pre-glottalisation.

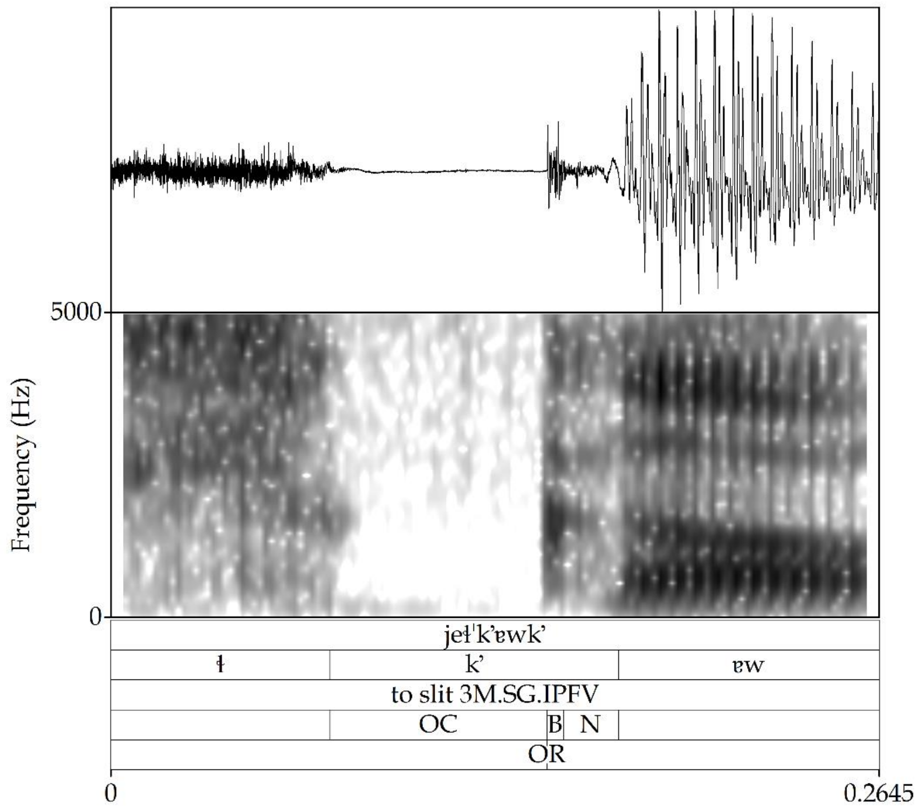

Figure 5.11: Spectrogram and waveform lacking the glottal release spike and burst in the emphatic /k'/ in /jeɫˈk'ɐwk'/ - [jəɫ.kˤɑuk'] 'to slit 3M.SG.IPFV'.

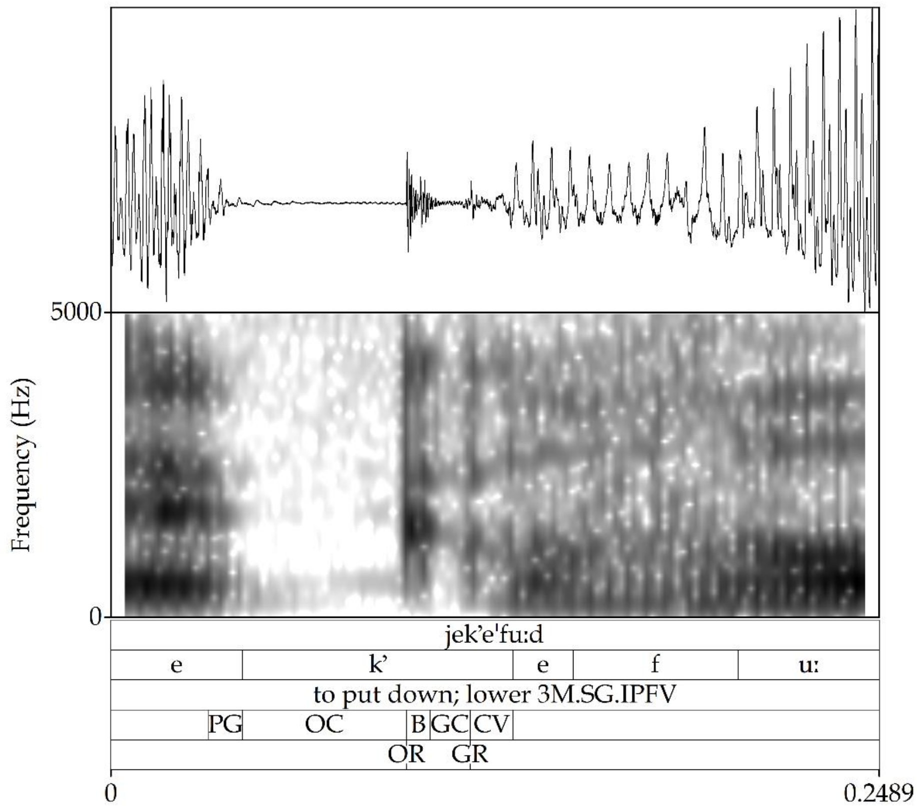

Figure 5.12: Spectrogram and waveform showing the glottal release spike and burst in the emphatic /k'/ in /jek' ˈfuːd/ - [jik'.fuːt̪'] 'to slit 3M.SG.IPFV'.

Given the previous results, it can be stated that in Ḥarsūsi the velar emphatic /k'/ is realised as an ejective consonant more commonly among the Ḥarsūsi emphatic stops. It is realised as an ejective in both utterance-initial and final positions, but in medial positions it is found to be realised as an ejective [k'] in some instances and as a backed [kˤ] in some other instances. On the other hand, the voiceless emphatic alveolar /tˤ/ is mostly realised as an ejective in utterance-final positions with very few instances in utterance-initial position, therefore, it is not an ejective consonant in Ḥarsūsi and found to be realised as a backed [t̪ˤ] in most positions.

5.3.1.2. Voiced Stops

The voiced stops of Ḥarsūsi, an alveolar /d/ and a velar /g/, have two allophones each which are context dependent as was discussed above in section 4.1.1. In the sections below, the alveolar /d/ and the velar /g/ are examined in turn.

5.3.1.2.1. Dental /d/

The visual inspection of waveforms and spectrograms showed two different realisations for the voiced dental stop /d/. In utterance-initial and medial positions it is realised as a voiced [d̪], while in utterance-final positions it is devoiced and typically realised as an ejective [t̪'].

Figure 5.13 and Figure 5.14 below show the voiced dental stop /d/ in utterance-initial and medial positions, respectively. It can be seen Figure 5.13 and Figure 5.14 below the voiced dental stop /d/ is prevoiced in utterance-initial and medial positions with a negative VOT.

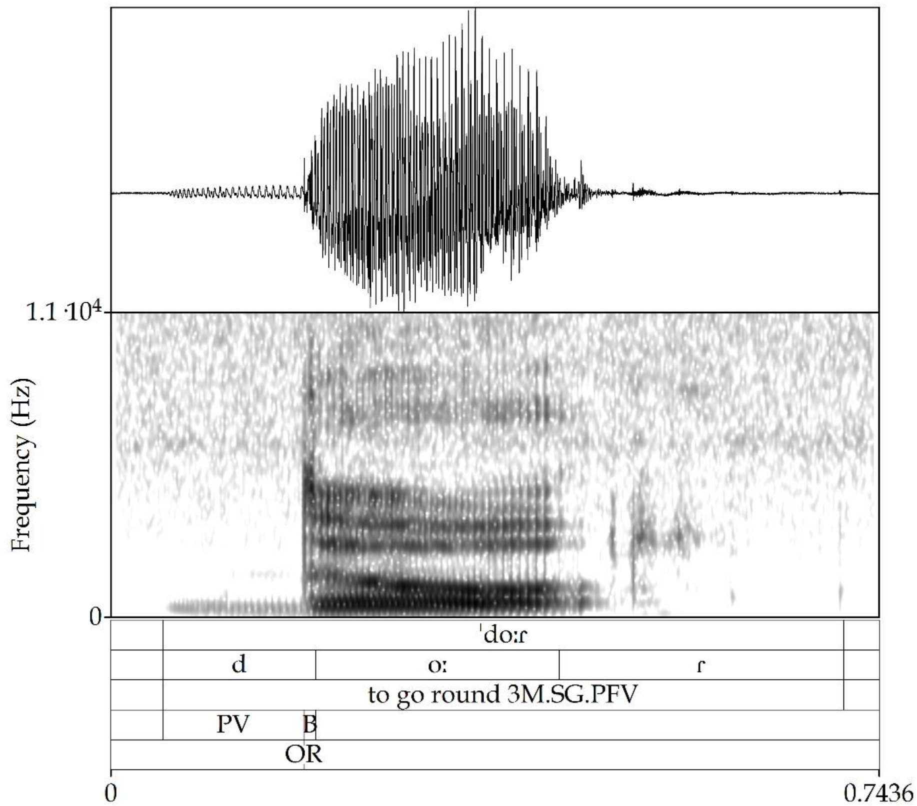

Figure 5.13: Spectrogram and waveform of /d/ in /ˈdoːɾ/ - [ˈd̪oːr] 'to go round 3M.SG.PFV'.

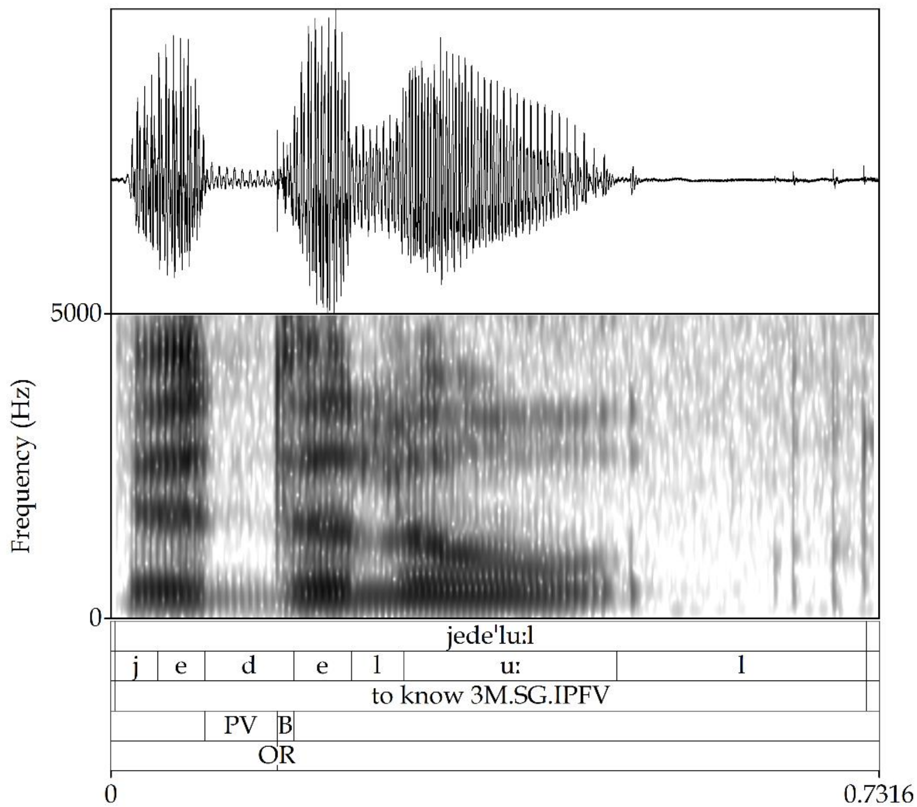

Figure 5.14: Spectrogram and waveform showing /d/ in /jedeˈluːl/ - [je.d̪ə.ˈluːl] ‘to know 3M.SG.IPFV’.

In utterance-final position, it is devoiced and typically realised as an ejective [t̪’]. It can be clearly seen in Figure 5.15 that the oral closure duration of voiced dental /d/ in utterance-final positions lacks any energy indicating a devoiced stop. In addition, its first burst, which is the oral burst, is followed by another closure duration, which is glottal closure, and a second burst indicating glottal release. This type of realisation is the same as was found in emphatic stops earlier in section 5.3.1.1 above. An interesting point about the voiced dental /d/ is that is also found with a period of irregular cycles preceding the oral closure similar to the emphatics in utterance-final positions as can be seen in Figure 5.15 below. Such periods were marked as PG in the textgrids which are suggestive of a pre-glottalisation.

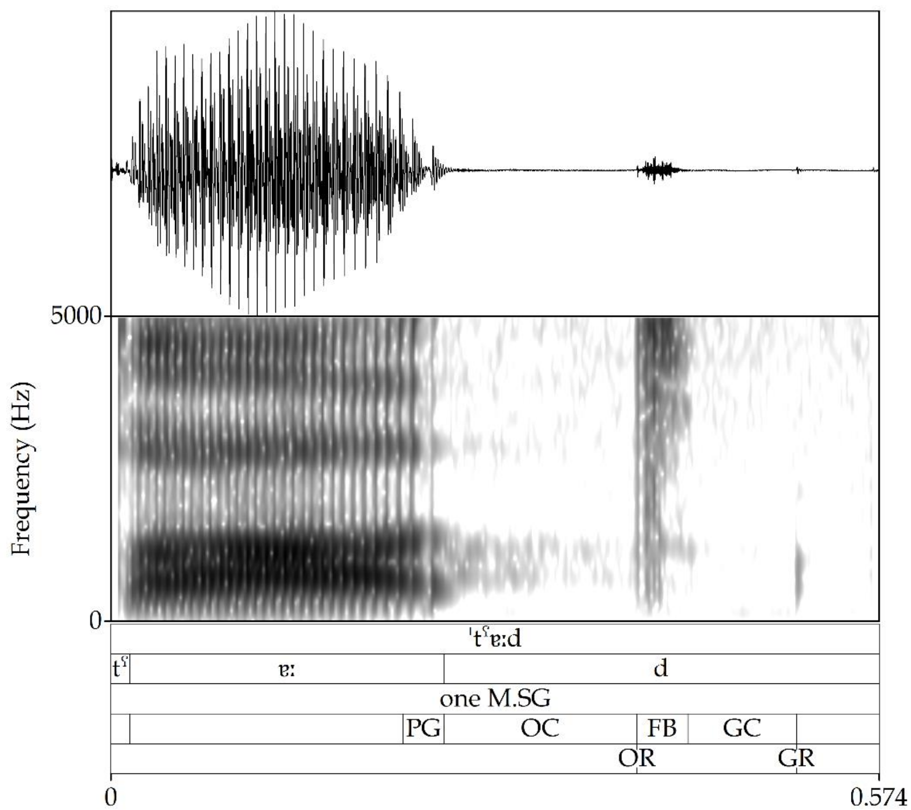

Figure 5.15: Spectrogram and waveform showing /d/ in /ˈtˤɐːd/ - [ˈtˤɑːt̪ʼ] ‘one M.SG’.

5.3.1.2.2. Velar /g/

Similar to the dental stop /d/, the voiced velar stop /g/ is realised in two different ways in the various positions checked in the data. The visual inspection of waveforms and spectrograms showed the voiced velar stop /g/ is realised as a voiced [g] in utterance-initial and medial positions. On the other hand, in utterance-final positions it is devoiced and typically realised as an ejective [k’]. Moreover, similar to the dental stop /d/, some tokens of the voiced velar /g/ in utterance-final position exhibited the irregular glottal cycles in the waveform suggestive of pre-glottalisation, as can be seen in Figure 5.18 below.

Figure 5.16 and Figure 5.17 below show the voiced velar stop /g/ in utterance-initial and medial positions, respectively. Here the voiced velar stop /g/ is prevoiced.

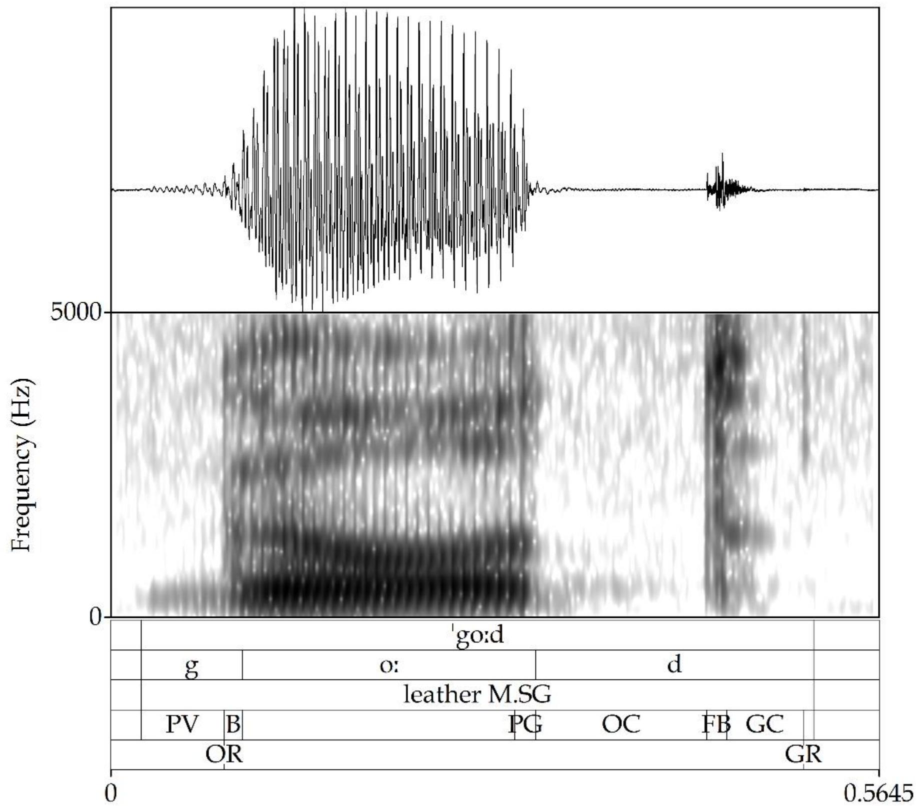

Figure 5.16: Spectrogram and waveform showing /g/ in /ˈgoːd/ - [ˈgoːt̪ʼ] ‘leather M.SG’.

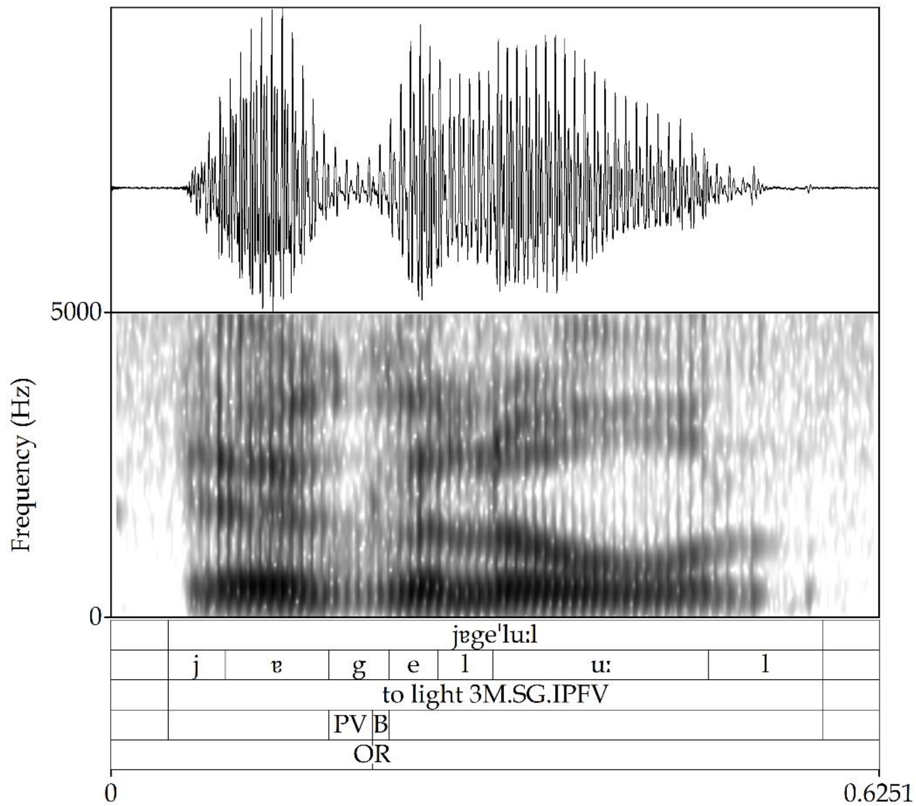

Figure 5.17: Spectrogram and waveform showing /g/ in /jɐgˈluːl/ - [jɐgəˈluːl] ‘to light 3M.SG.IPFV’.

In utterance-final position, the voiced velar stop /g/ is devoiced. Moreover, the waveforms and spectrograms show it is realised as an ejective [k’] as the spike of glottal release and glottal closure can be seen. In Figure 5.18 below, the oral closure duration of voiced velar stop /g/ in utterance-final position lacks any energy in the lower formants indicating a devoiced stop. The oral burst is followed by glottal closure, and a second burst indicating glottal release.

This type of realisation is the same which was found in emphatic stops earlier in section 5.3.1.1 above.

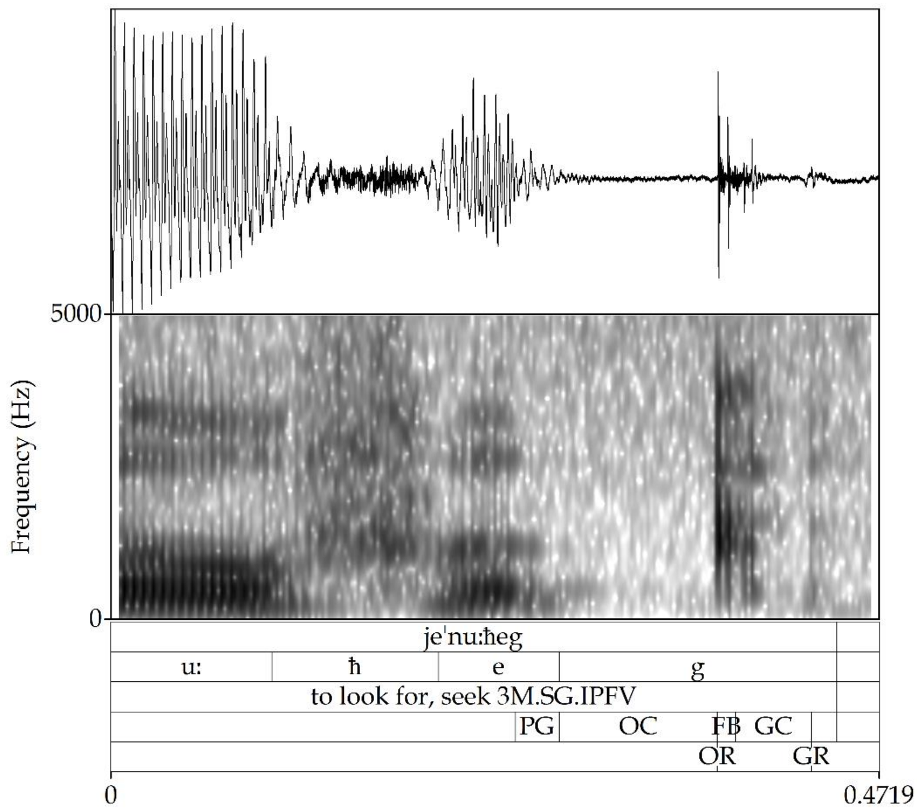

Figure 5.18: Spectrogram and waveform showing /g/ in /jeˈnuːħeg/ - [jiˈnuːħək’] ‘to play 3M.SG.IPFV’.

5.3.1.3. Voiceless Stops

Ḥarsūsi has two voiceless stops: a dental /t/ and a velar /k/. The voiceless stops have different allophones which are context dependent. In the sections below, the dental /t/ and the velar /k/ are examined in turn.

5.3.1.3.1. Dental /t/

The voiceless dental stop /t/ is realised as an aspirated [t̪ʰ] in utterance-final positions and in the onset of stressed syllables. In other positions, it is realised as a non-aspirated [t̪]. Figure 5.19 and Figure 5.20 below show the voiceless dental stop /t/ in utterance-initial stressed position and utterance-final position, respectively. In these positions, it is realised as an aspirated [t̪ʰ] with a higher intensity rate in the stressed syllables and longer noise duration in utterance-final positions. In some tokens, the utterance-medial and final dental stop /t/ was preceded by a short period of aperiodicity which was marked as pre-aspiration (PA) as can be seen in Figure 5.20 below.

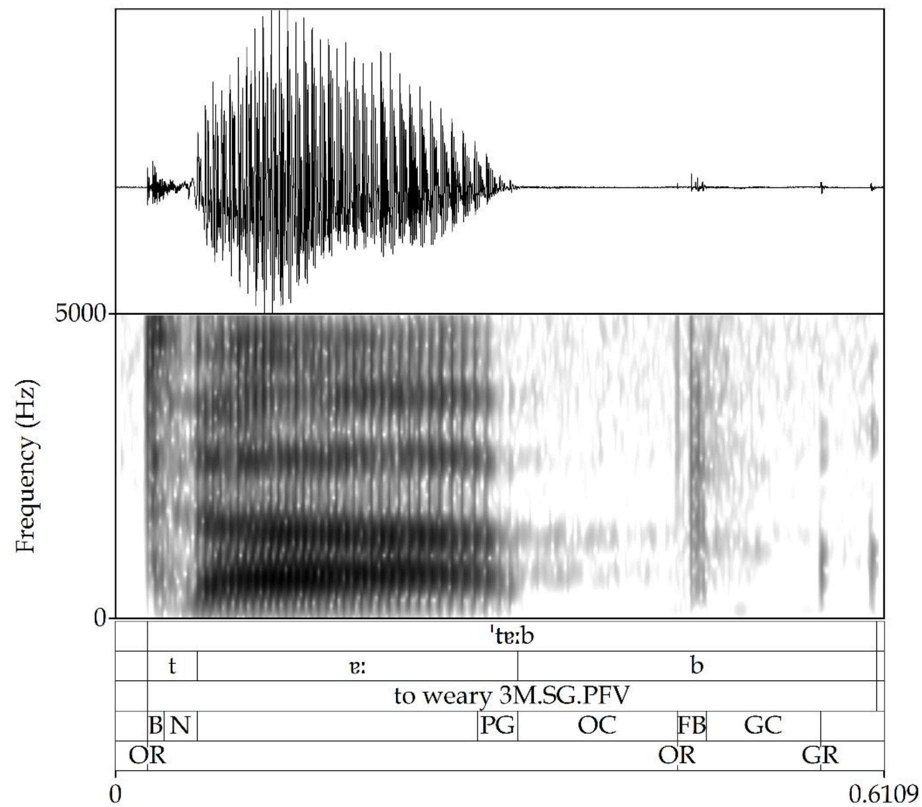

Figure 5.19: Spectrogram and waveform showing /t/ in /ˈtɐːb/ - [ˈt̪ʰɐːp'] ‘to be weary 3M.SG.PFV’.

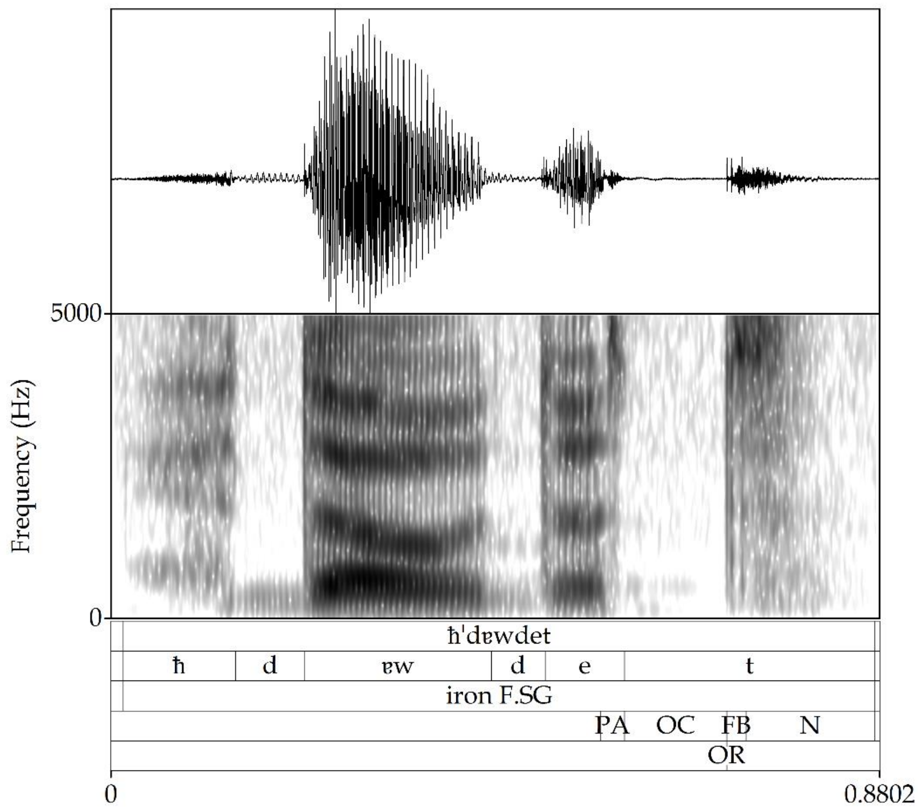

Figure 5.20: Spectrogram and waveform showing /t/ in /ħˈdɐwdet/ - [ħ.ˈd̪ɑu. d̪ət̪ʰ] ‘iron F.SG’.

In non-stressed syllables, it is realised as a non-aspirated variant [t̪] with a shorter noise duration and lower intensity. Figure 5.21 below shows the voiceless dental stop /t/ in such a position where it is not aspirated compared to Figure 5.20 above, for instance.

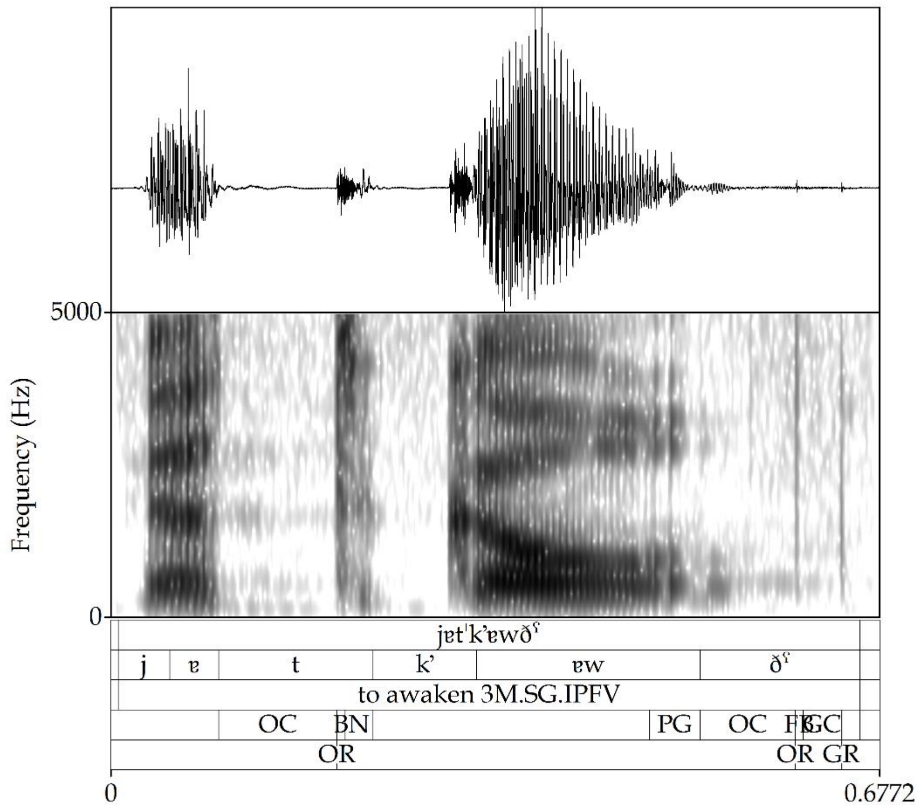

Figure 5.21: Spectrogram and waveform showing /t/ in /jɐtˈk’ɐwðˤ/ - [jɐt̪.ˈk’ɑuθ’] ‘to awaken 3M.SG.IPFV’.

5.3.1.3.2. Velar /k/

The voiceless velar stop /k/ follows a similar pattern to the dental stop /t/. It is realised as an aspirated [k^h] in utterance-final positions and in the onset to stressed syllables. In other positions, it is realised as a non-aspirated [k]. Figure 5.22 and Figure 5.23 below show the voiceless velar stop /k/ in utterance-initial stressed position and utterance-final non-stressed position, respectively. In these positions, it is realised as an aspirated [kʰ] with a higher intensity rate in the stressed syllables and longer noise duration in utterance-final positions. In utterance-final position, some tokens also show a short period of pre-aspiration preceding the oral closure, marked as PA, as can be seen in Figure 5.23 below.

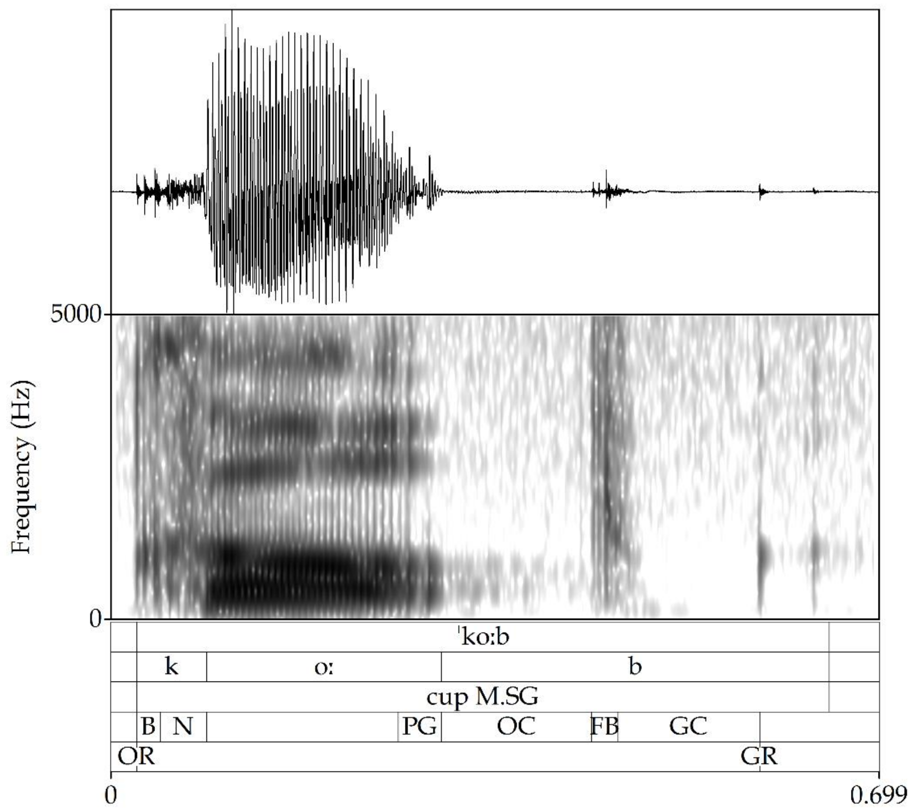

Figure 5.22: Spectrogram and waveform showing /k/ in /ˈkoːb/ - [ˈkoːp’] ‘cup M.SG’.

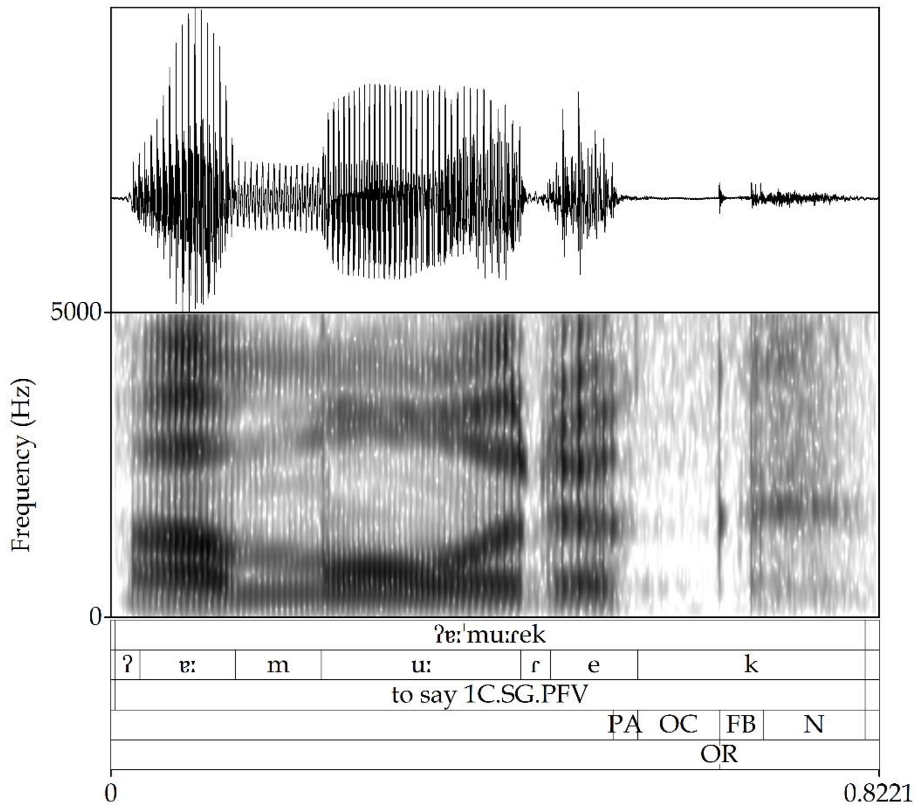

Figure 5.23: Spectrogram and waveform showing /k/ in /ʔɐːˈmuːɾek/ - [ʔɑː.ˈmuː.ɾekʰ] 'to say 1C.SG.PFV'.

In non-stressed syllables, it is realised as a non-aspirated variant [k] with a shorter noise duration and lower intensity. Figure 5.24 below shows the voiceless velar stop /k/ in such a position where it is not aspirated compared to Figure 5.22 above, for instance.

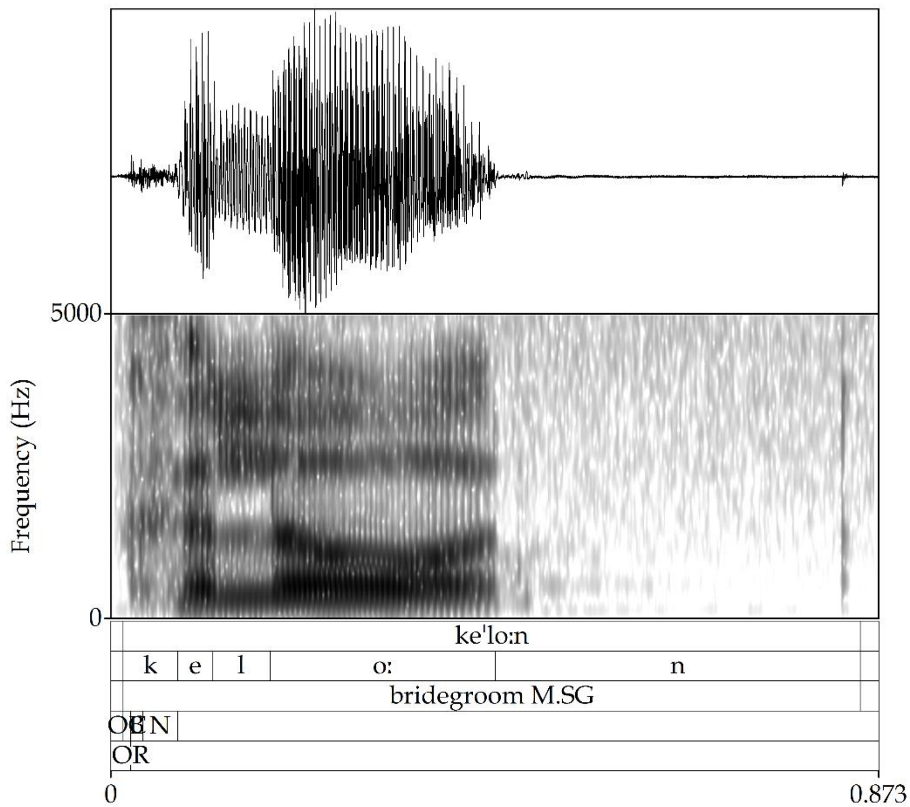

Figure 5.24: Spectrogram and waveform showing /k/ in /keˈloːn/ - [kə.ˈloːn] ‘bridegroom M.SG’.

5.3.2. Statistical Analyses

The results of the Pearson correlation test assessing the linear relationship between the dependent variables, oral closure duration and VOT, showed a non-significant negative relation. There was a negative correlation between the two variables, $r(1438) = -0.008$, $p = 0.75$.

The results of each acoustic cue for Ḥarsūsi stops are given separately under corresponding headings in the following sections below.

5.3.2.1. Glottal Closure

Out of the total 2160 tokens in the data, only 319 of the tokens included glottal closures in the different positions investigated in this study. The number of tokens with glottal closures in the data were as follows: voiced dental /d/ had 68 (18.8%), the voiced velar /g/ had 60 (16.6%), the emphatic alveolar /tˤ/ had 82 (22.7%), the emphatic velar /k'/ had 109 (30.2%), and the voiceless segments had none.

As was mentioned above in 5.1, impressionistic analysis suggests that among the emphatic stops, the velar /k'/ exhibits more glottal closures in various positions. In addition, both voiced and emphatic stops exhibit glottal closures in utterance-final position suggesting a phonological patterning in this position. Figure 5.25 below of target consonants' glottal closure values in various positions indicates that the observations made are robust across the data. As can be seen in Figure 5.25, overall, only the voiced and emphatic consonants had glottal closures. The voiceless consonants were not found with glottal closures in any position. In addition, voiced consonants had glottal closures only in utterance-final position, while the emphatics had glottal closures in utterance-initial, medial, and final positions with varying degrees across the data.

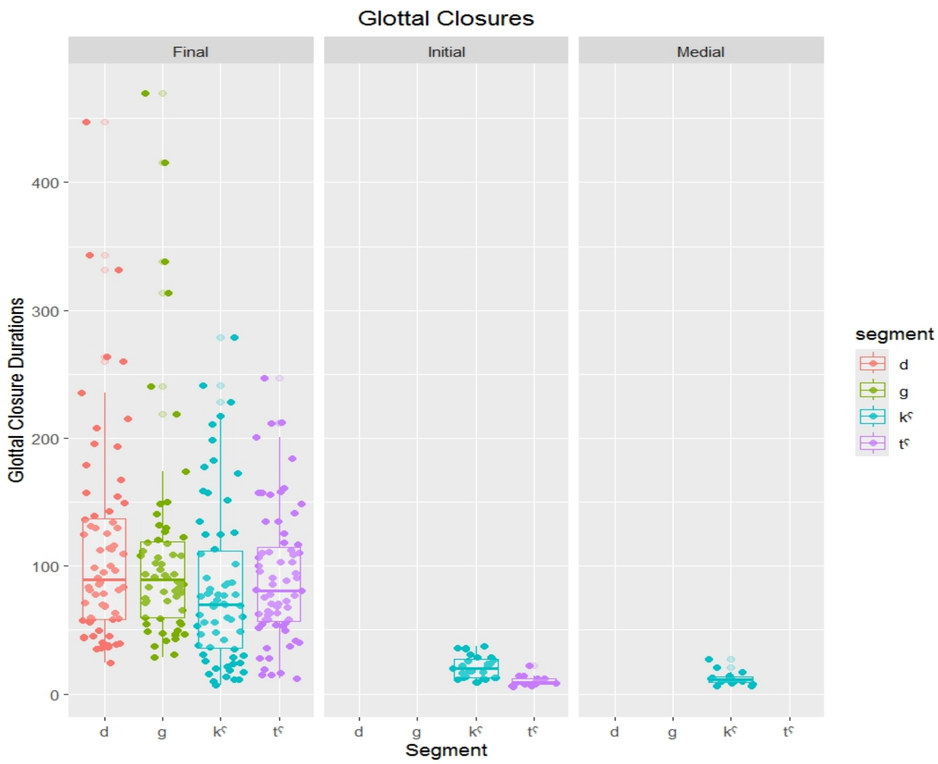

Figure 5.25: Glottal closures by segment and position.

Table 5.3 below shows the percentages of tokens found with glottal closures in various positions in the data. As can be seen below in Table 5.3, more than half of the voiced segments had glottal closures in utterance-final positions only. Similarly, more than half of the emphatic segments had glottal closures in utterance-final positions. On the other hand, 30.2% of the velar emphatic stop /k'/ were found with glottal closures in the data overall, while only 22.7% of the emphatic dental stop /tˤ/ were found with glottal closures in the data.

Segment	Percentage
Final	**120 tokens**
/d/	56.6%
/g/	50%
/k’/	55%
/tˤ/	55.8%
Overall	**360 tokens**
/k’/	30.2%
/tˤ/	22.7%

Table 5.3: Percentages of tokens with glottal closures.

Within the group of emphatic stops, the velar /k’/ was found with glottal closure in all environments to varying degrees. It was mostly found with glottal closures in utterance-initial and final positions. In utterance-medial positions, the emphatic velar /k’/ was found with glottal closure in much fewer tokens: out of 60 total tokens in utterance-medial stressed position, only seven tokens had glottal closure. Similarly, out of 60 tokens in utterance-medial unstressed position, only nine tokens had glottal closure.

On the other hand, the emphatic dental stop /tˤ/ was found with glottal closure in a smaller number of tokens compared to the velar emphatic stop /k’/ especially in utterance-initial position: it had glottal closure in only 10 tokens out of a total 60 tokens in utterance-initial stressed position. Similarly, it had glottal closure in five tokens out of a total of 60 tokens in utterance-initial unstressed position. In utterance-medial position, no tokens of /tˤ/ had glottal closure.

Glottal closure counts when grouped by speaker showed that all the participants of this study produced emphatic and voiced stops with glottal closures. The results showed that some participants produced glottal closures more than others. Figure 5.26 below shows the counts of glottal closures for each segment by each participant.

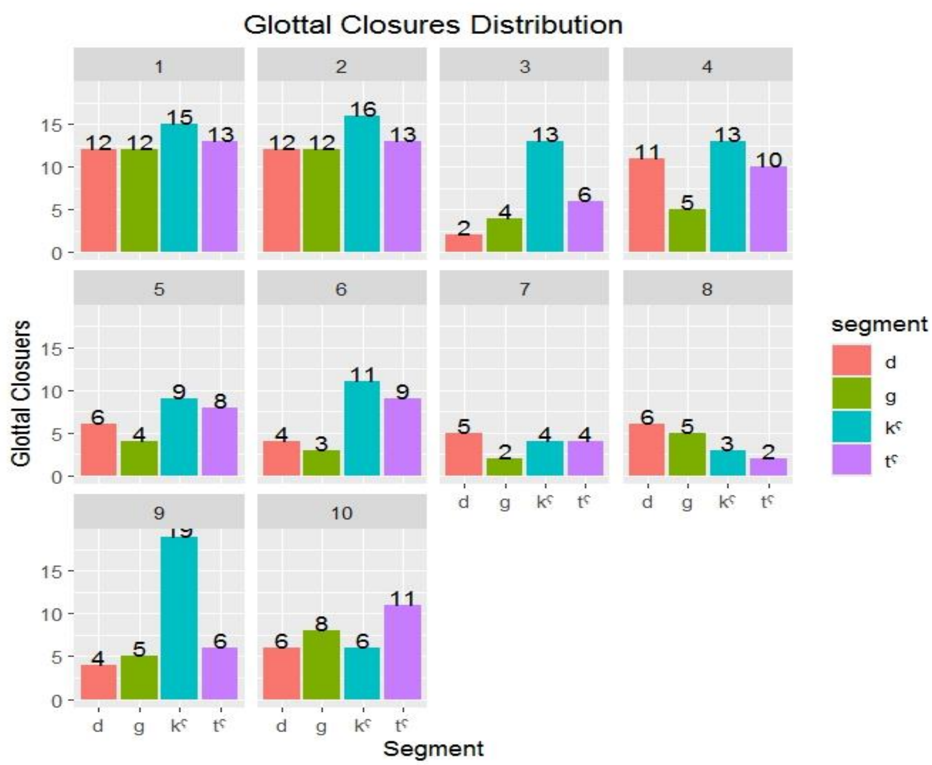

Figure 5.26: Counts of glottal closures for each segment by each participant.

The results of the logistic regression model for glottal closure confirmed the observation made earlier based on segmentation and results found in other MSAL such as Mehri and Baṭḥari.

The effect of segment type and position were significant on the presence of glottal closure. However, place of articulation was not found to be a significant factor. For instance, the presence of glottal closures in voiceless segments was significantly lower than their presence in the emphatic segments, b = -0.006693, t(0.022055) = -0.303, $p>0.5$. On the other hand, presence of glottal closures in voiced segments was not significantly lower than their presence in emphatic segments, b = -0.356, t(0.024804) = -14.376, $p<0.001$. In terms of position, segments in initial position had significantly less glottal closures than segments in final position, b = -0.207997, t(0.023655) = -8.793, $p<0.001$. Similarly, segments in medial position had significantly fewer glottal closures than segments in final position, b = -0.294272, t(0.024359) = -12.081, $p<0.001$. With regard to place of articulation, the results did not show any significant difference. Figure 5.27 below shows the results of the logistic regression model for glottal closures in stops.

	g_closure		
Predictors	*Estimates*	*CI*	*p*
(Intercept)	0.35	0.32 – 0.38	<**0.001**
segment [Voiced]	-0.01	-0.05 – 0.04	0.762
segment [Voiceless]	-0.36	-0.41 – -0.31	<**0.001**
position [Initial]	-0.21	-0.25 – -0.16	<**0.001**
position [Medial]	-0.29	-0.34 – -0.25	<**0.001**
stress [US]	-0.00	-0.03 – 0.02	0.837
place [Velar]	0.02	-0.01 – 0.04	0.207
segment [Voiced] * position [Initial]	-0.14	-0.21 – -0.07	<**0.001**
segment [Voiceless] * position [Initial]	0.21	0.14 – 0.28	<**0.001**
segment [Voiced] * position [Medial]	-0.06	-0.12 – 0.01	0.117
segment [Voiceless] * position [Medial]	0.29	0.22 – 0.37	<**0.001**
Observations	2453		
R^2 / R^2 adjusted	0.209 / 0.206		

Figure 5.27: Glottal closure model: lm (g_closure ~ segment * position + stress + place , data = Glottal_Closure) summary results.

The post-hoc pairwise comparison test showed the presence of glottal closure to be significantly different between some of the segments in various positions. Table 5.4 shows the significant pairwise comparisons in various positions.

Position	Segment Pair	B	DF	t-ratio	P value
Initial	Emphatic*Voiced	1.49e-01	2442	5.621	< **.0001**
	Emphatic*Voiceless	1.49e-01	2442	5.646	< **.0001**
Final	Emphatic*Voiceless	3.57e-01	2442	14.376	< **.0001**
	Voiced*Voiceless	3.50e-01	0.0249	14.053	< **.0001**

Table 5.4: Pairwise comparisons for glottal closure by segment type.

Table 5.4 shows that the presence of glottal closures was significantly lower in voiced and voiceless segments compared to emphatic segments in initial position, while in utterance-medial position the difference was not significant. In utterance-final position, the presence of glottal closures was significantly higher in both emphatic and voiced segments compared to voiceless segments. The difference in glottal closures in utterance-final position was not significant between the emphatic and voiced segments.

5.3.2.2. VOT

The distribution of VOT values in the data is given in Figure 5.28 below.

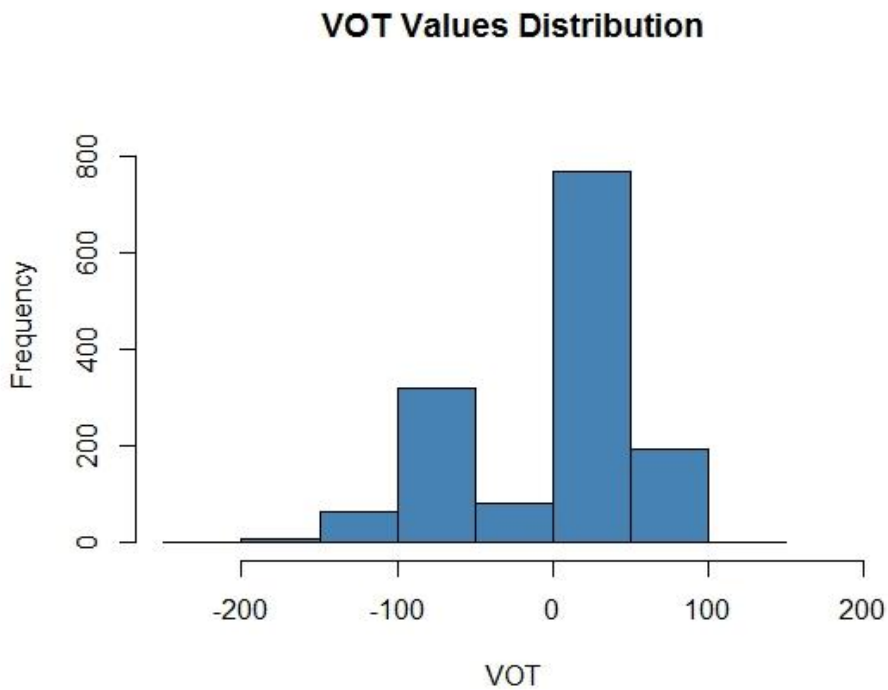

Figure 5.28: VOT value distribution.

The study hypothesised, based on results of other MSAL, that the emphatics would have the longest VOT in Ḥarsūsi, but statistical results do not confirm this hypothesis. Figure 5.29 below shows the VOT duration values of target consonants in utterance-initial and medial positions. As can be seen in Figure 5.29, voiceless segments had the longest VOT and not the emphatics as was hypothesised. The emphatic segments had an intermediate VOT between the voiceless and the voiced segments which in turn had a negative VOT.

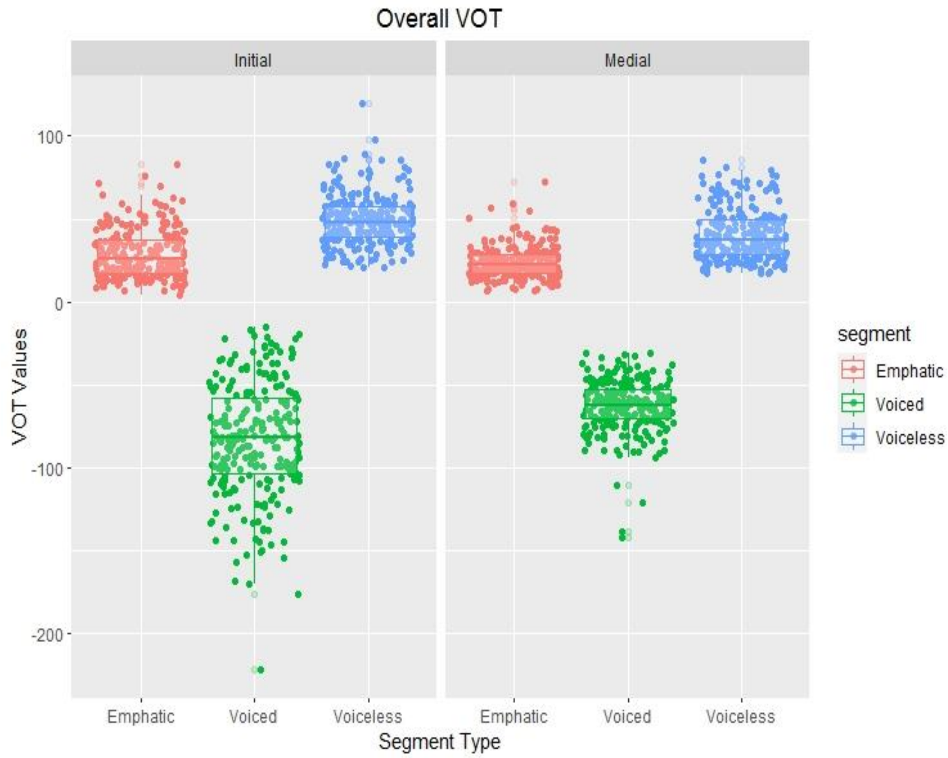

Figure 5.29: Overall VOT duration values by position.

The observation of velar segments having a longer VOT than alveolar segments has been confirmed by the statistical data. Figure 5.30 below shows the VOT duration values of target consonants separated by place of articulation, alveolar vs. velar. As can be seen in Figure 5.30 below, there was a clear difference in the VOT duration values between alveolar and velar emphatic stops, /tˤ/ and /k'/, respectively. Similarly, the voiceless dental stop /t/ differed in terms of VOT duration values from the voiceless velar stop /k/. However, the difference in VOT duration values between the voiced dental and velar, /d/ and /g/, was not very important and the values seemed close to each other.

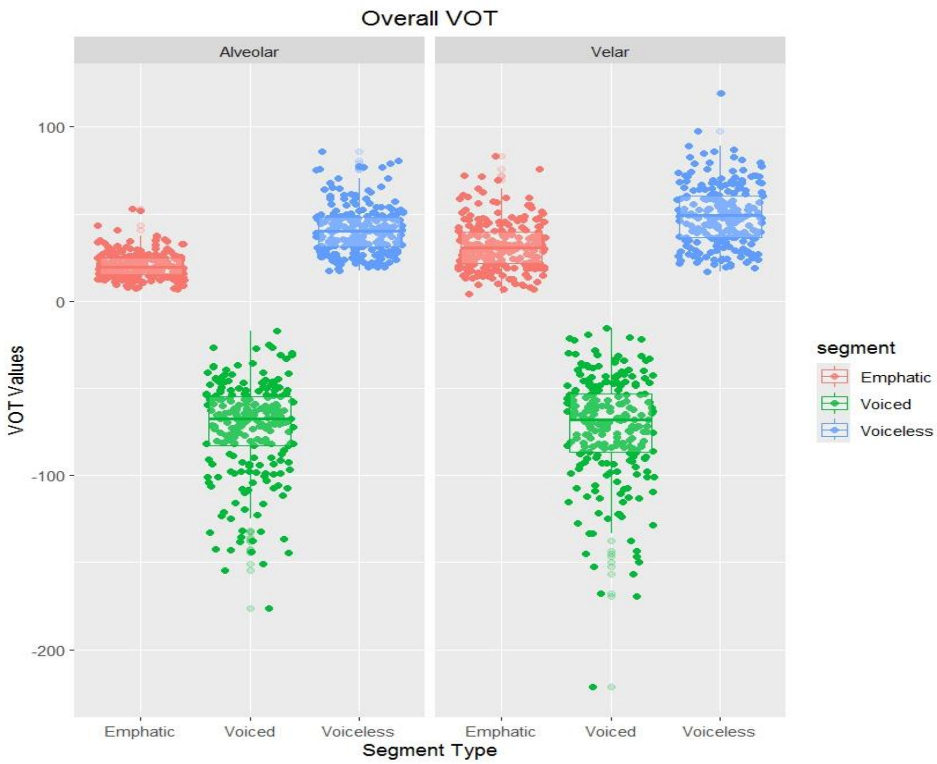

Figure 5.30: Overall VOT duration values by place of articulation.

In terms of the VOT means in utterance-initial and medial positions, the voiced segments had the shortest mean values, while the voiceless segments had the longest mean values. The emphatic segments had intermediate mean values. Within the emphatic stops of Ḥarsūsi, the velar /k'/ had a higher VOT mean duration than the alveolar /tˤ/ in utterance-initial and medial positions. Table 5.5 below shows the mean values of the segments and the overall mean values of each type of stops.

Segment	VOT	Overall
/tˤ/	20.36	26.19
/k’/	32.02	
/t/	40.84	44.95
/k/	49.06	
/d/	-72.9	-72.9
/g/	-72.9	

Table 5.5: VOT mean values.

Linear mixed-effects model results for VOT showed VOT to be significantly different between segments and places of articulation. The VOT of voiced segments was significantly shorter than the VOT of emphatic segments, b = -111.94, t(47.060) = -35.749, $p<0.001$. The VOT of voiceless segments was significantly longer than the VOT of emphatic segments, b = 20.621, t(46.845) = 6.592, $p<0.001$. In terms of the place of articulation, the VOT of velars was significantly longer than the VOT of alveolars, b = 6.687, t(46.951) = 3.701, $p<0.001$. The results also showed that the VOT in unstressed syllables was significantly longer than the VOT in stressed syllables, b = 4.197, t(54.408) = 2.385, $p<0.05$. Figure 5.31 below shows the results of the linear mixed-effects model for VOT duration.

	vot_duration		
Predictors	*Estimates*	*CI*	*p*
(Intercept)	23.27	17.91 – 28.63	**<0.001**
segment [Voiced]	-111.94	-118.08 – -105.79	**<0.001**
segment [Voiceless]	20.62	14.49 – 26.76	**<0.001**
position [Medial]	-5.03	-11.16 – 1.11	0.108
place [velar]	6.69	3.14 – 10.23	**<0.001**
stress [US]	4.20	0.74 – 7.65	**0.017**
segment [Voiced] * position [Medial]	25.46	16.77 – 34.14	**<0.001**
segment [Voiceless] * position [Medial]	-3.60	-12.28 – 5.08	0.416
Random Effects			
σ^2	313.29		
$\tau_{00\ word}$	28.68		
$\tau_{00\ participant}$	9.90		
ICC	0.11		
$N_{participant}$	10		
N_{word}	48		
Observations	1434		
Marginal R^2 / Conditional R^2	0.886 / 0.898		

Figure 5.31: VOT duration model: lmer (vot_duration ~ segment * position + place + stress + (1|participant) + (1|word), data = Vot_model, REML = FALSE) summary results.

The post-hoc pairwise comparison test showed the VOT duration to be significantly different between the segments in various in utterance-initial and medial positions. Table 5.6 shows the pairwise comparisons in various positions.

Position	Segment Pair	B	DF	t-ratio	P value
Initial	Emphatic*Voiced	111.9	56.5	32.810	< **.0001**
	Emphatic*Voiceless	-20.6	56.3	-6.049	< **.0001**
	Voiced*Voiceless	-132.6	56.5	-38.850	< **.0001**
Medial	Emphatic*Voiced	86.5	56.4	25.360	< **.0001**
	Emphatic*Voiceless	-17.0	56.4	-4.993	< **.0001**
	Voiced*Voiceless	-103.5	56.4	-30.359	< **.0001**

Table 5.6: Pairwise comparisons for VOT duration by segment type.

5.3.2.3. Oral Closure

Oral closure duration values distribution is given below in Figure 5.32.

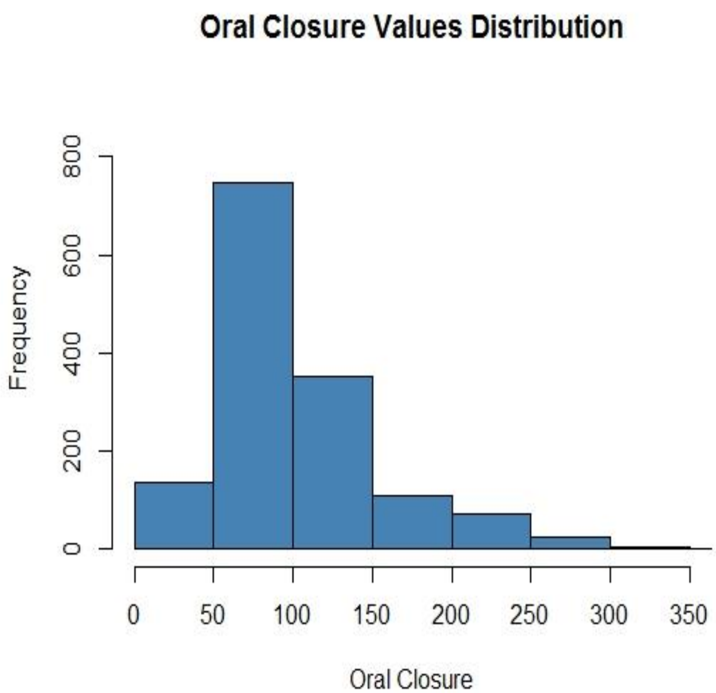

Figure 5.32: Oral closure duration values distribution.

Figure 5.33 below shows the overall oral closure duration values distribution of different types of segments in utterance medial and final positions. The observation made of emphatic segments having longer oral closure durations is not supported by statistical results. As can be seen in Figure 5.33 below, the oral closure values of different segment types seem to be very close to each other and no significant differences can be seen.

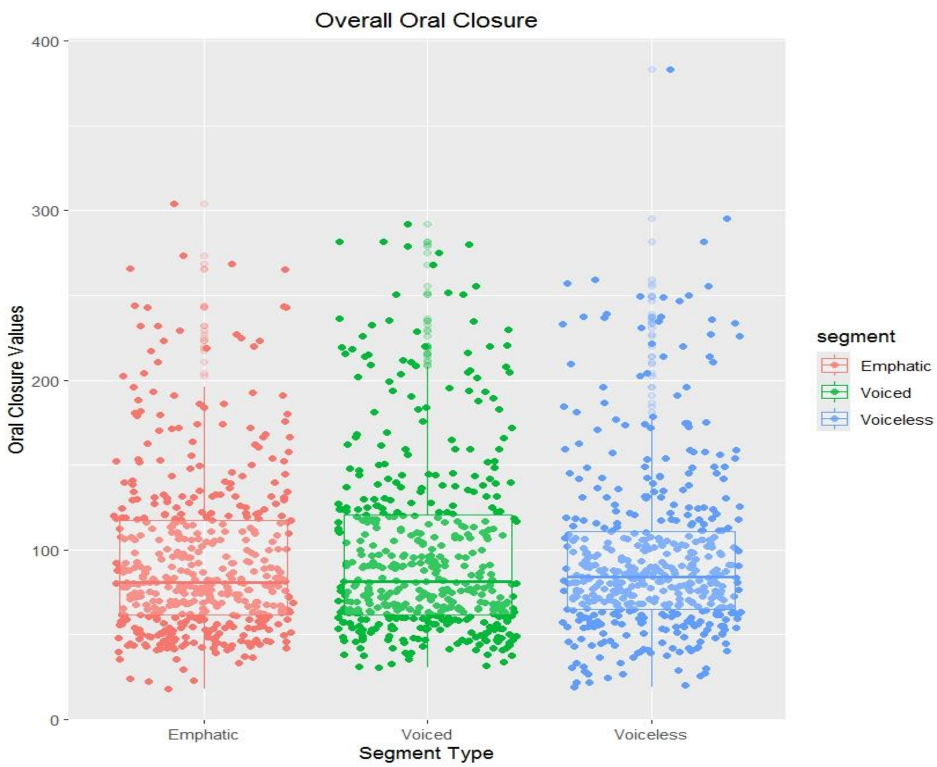

Figure 5.33: Overall oral closure values in medial and final positions.

When the target consonants are separated by utterance position (medial vs. final) differences become obvious between utterance-medial and final segments. As can be seen in

Figure 5.34 below, all three types of segments have longer oral closure durations in utterance-final positions. Moreover, the observation of emphatic segments having longer oral closure durations in final position does not seem to be robust across the data. The voiced had the longest mean (134.76 ms) compared to the emphatics (127.21 ms) and the voiceless (122.79 ms) in utterance-final position.

Figure 5.34: Overall oral closure values by position.

Similarly, when the oral closure duration values are separated by syllable type, stressed or unstressed, clear differences in oral closure durations can be easily seen. Figure 5.35 below shows the oral closure duration values separated by syllable type. Oral closures in stressed syllables are longer than oral closures in unstressed syllables. All types of segments had longer oral closures in stressed syllables in the data.

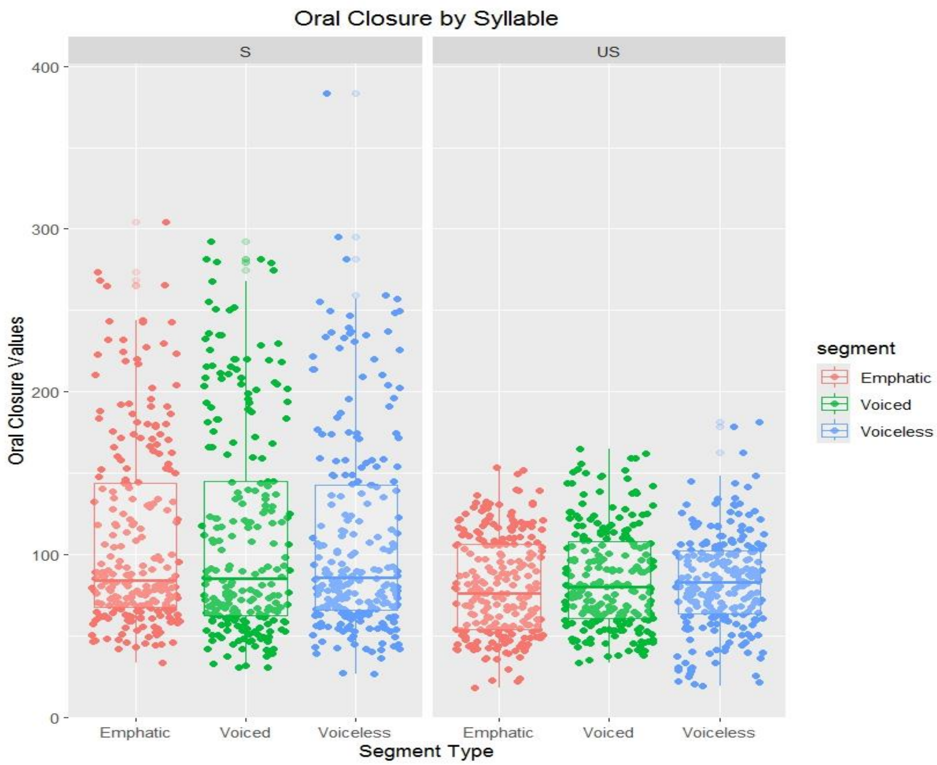

Figure 5.35: Oral closure values by segment and syllable type.

Linear mixed-effects model results of oral closure did not show a significant effect of segment type on oral closure durations, but only segment position and syllable type. Results for the segment type are given below. Segments in utterance-medial position had significantly shorter oral closure durations than segments in utterance-final position, b = -41.286, t(1387.154) = -18.187, *p*<0.001. Similarly, segments in unstressed syllables had significantly shorter oral closure durations than segments in stressed syllables, b = -27.020, t(56.090) = -3.156, $p<0.01$.

Figure 5.36 below shows the results of the linear mixed-effects model for oral closure duration.

	OC_duration		
Predictors	*Estimates*	*CI*	*p*
(Intercept)	132.14	110.27 – 154.00	**<0.001**
segment [Voiced]	3.18	-19.04 – 25.39	0.779
segment [Voiceless]	2.66	-20.27 – 25.59	0.820
position [Medial]	-41.29	-45.74 – -36.83	**<0.001**
stress [US]	-27.02	-43.81 – -10.23	**0.002**
place [velar]	-0.08	-18.12 – 17.97	0.993
Random Effects			
σ^2	474.07		
$\tau_{00\ word}$	892.22		
$\tau_{00\ participant}$	121.02		
$\tau_{11\ participant.segmentVoiced}$	26.44		
$\tau_{11\ participant.segmentVoiceless}$	71.24		
$\rho_{01\ participant.segmentVoiced}$	-0.81		
$\rho_{01\ participant.segmentVoiceless}$	-0.14		
ICC	0.68		
$N_{participant}$	10		
N_{word}	43		
Observations	1438		
Marginal R^2 / Conditional R^2	0.292 / 0.773		

Figure 5.36: OC duration model: lmer (OC_duration ~ segment + position + place + stress + (1+segment|participant) + (1|word), data = OC_model, REML = FALSE) summary results.

5.4. Discussion

This study addressed the following questions:

1. Do the emphatic stops in Ḥarsūsi display any known characteristics of ejective stops?
2. Do the emphatic stops differ from their plain counterparts in terms of VOT, oral closure duration, presence or absence of glottal closure and release?
3. Do the emphatic stops and their plain voiced counterparts pattern together in any position based on acoustic characteristics?

Based on the visual inspections of waveforms and spectrograms and the results of the statistical analyses, the results are consistent with the patterns described above in 4. Ḥarsūsi stops behave differently in various contexts with some patterning together in certain contexts. The emphatic stops in Ḥarsūsi are found to be of a mixed system that has both glottalised and pharyngealised stops as in other MSALs such as Mehri and Baṭḥari (Watson & Bellem, 2010, 2011; Bellem & Watson, 2014; Watson & Heselwood, 2016; Gasparini, 2017, 2018).

Only the velar emphatic stop /k'/ is realised as an ejective in most positions, while the alveolar /tˤ/ is realised as an ejective almost solely in utterance-final position. The acoustic parameters of VOT and glottal closure distinguish the emphatic stops from their plain counterparts except for the voiced and emphatics in utterance-final position where they pattern together.

In the sections below, the acoustic parameters of glottal closure, VOT, and oral closure duration are discussed in detail.

5.4.1. Glottal Closure

Glottal closure was analysed and taken into consideration to serve three purposes. The first purpose was to check if the emphatic segments exhibited glottal closures showing an ejective realisation in any given environment. The second purpose was to check if glottal closure could be taken as an acoustic parameter to distinguish between emphatics and their plain counterparts. The third purpose was to check whether the voiced stops patterned with the emphatic stops in any position by showing glottal closures as a similar articulation cue.

As for question 1, the results regarding the presence of glottal closure in Ḥarsūsi emphatic stops came in line with the study hypothesis of emphatic stops having glottal closures in places where they are realised as ejectives such as utterance-final position. Regarding question 2, results showed that not all emphatic stops exhibit glottal closures in all positions. Moreover, the results came with an affirmative answer for question 3 as the voiced stops patterned with emphatic stops in utterance-final position by having a glottal closure and being realised as ejectives which was also consistent with study hypotheses.

Based on the criteria of the presence of a clear glottal closure and release, the visual inspection of waveforms and spectrograms showed that the voiceless emphatic alveolar /tˤ/ was articulated as a pharyngealised [t̪ˤ] in most contexts except in utterance-final position where it was glottalised with a visible glottal release, and this is consistent with the patterns described in 4 and with what has been found for Mehri. A number of tokens of /tˤ/ in utterance-medial and final positions exhibited short periods of irregular glottal cycles before the oral closure, especially after long vowels. These short periods are suggestive of pre-glottalisation, but no clear glottal closure or release was seen in such cases. Bellem & Watson (2014) found that the voiceless emphatic alveolar /$t^ʕ$/ in the Mehri dialects of Mahriyōt and Mehreyyet is glottalised pre-pausally. On the other hand, in utterance-initial and medial positions, it is articulated as a pharyngealised [$t̪^ʕ$] consonant in Mahriyōt, and as an ejective [t̪'] in Mehreyyet except preceding long back vowels or in the onset of stressless syllables. Indeed, the results of the statistical analyses showed very few instances of glottalised /$t^ʕ$/ in utterance-initial and medial positions compared to utterance-final position in Ḥarsūsi. It was found to be articulated as a glottalised [t̪'] in utterance-initial position only in 10 out of 60 in total in stressed syllables (16.6%), and five out of 60 tokens in total in unstressed syllables (8.3%). In utterance-medial position, it was never found to be glottalised with clear glottal closure and release (0%). Similar patterns have also been found in the Mehreyyet dialect of Mehri. Bellem & Watson (2014)Bellem & Watson (2014) stated that the voiceless emphatic alveolar /$t^ʕ$/ tends to be a glottalic in initial position except preceding long back vowels. Moreover, they added that intervocalically it is likely to be glottalic preceding stressed vowels and less likely to be glottalic at the onset of a stressless syllable (Bellem & Watson, 2014). In addition, Ridouane & Buech (2022) Ridouane & Buech (2022) also found that the Mehri ejective alveolar exhibited silent lags after the oral release (which could be suggestive of glottal closure), but that these silent lags were speaker dependent as only two speakers out of seven had such silent lags (p. 3435). In this current study, silent lags were not common, but there were rather more closures followed by clear bursts.

Based on such results, it can be stated that the emphatic dental stop /$t^ʕ$/ in Ḥarsūsi resembles, to some extent, the emphatic alveolar /$t^ʕ$/ in Mehreyyet in the sense of being a pharyngealised emphatic and not a glottalised emphatic in all positions except in some tokens where a period of pre-glottalisation could be seen, but this needs further investigations.

Therefore, similar results of the emphatic alveolar /tˤ/ in Ḥarsūsi and Mehriyōt can suggest a similar sound shift/development in these two varieties.

The emphatic velar /k'/, on the other hand, was found through the visual inspection of waveforms and spectrograms to be articulated as a glottalised [k'] in more positions than the alveolar which was consistent with patterns described in ￼￼4A number of tokens of /k'/ in utterance-medial and final positions also exhibited short periods of irregular glottal cycles before the oral closure similar to the alveolar /tˤ/, which is suggestive of a pre-glottalisation in such cases. It was found as a glottalised [k'] in utterance-initial, medial, and final positions in both stressed and unstressed syllables. Such a conclusion has also been reached by Watson & Bellem (2010). In their investigation of the emphatic consonants of the MSAL Mahriyōt dialect of Mehri, they found that the emphatic velar stop /ḳ/ was the only emphatic which showed a sharp spike in the waveforms associated with glottalic consonants in all positions (Watson & Bellem, 2010, p. 349). In another study, Bellem & Watson (2014) found that the emphatic velar stop /ḳ/ was realised as glottalic in all contexts in MSAL Mahriyōt, while in MSAL Mehreyyet they found it to be glottalic except in some intervocalic tokens. In addition, Gasparini (2017) studied the emphatic consonants in MSAL Baṭḥari and found results in line with these in MSAL Mahriyōt (Watson & Bellem, 2010; Bellem & Watson, 2014) and MSAL Mehreyyet (Bellem & Watson, 2014). In his study focusing on initial and intervocalic positions, he found the emphatic velar stop /ḳ/ was the only segment in Baṭḥari which regularly showed to be realised as an ejective in the environments investigated (Gasparini, 2017, p. 82).

The results of the statistical analyses show similar results for the articulation of the emphatic velar stop /k'/ in Ḥarsūsi. Statistical results showed that the emphatic velar stop /k'/

was realised as a glottalised [k’] in all positions investigated, but to varying degrees. The highest number of glottalised realisations was found in utterance-final position followed by utterance-initial, with the lowest number of glottalised realisations in utterance-medial position. In every position, however, it was found to be realised as a glottalised [k’] in both stressed and unstressed syllable structures. For instance, in utterance-final position, it was found as a glottalised [k’] in 60% of stressed syllables and in 50% of unstressed syllables. In utterance-initial position, it was found as a glottalised [k’] in 25% of stressed syllables and in 20% of unstressed syllables. In utterance-medial position, the glottalised realisations were the lowest with the unstressed syllables having the lowest numbers. It was realised as a glottalised [k’] in 11.6% of stressed syllables structures, and in 15% of unstressed syllables. These results are not drastically different from what has been found in other MSALs, such as Mehri and Baṭḥari. Nonetheless, an interesting point is that contrary to the emphatic alveolar /tˤ/, the emphatic velar stop /k’/ in Ḥarsūsi has closer resemblance to the emphatic velar in the Mahriyōt dialect of Mehri than Mehreyyet. For instance, in Mahriyōt, Bellem & Watson (2014) found that it may be ejective in all positions, but in Mehreyyet there were instances where it was not ejective intervocalically.

Given these results for the emphatic velar stop /k’/, it can be stated that it is the only segment in Ḥarsūsi which is glottalised in most positions. Unlike the dental stop /tˤ/, such results of the emphatic velar stop /k’/ in Ḥarsūsi look closer to the results of the emphatic velar stop /ḳ/ in Mahriyōt than in Mehreyyet, which at least has some areal connection with Ḥarsūsi. Nonetheless, this could be due to language specific traits in Ḥarsūsi and Mahriyōt as it is well known that ejective stops generally prefer velar articulation (Ladefoged & Maddieson, 1996, p. 78).

As for the voiced stops, as was hypothesised, the results showed their patterning with the emphatic in utterance-final position. The voiced stops were found to have glottal closures in utterance-final position suggesting their realisation as ejectives in this position. Voiced stops also showed periods of irregular glottal cycles occurring before the oral closure in utterance-medial and final positions: 28.3% (out of 240 in total) of voiced alveolar /d/ tokens and 25% (out of 240 in total) of voiced velar /g/ tokens in utterance-medial and final positions were found with such periods.

The utterance-final patterning of the emphatics and voiced segments by showing clear glottal closures and releases was also found in Mehri (Watson & Asiri, 2007; Watson & Bellem, 2010). This phonetic patterning in this position backs the view of categorising the sounds of MSAL into two categories of 'Breathed' and 'Unbreathed', as proposed by Watson & Heselwood (2016). Their proposal, which is based on the amount of air passing through glottis during the articulation of these sounds rather than the vibration of the vocal folds, has been proven based on phonological patterning and instrumental phonetic analyses. The phonetic analyses of Ḥarsūsi are in line with their findings in Mehri suggesting the possibility of such a distinction of sounds in Ḥarsūsi as well.

To sum up, glottal closure results show that the emphatic velar stop in Ḥarsūsi is glottalised in most positions, while the emphatic dental stop is glottalised mainly in utterance-final positions. In addition, glottal closure can be taken as an acoustic parameter to distinguish between various types of stops except in utterance-final position where voiced stops also exhibit glottal closures. Indeed, voiced stops are also found with glottal closures in utterance-final position, which suggests a similar phonetic patterning with emphatic stops in this position.

5.4.2. VOT

The purpose behind measuring VOT durations in this study was to see if it helps in distinguishing as an acoustic cue between the emphatic stops and their plain counterparts in Ḥarsūsi. Therefore, it aimed to answer question 2, and the results obtained lead to an affirmative answer to this question.

There were a number of contesting hypotheses with regard to VOT based on results of previous studies in other languages. However, this study, based on the impressionistic inferences during segmentation of waveforms and spectrograms and results of the closely related Baṭḥari language, hypothesised that the emphatic stops will have a longer VOT than their plain counterparts, in addition, the voiceless stops will have an intermediate VOT between the emphatic and voiced stops.

Surprisingly, not all parts of the hypothesis put forward regarding VOT in this study came to be applicable for VOT in stops in Ḥarsūsi. For instance, as was expected, the results showed that the plain voiced stops had the shortest VOT duration among Ḥarsūsi stops (-72.9 ms); however, the emphatics did not have the longest VOT duration (26.19 ms), but rather the plain voiceless stops (44.95 ms). These results were consistent with what has been found in languages, such as Amharic (Seid et al., 2009), Ingush (Warner, 1996), and Tsova-Tush (Hauk & Hakim, 2019), but inconsistent with others, such as Cochabamba Quechua (Gallagher & Whang, 2014), Hul’q’umi’num’ (Percival, 2019), and especially Baṭḥari (Gasparini, 2017). Such varying results of VOT values are not very surprising between languages and have been documented previously. For example, Cho & Ladefoged (1999) compared the VOT values of 18 different languages and found that there are unpredictable variations in VOT values between languages even within the same place of articulation (p. 226). An interesting point in VOT duration results in Ḥarsūsi is that they are inconsistent with the closely related Baṭḥari language for which Gasparini (2017) found emphatics to have longer VOTs than their voiceless counterparts (p. 78). This could be due to different factors related to either methodological differences or language-specific traits. Gasparini (2017) relied on data obtained from natural speech recordings done by himself and Miranda Morris, therefore, lacking a list of carefully elicited words in desired environments for acoustic study purposes. In addition, analysed data was limited to only 169 tokens making it difficult to run any statistical tests or to prove significance (Gasparini, 2017). Another reason which could account for the difference in VOT durations between Ḥarsūsi and Baṭḥari could be due to language-specific traits or rules. Cho & Ladefoged (1999) mentioned that languages that have more than two types of stops tend to enrich the difference between the various types of stops by scattering VOT values on a VOT continuum (p. 224). They mentioned that possible VOTs may be chosen by languages from a continuum and this selection is controlled by two processes conducted by the grammar specific to language which are of choosing a modal value of phonological features such as voiced, voiceless aspirated, and voiceless unaspirated, and then assigning a target value for timing (Cho & Ladefoged, 1999, p. 226).

Based on within language differences, the shorter VOT durations for Ḥarsūsi emphatic compared to the plain voiceless stops could be due to the nature of articulation of these segments. In languages where ejectives were compared to voiceless aspirated and voiceless unaspirated stops such as Waima’a, the ejectives were found to have an intermediate VOT following the voiceless aspirated stops (Hajek & Stevens, 2005, p. 2891). Watson & Heselwood (2016) looked at sample tokens of emphatic stop /tˤ/ released as an ejective and plain voiceless stop /t/ and found that the emphatic had a short-lag VOT of (22 ms), while the plain voiceless had a VOT of (37 ms) (p. 25). Hence, it can be speculated that the plain voiceless stops in Ḥarsūsi are articulated with a longer aspiration period resulting in longer VOT durations for the plain voiceless stops. In comparison, shorter VOT durations for the emphatic stops in Ḥarsūsi can suggest that their ejective realisation is of lax rather than tense ejectives (Lindau, 1984; Warner, 1996).

With regard to place of articulation of segments, this study hypothesised segments articulated at a farther back place of articulation to have longer VOT durations than segments articulated at a fronter place of articulation. This it was expected that velar stops in Ḥarsūsi have longer VOT durations than the dental stops. As was hypothesised, the results showed the velar stops in Ḥarsūsi to have longer VOT durations compared with the dental stops. These longer VOT durations were clear for the groups of emphatic and voiceless stops. For instance, the emphatic and voiceless stops, /k'/ and /k/ respectively, had mean VOT durations of (32.02 ms) and (49.06). In comparison, the emphatic alveolar /tˤ/ and the voiceless alveolar /t/ had mean VOT durations of (20.36 ms) and (40.84 ms), respectively. These VOT duration patterns are similar to findings in some other languages, but contradict some others. For instance, velars in Ingush (Warner, 1996, p. 1525), Apache, Salish, and Yapese (Cho & Ladefoged, 1999, p. 222) have longer VOT durations than alveolars, while velars in Navajo, Hupa, and Tlingit (Cho & Ladefoged, 1999, p. 222) have shorter VOT durations than alveolars. Cho & Ladefoged (1999, pp. 222 - 223) suggested that such differences might be due to the timing between both oral and glottal closures being a language specific matter, and supported this view based on the differences between Navajo and Apache which are closely related languages. The results in Ḥarsūsi can be taken from this perspective as well, given the fact that the results of VOT durations of the closely related language Baṭḥari do not follow a similar pattern. For instance, the emphatic velar stop /ḳ/ in Baṭḥari had longer VOT durations than the emphatic dental stop /ṭ/ in initial position, but in intervocalic position the velar /ḳ/ had shorter VOT durations than the alveolar /ṭ/ (Gasparini, 2017, p. 78).

In summary, results of the VOT durations in Ḥarsūsi show that it can be taken as an acoustic parameter to distinguish different types of stops. The results were in line with results of other languages such as Amharic (Seid et al., 2009), Ingush (Warner, 1996), and Tsova-Tush (Hauk & Hakim, 2019). In addition, results show that, as hypothesised, the velars have longer VOT durations than alveolars in Ḥarsūsi. Similarly, segments in unstressed syllables have longer VOT durations than segments in stressed syllables.

5.4.3. Oral Closure

Oral closure measurements were calculated to examine if it could be taken as an acoustic cue for distinguishing different types of Ḥarsūsi stops. Hence, it aimed to answer question 2, and the results obtained lead to a negative answer to this question.

It was expected that different types of stops could be distinguished based on oral closure durations. The emphatics were expected to have the longest duration, the voiced were expected to have an intermediate duration, and the voiceless were expected to have the shortest duration.

As was the case with VOT, there were varying results with regard to oral closure durations in ejectives in other languages. This study took the results of one of the other Semitic languages which is Amharic as a reference point to speculate oral closure results for Ḥarsūsi. The results obtained were not consistent with what was expected. Oral duration measurements were not significant to help in distinguishing the different types of stops in Ḥarsūsi. Oral closure durations in utterance-medial and final positions of the different types of stops were close to each other and did not mark any type to be different than the others. This result is consistent with what has been found in languages such as Tsova-Tush (Hauk & Hakim, 2019), but contradicts with the results for Amharic (Seid et al., 2009) and Mehri (Ridouane & Buech, 2022). In Tsova-Tush it was found that the ejective measurements were not different than the grand mean (Hauk & Hakim, 2019, p. 3485). On the other hand, in Amharic the ejective stops had significantly longer oral closure duration (Seid et al., 2009, p. 2289). In Mehri, Ridouane & Buech (2022) showed that the closure duration of ejective velars was significantly longer than their plain counterparts (p. 3435). Given the oral closure results obtained in Ḥarsūsi, it could be stated that oral closure does not seem to be a good acoustic cue to distinguish the different types of stops in Ḥarsūsi.

The results did, however, show a significant effect of segment position on oral closure duration as was expected. All types of stops had longer oral closure durations in utterance-final position compared to utterance-medial position.

Similarly, the syllable structure (stressed vs. unstressed) was found to affect the oral closure duration of Ḥarsūsi stops. Results showed that all types of stops had longer oral closure durations in stressed syllables compared to non-stressed syllables in utterance-medial and final positions.

To sum up, the results obtained on oral closure show that oral closure in Ḥarsūsi cannot be taken as an acoustic parameter to distinguish between the different types of stops. No significant differences were found in oral closure durations between the different types of stops. Nonetheless, oral closure durations of Ḥarsūsi stops differ significantly based on segment position and syllable type.

5.5. CONCLUSION

To conclude, this study investigated some acoustic parameters in Ḥarsūsi stops in an attempt to: establish the nature of emphatic stops in Ḥarsūsi; check which acoustic parameters could help in distinguishing between the different types of stops; and investigate any phonetic patterning of voiced and emphatic stops in any position.

The results were consistent with the patterns described above in 4. Glottal closures were found in both emphatic and voiced stops with the exclusion of voiceless, but with varying degrees and in different positions. In utterance-initial and medial positions, only the emphatic velar stop /k'/ had a high number of glottal closures suggesting it to be an ejective stop unlike the emphatic dental stop /tˤ/ which did not exhibit a high number of glottal closures in these positions in the data. These results are in line with previous studies in other MSALs such as Mehri and Baṭḥari (Bellem & Watson, 2014; Gasparini, 2017).

In addition, results also showed that glottal closure can be taken as an acoustic parameter to distinguish between emphatics and their plain counterparts in non-utterance-final position. Both emphatic and voiced stops had glottal closures in utterance-final position suggesting a phonetic patterning in this position. This patterning of the voiced stops in utterance-final position with the emphatic stops by being realised as ejectives was also consistent with results of previous studies on MSAL Mehri (Bellem & Watson, 2014). Such results support the proposal put forward by Watson & Heselwood (2016) for a laryngeal categorisation based on breath, termed as 'voiceless turbulence', rather than one based on voicing for MSAL. As was mentioned above in section 2.6, the three different phonetic categories of emphatics, voiced, and voiceless consonants were found to pattern together phonologically and fall into two categories (Heselwood & Maghrabi, 2015; Watson & Heselwood, 2016). The results of phonetic instrumental analyses of this study support the morphophonological patterning of Ḥarsūsi emphatic and voiced stops to the exclusion of voiceless stops which supports the view of labelling the emphatic and voiced as 'Unbreathed' (Heselwood & Maghrabi, 2015, p. 159) and labelling the voiceless as 'Breathed' (Heselwood & Maghrabi, 2015, p. 159).

In terms of distinguishing the emphatic stops from their plain counterparts, the results showed that among the acoustic parameters examined, VOT was a significant parameter to distinguish the various types of stops, while oral closure was not significant. The voiced stops had the shortest VOT, followed by the emphatic stops with an intermediate VOT, while the voiceless stops had the longest VOT.

6. Chapter Six: The Phonetic Realisation of Ḥarsūsi Fricatives

6.1. Research Questions and Hypotheses

Recent developments in the study of MSAL and the findings on emphatics in related languages such as Mehri and Baṭḥari made it of great interest to study the emphatic fricatives in Ḥarsūsi in depth and compare the results with what is known about this class of sounds in MSAL.

The aim behind investigating Ḥarsūsi fricatives was threefold. Firstly, to find out whether the emphatic fricatives in Ḥarsūsi displayed any acoustic cues known for ejective fricatives in other languages. Secondly, to see what acoustic parameters could help distinguish the emphatic fricatives from their plain counterparts as was found in some other languages (Gordon & Applebaum, 2006; Seid et al., 2009; Shosted & Rose, 2011; Gasparini, 2017; Ridouane & Gendrot, 2017). The acoustic parameters investigated are fricative overall duration, frication duration, frication intensity, presence of pre- or post-frication silent lags, and CoG. Thirdly, based on the phonological patterning of some consonants in other MSAL languages (see 2.5), the investigation aimed to check if such patterning can be acoustically supported in Ḥarsūsi.

The investigation for the nature emphatic fricatives was done by checking for acoustic characteristics found to occur in ejective fricatives in other languages, namely pre- or post-frication silent lags/or glottal lags, shorter frication duration, shorter overall duration, and higher CoG values (Gordon & Applebaum, 2006; Seid et al., 2009; Shosted & Rose, 2011; Ridouane et al., 2015; Ridouane & Gendrot, 2017).

The second aim of the study was achieved by comparing the previously mentioned acoustic parameters of emphatic fricatives and their plain counterparts to see which acoustic parameters significantly differentiated the different categories.

The third aim of the study was achieved by investigating any shared acoustic parameters between the emphatic fricatives and their plain voiced counterparts especially in utterance-final positions.

The questions raised in this study were the following:

1. Do the emphatic fricatives in Ḥarsūsi display any known acoustic characteristics of ejective fricatives?
2. Do the emphatic fricatives differ from their plain counterparts in terms of their overall duration, frication duration, frication intensity, pre- or post-frication silent lags, and CoG?
3. Do the emphatic fricatives and their plain voiced counterparts pattern together in any position based on acoustic characteristics?

In terms of displaying characteristics of ejective fricatives, it has been observed during the manual segmentation of tokens and checking the preliminary results that the emphatic fricatives of Ḥarsūsi only displayed characteristics of ejective fricatives in utterance-final position. Contrary to what Ridouane & Gendrot (2017) found in Mehri with regard to pre- and post-frication silent lags (p. 155), the emphatic fricatives in Ḥarsūsi lacked any systematic pre- or post-frication silent lags except in utterance-final position. In addition, the plain voiced fricatives patterned similarly with the emphatics in terms of being realised as ejectives and showing pre- or post-frication silent lags in utterance-final position only, as was found for Mehri (Bellem & Watson, 2014). Hence, this study tried to establish the extent to which the emphatic fricatives and the non-emphatic voiced counterparts showed pre- or post-frication silent lags across the data set.

The frication duration of ejective fricatives was found to be shorter than their other counterparts in Tigrinya (Shosted & Rose, 2011), Turkish Kabardian (Gordon & Applebaum, 2006), and Amharic (Demolin, 2004). Ridouane & Gendrot (2017) found the frication noise of ejective fricatives in Mehri to be shorter than that of their plain counterparts (p. 154). On the other hand, according to Gasparini (2017) all but the lateral emphatic fricatives in Baṭḥari had a longer duration in initial position (p. 82). Based on the visual inspections and some manual measurements of some tokens, the frication duration of emphatic fricatives in Ḥarsūsi seemed shorter than that of their plain counterparts. Therefore, this study hypothesised the frication duration of emphatic fricatives in Ḥarsūsi to be shorter than that of their plain counterparts as was found in some previous studies.

In terms of the overall duration, preliminary results showed the emphatic fricatives in Ḥarsūsi to have a shorter overall duration than their plain counterparts as was found in Amharic by Seid et al. (2009). However, in utterance-final position, the overall duration did not look shorter in the tokens. The study hypothesised the overall duration of emphatic fricatives to be shorter than that of their plain counterparts except in utterance-final position where they include systematic silent lags.

In terms of frication intensity, the visual inspection of a number of tokens and their manual measurement showed frication intensity to be lower in emphatic fricatives than in their non-emphatic counterparts. By contrast, Gasparini (2017) found the emphatic fricatives in Baṭḥari have a higher intensity rate than their plain counterparts in initial position except the lateral fricative (p. 82). Ridouane & Gendrot (2017) also found initial ejective fricatives in Mehri to have significantly higher frication intensity than their plain counterparts. As a result, the study hypothesised the emphatic fricatives in Ḥarsūsi to have a higher intensity rate than their plain counterparts.

Since CoG was found to be higher in Mehri emphatic fricatives (Ridouane & Gendrot, 2017), this study hypothesised a similar patterning in terms of CoG values in positions where Ḥarsūsi emphatics were realised as ejectives. In addition, after checking a few tokens manually, the study hypothesised that the emphatic and voiced fricatives will probably show similar CoG values in utterance-final position.

6.2. METHODOLOGY

Ḥarsūsi words including emphatic fricatives and their plain counterparts, voiced and voiceless, were recorded in isolation for this study (see 3.2 for data sources). For the target fricatives, the measurements of temporal and non-temporal parameters of overall duration, frication duration, frication intensity, and CoG were taken for all the fricatives. Moreover, all the fricatives were checked for the presence or absence of pre- and post-frication silent lags (glottal closure) in all positions, and the number of these silent lags were considered for the analyses. Linear mixed model and logistic regression tests were run to check the significance of different factors taken into consideration, such as segment type, segment position, place of articulation, and syllable structure.

6.2.1. Stimulus Material

Ḥarsūsi words with target consonants in utterance-initial, medial, and final positions were recorded in isolation. Each target consonant was found in 4 different words in two stressed and two unstressed syllable structures (see 3.2 for details on word list preparation). Therefore, a total of 12 words for each target consonant were repeated 3 times which resulted in 36 tokens. So, the total number of tokens for each target consonant was 360 produced by the10 participants, who produced the data for chapter 5, except the emphatic palato-alveolar fricative /ʃˤ/ which had only 150 tokens from all speakers. Since the emphatic palato-alveolar fricative /ʃˤ/ rarely occurs in Ḥarsūsi, it was not possible to find it in all the previously mentioned positions in this study. It was found in three words in utterance-initial position and two words in utterance-medial position resulting in five words in total and 15 tokens from each participant. Therefore, the total number of tokens taken into consideration in this study is 3390 which is the result of 3240 tokens (12 words * three repetitions * nine target consonants * 10 speakers) + 150 tokens of the palato-alveolar fricative /ʃˤ/ (5 words * three repetitions * 10 speakers). All the fricatives of Ḥarsūsi were recorded except the voiceless labio-dental fricative /f/ since it lacks an emphatic counterpart.

The words used have the following syllable structures given below, and the target consonants occur in stressed and unstressed syllables in these words. Note that structures followed by an asterisk were each found in one word only in the word list.

***Utterance-initial*:**

Stressed **C**VVC and **C**VCCV*

Unstressed **C**V.CVVC, **C**V.CVC*, and **C**VC.CVVC*

Utterance-medial:

Stressed CVC.**C**VVC, CVC.**C**VCC, and CV.**C**VV.CV*

Unstressed CV**C**.CVVC, CV**C**.CVCC, and CV**C**.CV*

Utterance-final:

Stressed CV**CC**, CV**C***, CVC.CVC**C**, and CVC.CVV**C**

Unstressed CV.CVV.CV**C**, CV.CVC.CV**C**, CVV.CV**C***, and CV.CV**C***

Table 6.1 below shows the Ḥarsūsi words with the target consonants in different positions.

Phoneme	Stress	Initial	Medial	Final
θ	S	/ˈθɐːb/ ‘to cough 3M.SG.PFV’ /ˈθiːt/ ‘sheep F.SG’	/jenˈθoːk/ ‘to bite 3M.SG.IPFV’ /jenˈθoːɾ/ ‘to pour; disperse 3M.SG.IPFV’	/ˈteθ/ ‘woman; wife F.SG’ /jelˈʁoːθ/ ‘to speak badly 3M.SG.IPFV’
	US	/θeˈbuːɾ/ ‘to break 3M.SG.PFV’ /θeˈmoːɾ/ ‘to bear fruit 3M.SG.PFV’	/jeθˈboːt/ ‘to be firm 3M.SG.IPFV’ /jeθˈkʼoːl/ ‘to get heavier 3M.SG.IPFV’	/jeˈkuːleθ/ ‘to talk 3M.SG.IPFV’ /jeˈnuːbeθ/ ‘to dig up; take out 3M.SG.IPFV’

ð	S	[8]/ˈðɐːb/ ‘to melt 3M.SG.PFV’ /ˈðiːb/ ‘wolf M.SG’	/jehˈðuːð/ ‘to go around aimlessly-to shear 3M.SG.IPFV’ /jebˈðoːr/ ‘to sow seed 3M.SG.IPFV’	/ˈheðð/ ‘to shear 3M.SG.PFV’ /jehˈðuːð/ ‘to shear 3M.SG.IPFV’
	US	/ðeˈheːb/ ‘gold M.SG’ /ðeˈrɐːʔ/ ‘forearm M.SG’	/jeðˈkoːr/ ‘to mention 3M.SG.IPFV’ /jeðˈruːr/ ‘to spread out 3M.SG.IPFV’	/feˈχɐːjeð/ ‘tribes; clans M.PL’ /ˈjɐːweð/ ‘to warn 3M.SG.IPFV’
ðˤ	S	/ˈðˤɐːr/ ‘on ADV’ /ˈðˤɐwlɐ/ ‘to limp 3M.SG.PFV’	/jekˈðˤoːðˤ/ ‘to squeeze against 3M.SG.IPFV’ /jenˈðˤoːf/ ‘to clean against 3M.SG.IPFV’	/ˈkeðˤðˤ/ ‘to squeeze against 3M.SG.PFV’ /jekˈðˤoːðˤ/ ‘to squeeze against 3M.SG.IPFV’
	US	/ðˤeˈfiːr/ ‘fingernail M.SG’ /ðˤeˈloːk/ ‘to notice 3M.SG.PFV’	/jeðˤˈhoːr/ ‘to appear 3M.SG.IPFV’ /meðˤˈħɐːm/ ‘bladder M.SG’	/jeˈmuːreðˤ/ ‘to advise 3M.SG.IPFV’ /jeˈhɐwkʼeðˤ/ ‘to wake 3M.SG.IPFV’
s	S	/ˈseːn/ ‘they F.PL’ /ˈseːkʼ/ ‘flame; spark M.SG’	/jeħˈsuːs/ ‘to feel 3M.SG.IPFV’ /jemˈsoːs/ ‘to touch 3M.SG.IPFV’	/ˈħess/ ‘to feel 3M.SG.PFV’ /jeħˈsuːs/ ‘to feel 3M.SG.IPFV’
	US	/seˈħoːb/ ‘cloud M.PL’ /seˈboːχ/ ‘to talk without result 3M.SG.PFV’	/jesˈguːg/ ‘to daydream 3M.SG.IPFV’ /jesˈhoːr/ ‘to stay awake 3M.SG.IPFV’	/jeˈkuːdes/ ‘to heap, heap up 3M.SG.IPFV’ /jeˈruːfes/ ‘to kick 3M.SG.IPFV’
sˤ	S	/ˈsˤoːr/ ‘to stand; stop 3M.SG.PFV’ /ˈsˤɐːr/ ‘gazelle M.SG’	/jemˈsˤɐwsˤ/ ‘to suck 3M.SG.IPFV’ /ʃekʼˈsˤɐwr/ ‘to run short of something 3M.SG.PFV’	/ˈmesˤsˤ/ ‘to suck 3M.SG.PFV’ /jemˈsˤɐwsˤ/ ‘to suck 3M.SG.IPFV’

[8] Some participants mentioned /ðejo:b/ as an alternative word also used.

	US	/sˤeˈbuːʁ/ ‘to dye 3M.SG.PFV’ /sˤeˈduːɾ/ ‘to come from water 3M.SG.PFV’	/jesˤˈħoːɾ/ ‘to brand 3M.SG.IPFV’ /jesˤˈkʼɐwkʼ/ ‘to yell 3M.SG.IPFV’	/jeˈkʼuːbesˤ/ ‘to bite 3M.SG.IPFV’ /ʔɐˈgɐɾmesˤ/ ‘to hop 3M.SG.PFV’
z	**S**	/ˈzoːɾ/ ‘to visit 3M.SG.PFV’ /ˈzoːd/ ‘to increase 3M.SG.PFV’	/jefˈzuːz/ ‘to jump; spring up 3M.SG.IPFV’ /jehˈzuːz/ ‘to shake 3M.SG.IPFV’	/ˈfezz/ ‘to jump; spring up 3M.SG.PFV’ /jefˈzuːz/ ‘to jump; spring up 3M.SG.IPFV’
	US	/zeˈguːd/ ‘to lift; loot 3M.SG.PFV’ /zeˈheːb/ ‘camel cloth M.SG’	/jezˈjuːd/ ‘to grow; increase 3M.SG.IPFV’ /jezˈħoːf/ ‘to crawl 3M.SG.IPFV’	/jeˈfoːɾez/ ‘to palpate; massage 3M.SG.IPFV’ /ˈɬeħez/ ‘frankincense-luban M.SG’
ʃ	**S**	/ˈʃɐːl/ ‘to spark 3M.SG.PFV’ /ˈʃoːb/ ‘round of bread M.SG’	/jeʁˈʃuːʃ/ ‘to dirty 3M.SG.IPFV’ /jekˈʃuːf/ ‘to uncover 3M.SG.PFV’	/ˈʁeʃʃ/ ‘to dirty 3M.SG.PFV’ /jeʁˈʃuːʃ/ ‘to dirty 3M.SG.IPFV’
	US	/ʃeˈhɐwkʼ/ ‘to hiccup 3M.SG.PFV’ /ʃeˈmiːm/ ‘cloth wrapped over mother-camel teats M.SG’	/jeʃˈhɐwkʼ/ ‘to hiccup 3M.SG.IPFV’ /ʔeʃˈkeːw/ ‘sword M.SG’	/keˈʃuːfeʃ/ ‘to uncover 2F.SG.PFV’ /seˈjoːɾeʃ/ ‘to go 2F.SG.PFV’
ʃˤ	**S**	Not Found	/ħeˈʃˤɐːbɐ/ ‘finger M.PL’	Not Found
	US	/ʃˤefˈɾuːt/ ‘bird M.SG’ /ʃˤeˈfɐːɾ/ ‘bird M.PL’ /ʃˤeˈɾuːm/ ‘to slap 3M.SG.PFV’	/ħeʃˤˈbɐ/ ‘finger M.SG’	Not Found

ɬ	S	/ˈɬoːm/ ‘to sell 3M.SG.PFV’ /ˈɬeːf/ ‘footprint; track M.SG’	/jetˤˈɬoːɬ/ ‘to shower; rain in showers 3M.SG.IPFV’ /jeɾˈɬoːɬ/ ‘to sprinkle 3M.SG.IPFV’	/ˈtˤeɬɬ/ ‘to shower; rain in showers 3M.SG.PFV’ /jetˤˈɬoːɬ/ ‘to shower; rain in showers 3M.SG.IPFV’
	US	/ɬeˈbuːkʼ/ ‘to tie camels into line 3M.SG.PFV’ /ɬeˈχɐːf/ ‘to drink milk 3M.SG.PFV’	/jeɬˈkʼɐwkʼ/ ‘to slit 3M.SG.IPFV’ /jeɬˈtoːm/ ‘to buy 3M.SG.IPFV’	/jeˈħoːfeɬ/ ‘to collect 3M.SG.IPFV’ /jeˈʃɐwgeɬ/ ‘to go in the evening 3M.SG.IPFV’
ɬˤ	S	/ˈɬˤɐːf/ ‘to be tired; exhausted 3M.SG.PFV’ /ˈɬˤoːb/ ‘monitor lizard M.SG’	/jeʁˈɬˤɐwɬˤ/ ‘to wink 3M.SG.IPFV’ /jeʁˈɬˤoːf/ ‘to pull legs up M.SG.IPFV’	/ˈʁeɬˤɬˤ/ ‘to wink 3M.SG.PFV’ /jeʁˈɬˤɐwɬˤ/ ‘to wink 3M.SG.IPFV’
	US	/ɬˤeˈħɐk/ ‘to laugh 3M.SG.PFV’ /ɬˤeˈʁɐːtˤ/ ‘to squeeze 3M.SG.PFV’	/jeɬˤˈħoːk/ ‘to laugh 3M.SG.IPFV’ /jeɬˤˈboːb/ ‘to converse, chat 3M.SG.IPFV’	/jeˈkʼoːbeɬˤ/ ‘to herd 3M.SG.IPFV’ /jeˈkʼɐwɾeɬˤ/ ‘to cut up 3M.SG.IPFV’

Table 6.1: List of elicited words with target fricatives in various positions.

For word list recording procedures and related details see 5.2.2 above.

6.2.2. Measurements

In contrast to segmentation of the stops, the range of viewed frequencies in spectrogram settings was set between 0-11000 Hz for fricatives. This viewing range stretched the fricative higher frequencies which turned out to aid in setting the boundaries and increase the pace of segmentation process (see 3.5 for PRAAT settings and other segmentation protocol details).

During the segmentation process, spectrograms and waveforms were carefully checked for any parameters known for ejective fricatives. The spectrograms and waveforms were checked for the presence of pre- or post-frication silent lags (glottal closure) and glottal release, and any such instances were marked in the specified tier. Figure 6.1 below of an emphatic fricative token shows how the segmentation was done in various tiers.

All data in the illustrative images below are phonemically transcribed. Broad phonetic transcriptions are given in case of some long vowels. The phonetic transcriptions are given in the text only (see 3.5 for segmentation procedures). Only the segment in focus is segmented in detail in the image for illustrative purposes.

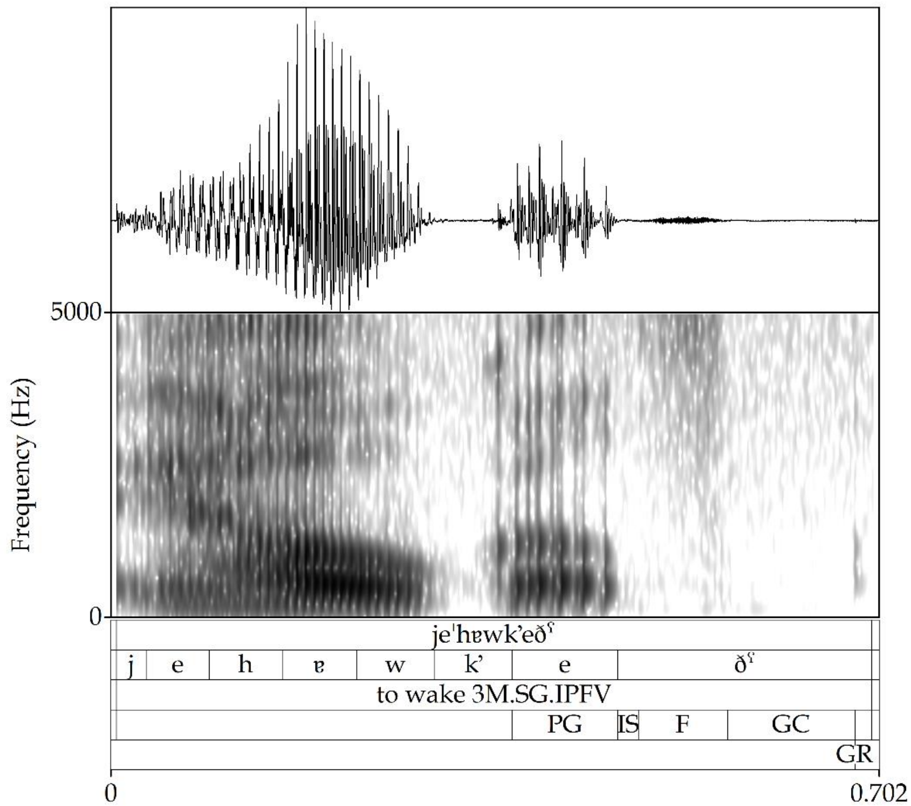

Figure 6.1: An emphatic fricative token showing the tiers and segmentation style.

As illustrated in Figure 6.1 above, fricative overall duration was measured in tier 2, the segment tier. Pre- or post-frication silent lags, frication duration, and any glottal closures were marked in tier 5. The expected periods of pre-glottalisation (PG), pre-aspiration (PA), and creaky voice were marked in tier 5 as well. Oral and glottal releases, if found, were marked in tier 6 as OR and GR, respectively. Table 6.2 below explains the meanings of abbreviations used in segmenting the data.

Abbreviation	Meaning
IS	Pre-frication Silent Lag
BS	Post-frication Silent Lag
F	Frication Duration
GC	Glottal Closure
OR	Oral Release
GR	Glottal Release
S	Stressed
US	Unstressed
PA	Pre-aspiration
PG	Pre-glottalisation
CV	Creaky Voice

Table 6.2: List of segmentation abbreviations and their meanings.

The onset of the fricatives was set at the start of frication at the point where the waveform became aperiodic and energy showed up at higher frequencies in the spectrogram except when preceded by an initial silent lag. In case of initial silent lags in positions other than utterance-initial, the period of the lag was included as part of the fricative. The onset of voiced fricatives was set at the start of voicing where energy showed in lower formants if there were any instances of pre-voicing in utterance-initial positions. The offset of the fricatives was set at the onset of the following vowel at the point immediately prior to where the waveform became periodic, and the sine line did not show any jerky or jagged parts. Figure 6.2 below shows the onset and offset of the emphatic alveolar fricative /sˤ/ in utterance initial position.

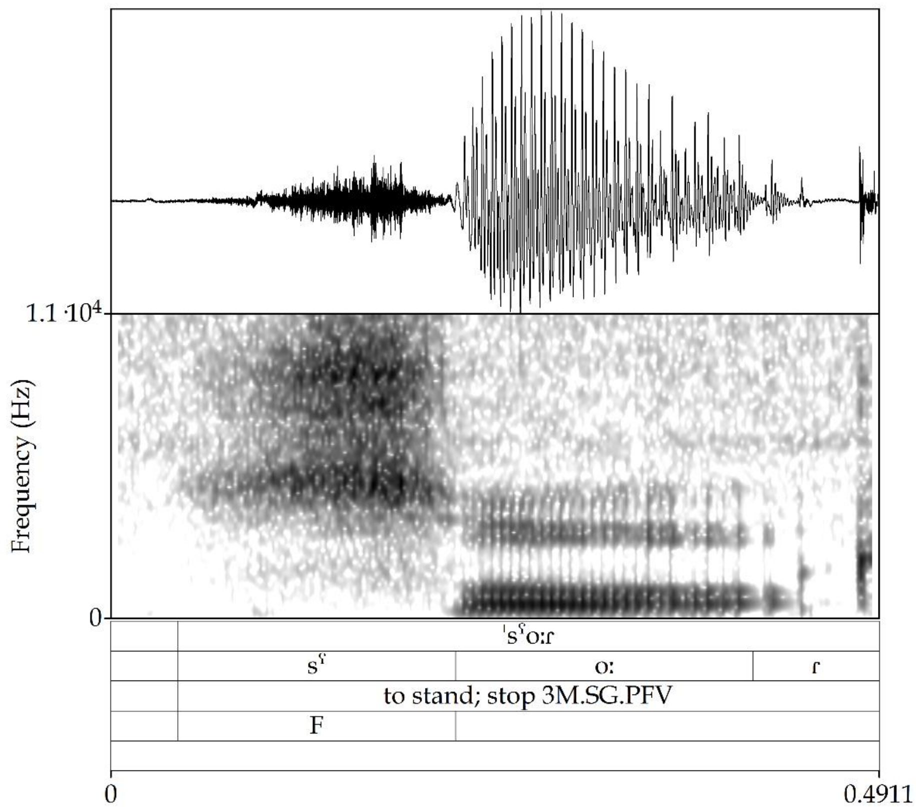

Figure 6.2: Fricative in initial position.

In case of a following stop, the fricative's offset was set at the point where there was a sudden drop in amplitude consistent with closure in the spectrogram and a dampened signal in the waveform signalling oral closure as can be seen in Figure 6.3 below.

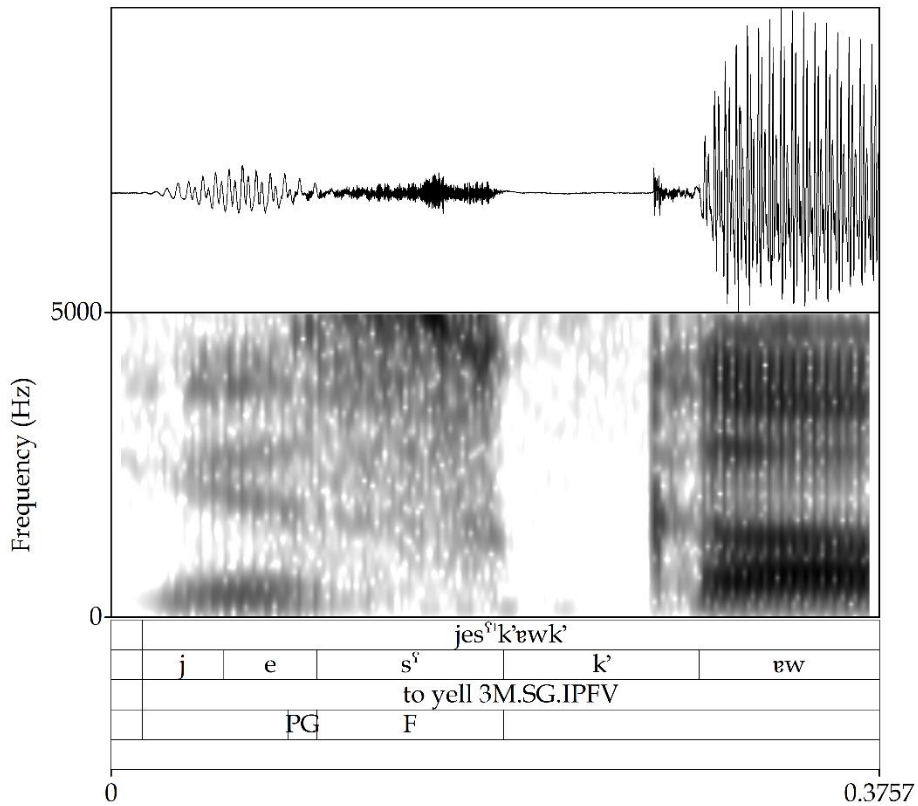

Figure 6.3: Fricative followed by a stop.

In case of a preceding or following fricative, setting the target fricative onset or offset became more challenging. Nonetheless, depending mainly on the spectrogram with a higher view range, the onset or offset of the target fricative was set at the points where there appeared a change in spectrogram structure and intensity. Figure 6.4 below shows the palato-alveolar fricative /ʃ/ followed by the glottal fricative /h/ in utterance-medial position. Distinguishing both fricatives from each other and setting their boundaries became easier with a higher viewing range in the spectrogram, even though not as straightforward as in the case with following vowels or stops.

See Segmentation Protocol in Appendices for detailed criteria followed in segmenting the fricatives.

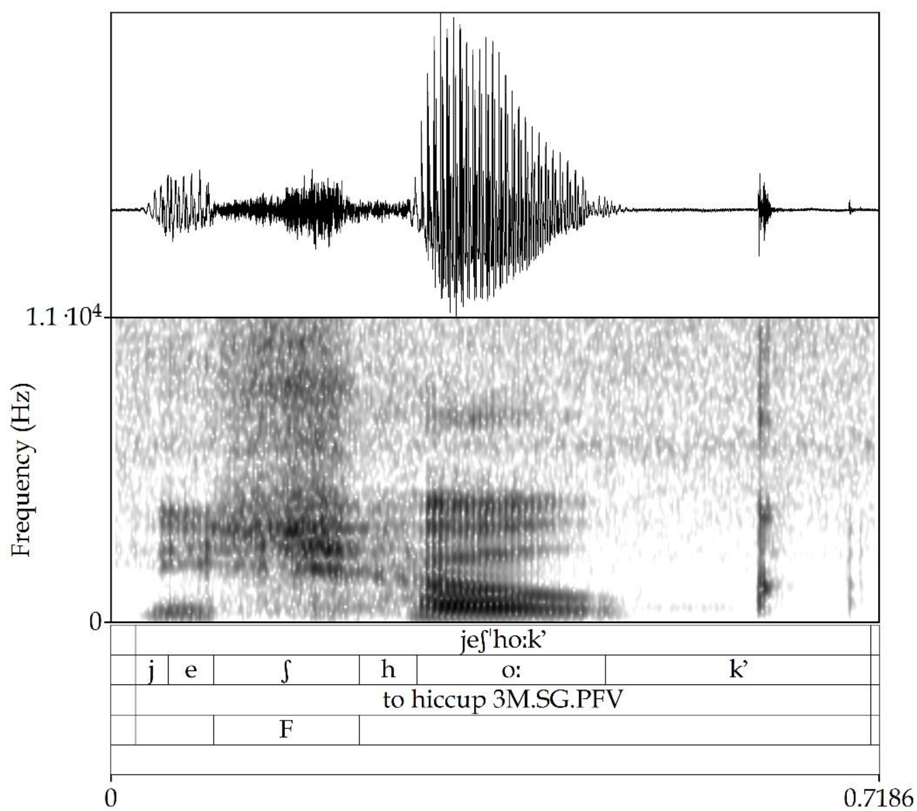

Figure 6.4: Fricative followed by another fricative.

Target fricative overall duration was measured as the total duration of the segment including any pre- or post-frication silent lags found in the segment. After running the linear mixed-effects model, the means of target fricative overall durations were measured by averaging the overall durations of each fricative across speakers.

Frication duration was measured as the total duration of frication noise excluding any pre- or post-frication silent lags, if found in the segment. Similar to overall duration, after running the linear-mixed effects model, frication durations were averaged across speakers to get their mean values for comparison purposes.

Frication intensity of target fricatives was measured in the period of frication noise/duration of each target fricative by getting the mean intensity in dB using a PRAAT script (Boersma & Weenink, 2020). The mean intensities of target fricatives were then averaged across speakers to get an overall mean for each target fricative.

After the segmentation process, the second part of the analyses included running a PRAAT script written by Dr. Gisela Lourido and modified by me to get the measurements of overall fricative duration, frication duration, frication intensity, pre- or post-frication silent lags, and CoG.

6.2.3. Analyses

The same steps mentioned in 5.2.4 were followed to analyse the obtained data. Separate linear mixed-effects models were run for the various dependent variables of overall duration, frication duration, frication intensity, and CoG. A logistic regression model was run for the presence or absence of pre- or post-friction silent lags.

The main effects in the linear mixed-effects models were kept constant as segment type (voiced, voiceless, or emphatic), segment position (utterance-initial, medial, or final), syllable type (stressed or unstressed), and place of articulation (interdental, alveolar, palato-alveolar, or alveolar lateral). Unfortunately, it was not possible to include varying random slope of segment type by participant in all the models due to fit being singular. Nonetheless, all the models included the random intercept by participant and a random intercept by item.

The linear mixed-effects model for the overall duration of the fricative had the main effects of segment type (voiced, voiceless, or emphatic), segment position (utterance-initial, medial, or final), syllable type (stressed or unstressed), and place of articulation (interdental, alveolar, palato-alveolar, or alveolar lateral). As for the varying random slope of segment, it was not possible to add it to this model as it resulted in fit being singular. Thus, only random intercepts by participant and item were added to the model. The final model had the best overall fit results for AIC and BIC among the various tested models, and the Anova results showed all the included variables to be significant.

Similarly, in the model for frication duration, the main effects were kept constant as mentioned earlier, and the varying random slope of segment was excluded due to fit being singular. The model did include random intercepts by participant and item.

The frication intensity linear mixed-effects model included varying random slope of segment type by participant, which included random intercept by participant and random intercept by item.

As for the logistic regression model of pre- or post-frication silent lags, the data were modified by adding a new column and assigning values of zero and one to the segments.

Segments lacking pre- or post-frication silent lags were assigned zero, while segments with silent lags were assigned 1. The independent variables were similar to the previous models as segment type (voiced, voiceless, emphatic), segment position (utterance-initial, medial, final), syllable type (stressed or unstressed), and place of articulation (interdental, alveolar, palato-alveolar, alveolar lateral).

For CoG, the linear mixed-effects model had the same fixed effects similar to the other models and the same procedures mentioned in 5.3.5 were followed to reach the best model with best results of AIC and BIC. The model included varying random slope of segment type by participant, which included random intercept by participant and random intercept by item.

6.3. Results

The results section is divided into two separate sections. The first section deals with the visual inspections of waveforms and spectrograms and investigates any acoustic parameters related to ejective fricatives. The second section deals with the statistical analyses of the data and checks for the effects and relations between fixed and dependent variables being investigated in this study.

6.3.1. Visual Inspection of Waveforms and Spectrograms

During the segmentation process, it was inferred through the visual inspection of waveforms and spectrograms that the fricatives in Ḥarsūsi are realised differently in different contexts. Moreover, inter-speaker variability was also noticed in certain cases. Under this section, the results of each type of fricatives are given separately.

The results given under this section are from carefully elicited data from the 10 speakers of Ḥarsūsi (see 6.2.1) contrasting to the results of chapter 4 which were mainly based on natural speech data. The results in the following section mainly focus on the ejective realisation in the different positions studied in this research.

6.3.1.1. Emphatic Fricatives

In the sections below, the interdental /ðˤ/, the alveolar /sˤ/, the palato-alveolar /ʃˤ/, and the alveolar lateral /ɬˤ/ are examined in turn.

6.3.1.1.1. Interdental /ðˤ/

The results of the controlled data set are consistent with the patterns mentioned in 4.1.2 and 4.3.2 which were based mainly on non-controlled data. The emphatic interdental fricative /ðˤ/ has more than one allophone. In utterance-initial position, it can be realised as a voiced [ðˤ] or voiceless [θˤ]. Its realisation in this position, however, is speaker dependent as there was a variability in the production of different speakers in the data. Some speakers realised it only as voiced [ðˤ], while others realised it as [θˤ] in some tokens in utterance-initial position. Figure 6.5 and Figure 6.6 below show the emphatic interdental fricative /ðˤ/ in utterance-initial position.

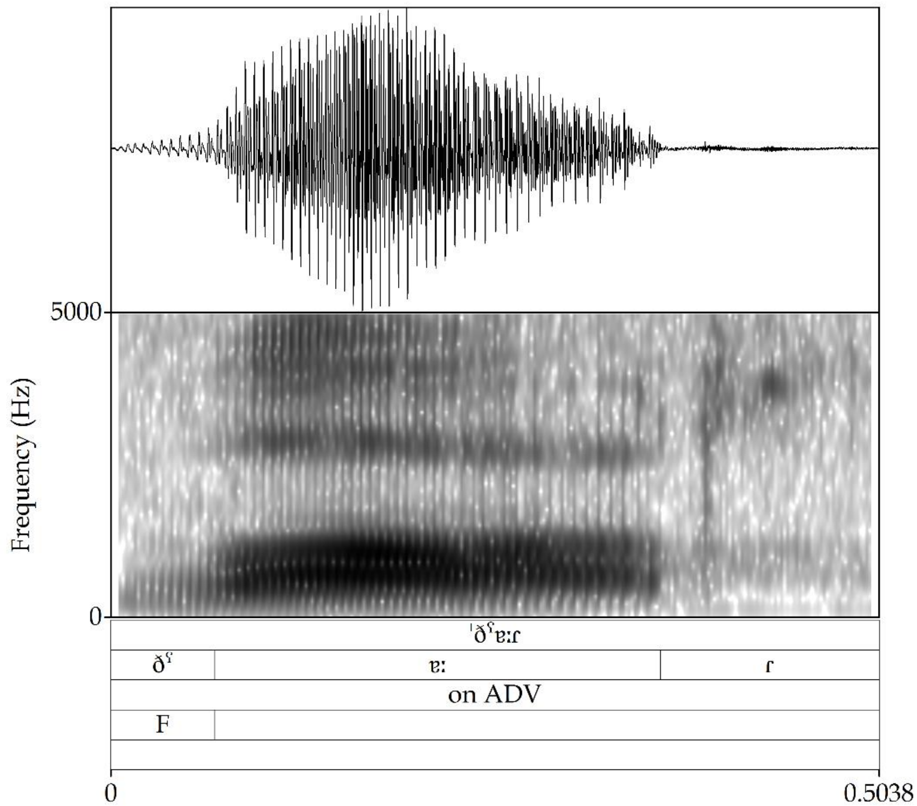

Figure 6.5: Voicing energy in the emphatic /ðˤ/ in /ˈðˤɐːɾ/ - [ˈðˤɑːr] ‘on ADV’.

In Figure 6.5, the emphatic interdental /ðˤ/ is almost fully voiced [ðˤ] . Voicing energy is clearly seen in this token as a darker shade in the lower formant. In addition, glottal pulses were detected by PRAAT as visible blue lines in the waveform throughout the segment.

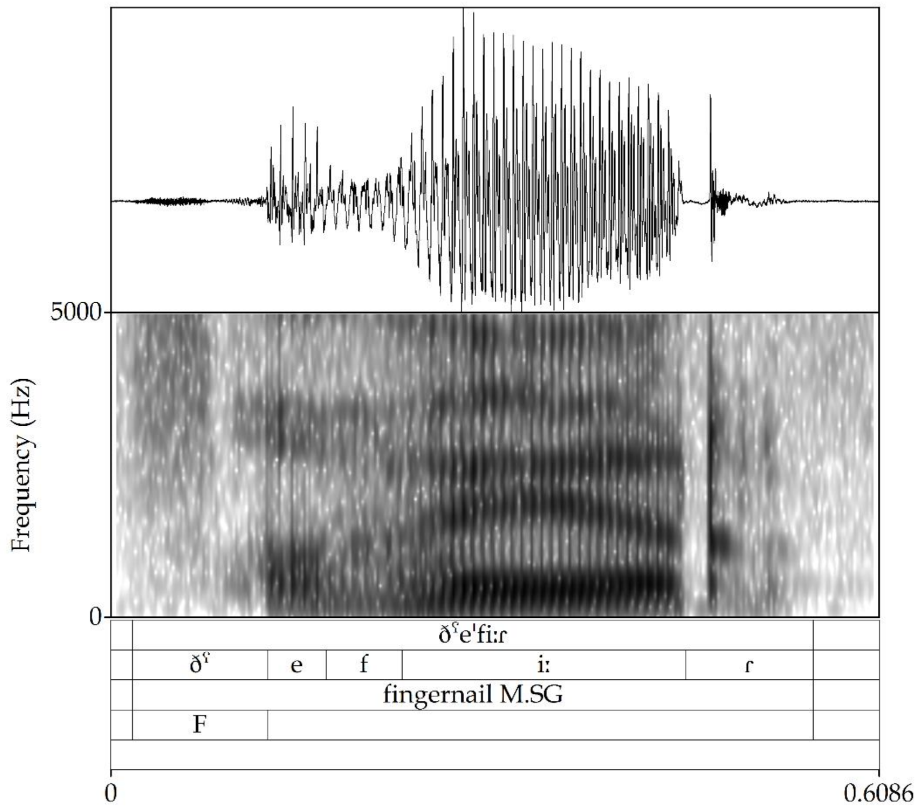

Figure 6.6: Lack of voicing energy in the emphatic /ðˤ/ in /ˈðˤefiːɾ/ - [ðˤə.ˈfiːr] ‘fingernail M.SG’.

On the other hand, Figure 6.6 shows the emphatic interdental /ðˤ/ realised as a voiceless [θˤ]. In this token, the spectrogram does not show any energy during the frication period in the lower formant, and glottal pulse detection algorithm in PRAAT did not detect any pulses.

In utterance-medial position, the emphatic interdental /ðˤ/ is realised as a fully voiced [ðˤ] as can be seen in Figure 6.7 below. The voicing in this position can be seen by the high energy in low formants. In addition, there is no pre- or post-frication silent lag to suggest ejectivity as was found in some tokens of Mehri emphatic fricatives by Ridouane & Gendrot (2017). It is worth mentioning here that this token of /ðˤ/ in Figure 6.7 shows that it is lenited and realised more like an approximant.

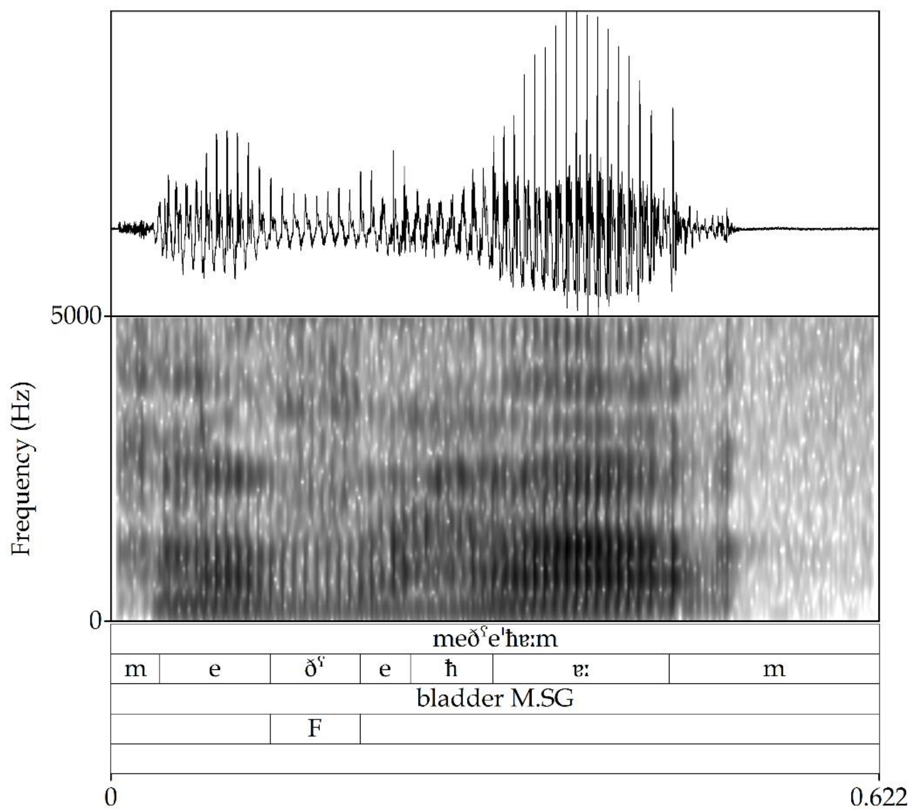

Figure 6.7: Voicing energy in the emphatic /ðˤ/ in /me.ðˤe.ˈħɐːm/ - [mə.ðˤə.ˈħɑːm] 'bladder M.SG'.

In utterance-final position, the emphatic interdental /ðˤ/ lacks voicing and is realised as an ejective. The ejective realisation of /ðˤ/ in utterance-final position can be clearly seen in Figure

6.8. The frication period of the emphatic /ðˤ/ is followed by a period of silence which is the period of glottal closure. The glottal closure in turn is followed by a burst which is the glottal release. The ejective realisation in this position was not found in all tokens in the data. Ridouane & Gendrot (2017) found similar post-frication silent lags in Mehri emphatic fricatives which they termed 'glottal-lag'; however, their data included only word-initial and medial fricatives, and word-final fricatives were not analysed in their study.

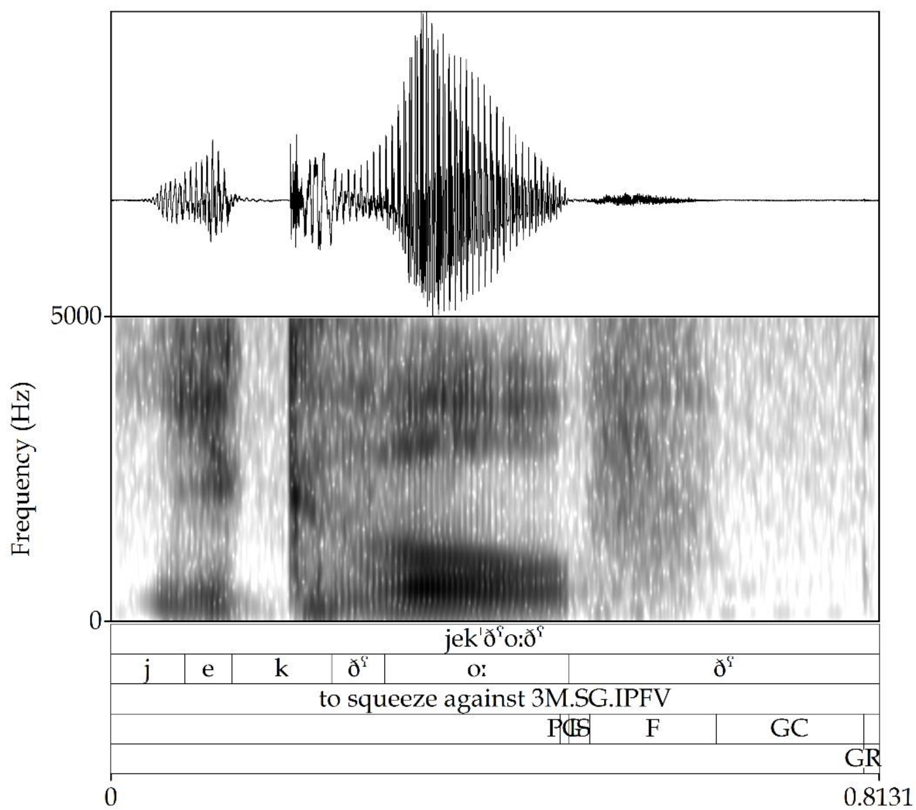

Figure 6.8: Glottal closure and burst in the emphatic /ðˤ/ in /jekˈðˤoːðˤ/ - [jək.ðˤo̱ːθ'] 'to squeeze against 3M.SG.IPFV'.

Seven of the emphatic interdental /ðˤ/ tokens in utterance-final position included pre-frication silent lags. In addition, a number of the tokens in utterance-final position included short periods of pre-glottalisation (PG).

6.3.1.1.2. Alveolar /sˤ/

The emphatic alveolar fricative /sˤ/ has two allophones. In utterance-initial and medial positions it is realised as a 'backed' [sˤ], while in utterance-final positions it is realised as an ejective [s']. As mentioned in 4.3.2, the ejective realisation of the emphatic alveolar /sˤ/ has been attested only in utterance-final position in the data. The acoustic parameters known for ejective fricatives, such as pre- or post-frication silent lags, have not been found systematically in all positions, suggesting a typical 'backed' realisation for the emphatic fricative /sˤ/ in Ḥarsūsi. Figure 6.9, Figure 6.10 and Figure 6.11 below illustrate tokens of the emphatic alveolar /sˤ/ in utterance-initial, medial and final positions, respectively. In the spectrograms and waveforms, the frication period of /sˤ/ in utterance-initial and medial positions is continuous throughout its realisation as the waveforms are aperiodic and high energy at higher frequencies shows in the spectrograms in Figure 6.9 and Figure 6.10. On the other hand, in utterance-final position, the frication period is followed by a period of silence (glottal closure) which is followed in turn by a burst (glottal burst) as can be seen in Figure 6.11 below.

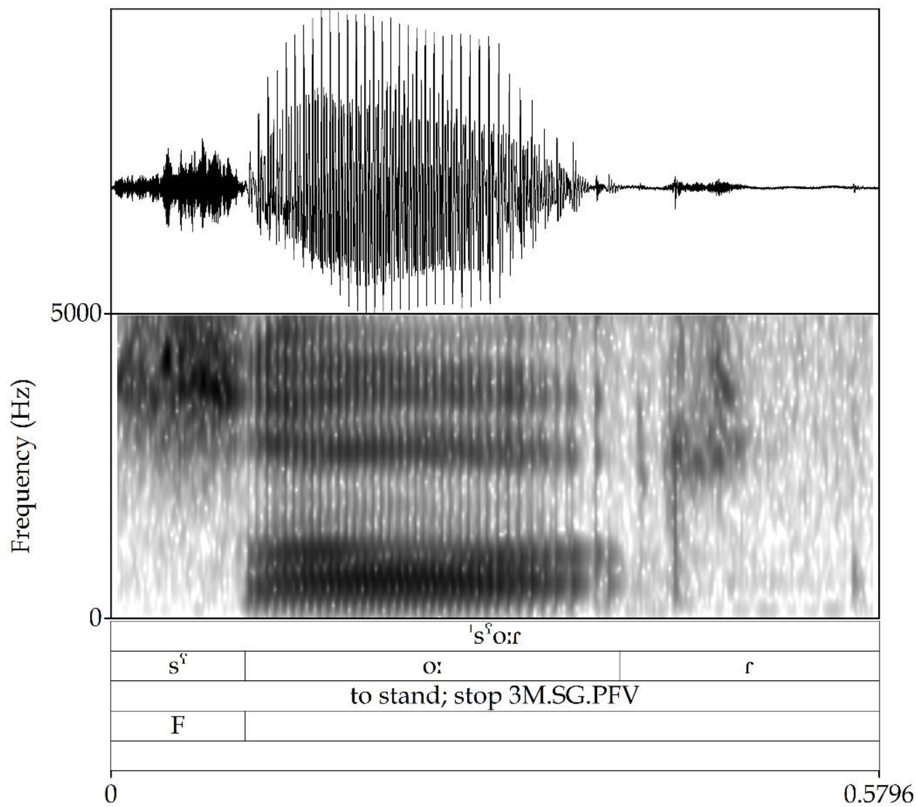

Figure 6.9: Emphatic /sˤ/ in /ˈsˤoːɾ/ - [ˈsˤo̠ːr] ‘to stand; stop 3M.SG.PFV’.

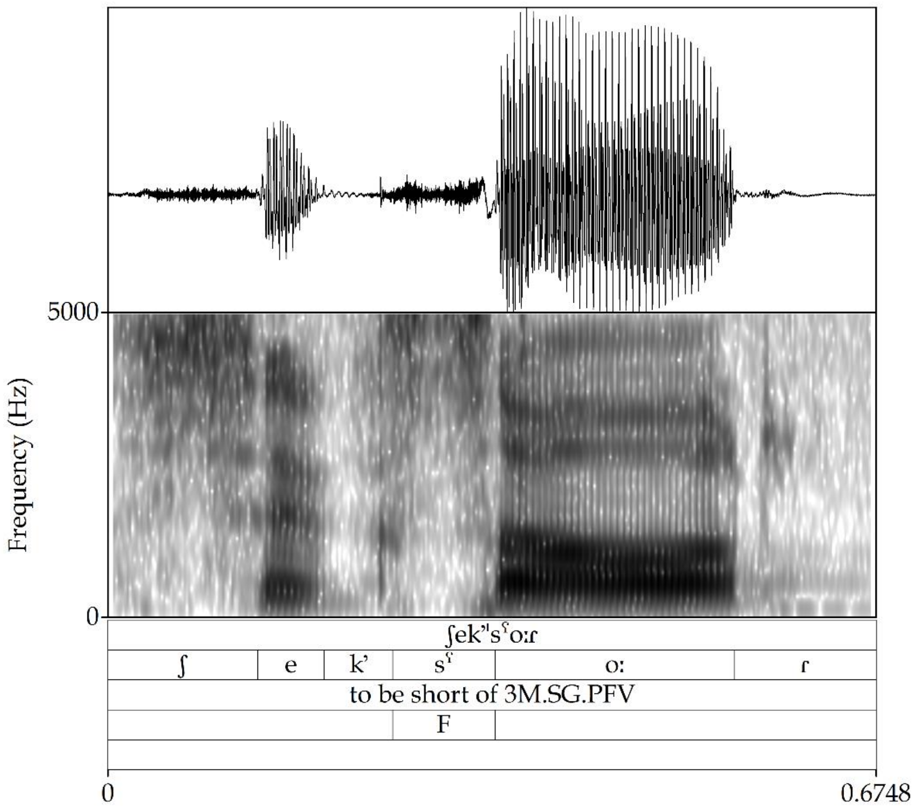

Figure 6.10: Emphatic /sˤ/ in /ʃek’ˈsˤoːɾ/ - [ʃəkˤ.ˈsˤo̱ːr] ‘to be short of 3M.SG.PFV’.

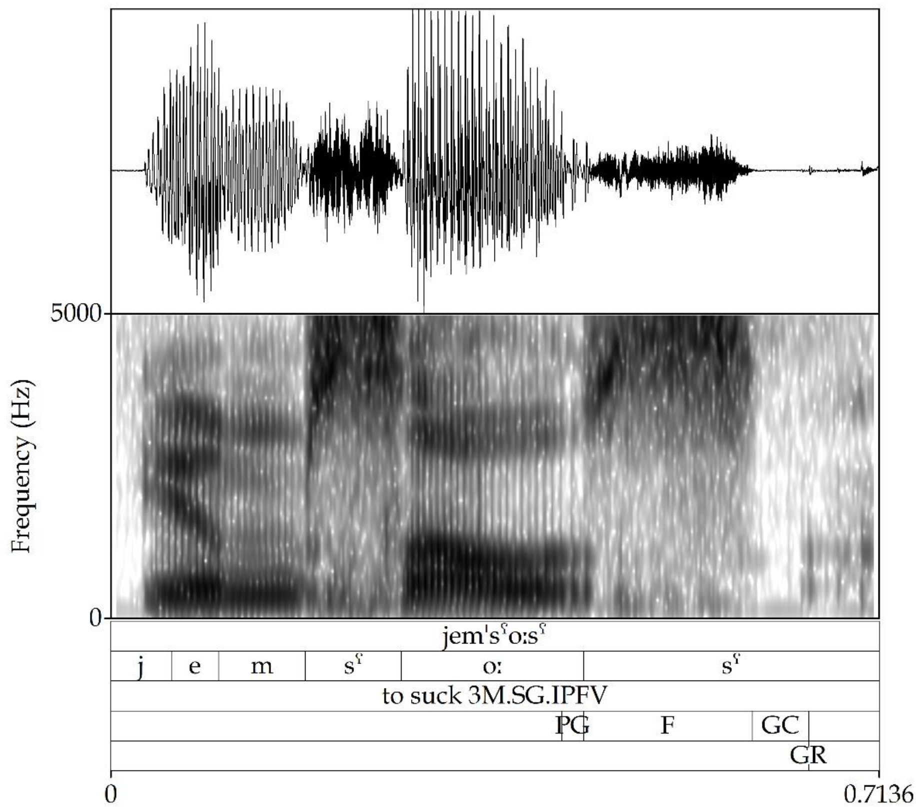

Figure 6.11: Glottal closure and burst in the emphatic /sˤ/ in /jemˈsˤoːsˤ/ - [jəm.ˈsˤo̠ːs’] ‘to suck 3M.SG.IPFV’.

Pre-frication silent lags were found in tokens of the emphatic alveolar fricative /sˤ/ in utterance-final position only. A few tokens exhibited post-frication silent lags in utterance-initial and medial position, but no pre-frication silent lags. Figure 6.12 below shows a token of the emphatic alveolar /sˤ/ with a post-frication silent lag (BS). However, unlike Mehri where Ridouane & Gendrot (2017) found a higher number of tokens of the emphatic alveolar /sˤ/ with pre- and post-frication silent lags in initial and medial positions (22 tokens) compared to the total data (50 tokens), the number of tokens with silent lags in Ḥarsūsi is very small (39 out of 360). Moreover, the post-frication silent lags in initial and medial positions are very short in Ḥarsūsi and are not periods of complete silence as the waveforms show minimal aperiodicity, as can be seen in Figure 6.12 below. In utterance-final position, the post-frication silent lags are long, and the waveforms show no activity suggesting total glottal closure as can be seen in Figure 6.11 above. Given these observations, it could be concluded that the emphatic alveolar fricative /sˤ/ in Ḥarsūsi is typically realised as an ejective [s’] only in utterance-final position, while in other positions it is typically realised as a ‘backed’ [sˤ].

It should be noted here that a number of the emphatic alveolar fricative /sˤ/ tokens were preceded by short periods of pre-glottalisation (PG) in utterance-final position, as can be seen in Figure 6.11 above.

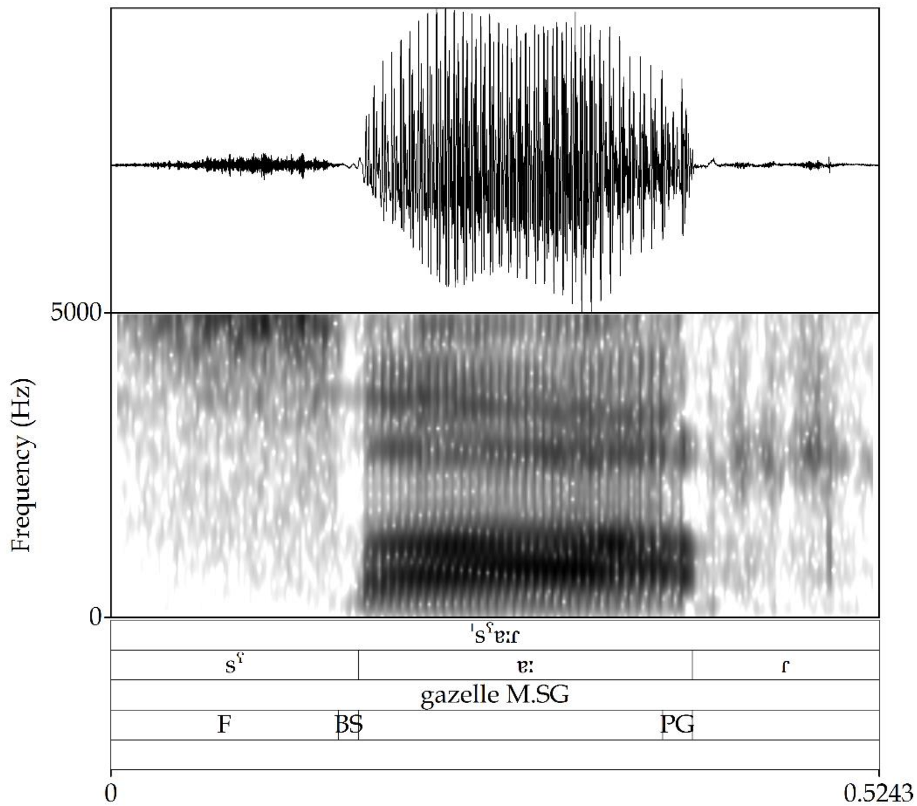

Figure 6.12: Post-frication silent lag in the emphatic /sˤ/ in /sˤɐːɾ/ - [ˈsˤɑːr] 'gazelle M.SG'.

6.3.1.1.3. Palato-alveolar /ʃˤ/

The occurrence of the emphatic palato-alveolar fricative /ʃˤ/ in Ḥarsūsi is very limited 6.2.1). Therefore, it was not possible to investigate its realisation in utterance-final position. In utterance-initial and medial positions, it is not realised as an ejective as no clear glottal closures or releases can be seen, but rather a 'backed' [ʃˤ]. Figure 6.13 and Figure 6.14 below show the emphatic palato-alveolar fricative /ʃˤ/ in utterance-initial and medial positions. It should be noted here, however, that a few tokens did include short periods of irregular glottal cycles which were marked as expected glottalised periods. Such periods were not very common across the data, however.

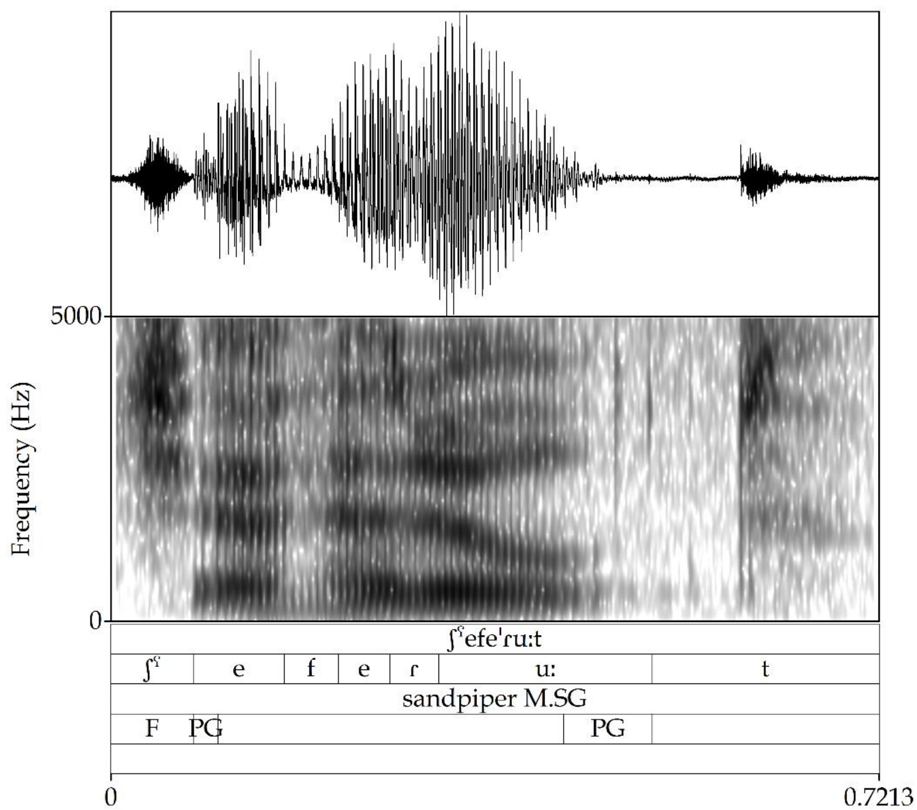

Figure 6.13: Emphatic /ʃˤ/ in /ʃˤefeˈɾuːt/ - [ʃˤə.fə.ˈɾuːtʰ] 'bird M.SG'.

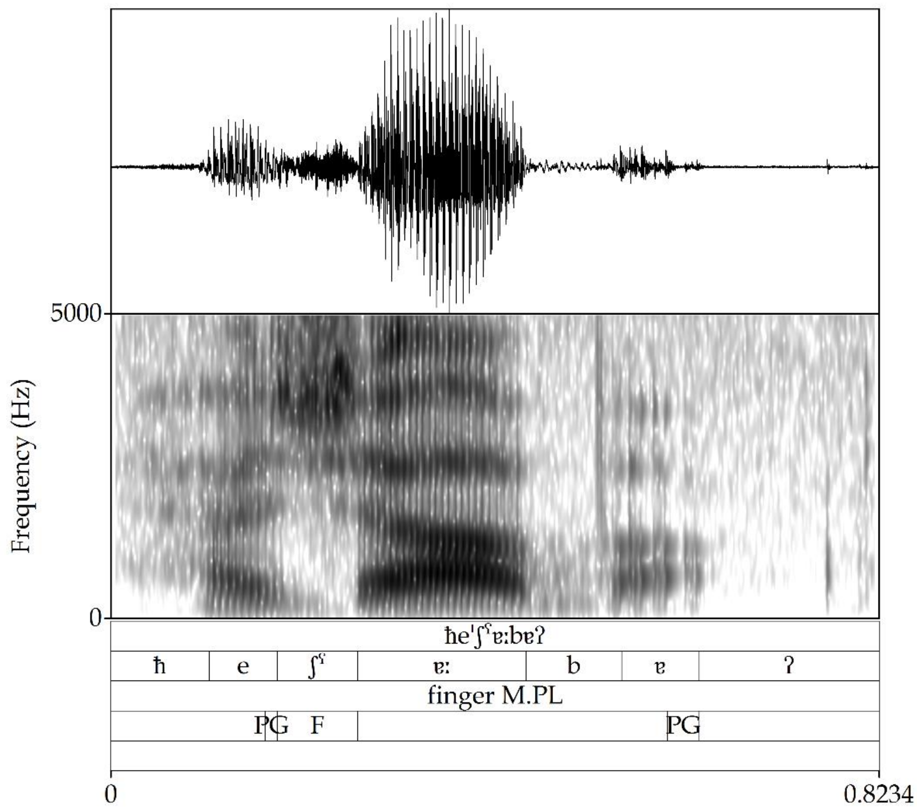

Figure 6.14: Emphatic /ʃˤ/ in /ħeˈʃˤɐːbɐʔ/ - [ħə.ˈʃˤɑː.bɐʔ] ‘finger M.PL’.

With regard to pre- or post-frication silent lags, few tokens in the data exhibited such lags; nonetheless, their occurrence was not consistent throughout the data. Moreover, the silent lags found were not complete silences and minimal energy could be seen in the spectrograms. Close examination of the waveforms also showed some minimal aperiodicity suggesting no complete closures in these tokens. Figure 6.15 below shows the emphatic palato-alveolar fricative /ʃˤ/ in utterance-initial position with a post-frication silent lag. As can be seen in this figure, the post-frication silent lag (BS) is rather short. The close examination of the waveform also showed some minimal aperiodicity which could mean non-complete closure unlike what was found in utterance-final positions for some other segments. Moreover, other parameters associated with ejective realisation such as initial occlusion or bursts cannot be seen in the waveform or spectrogram. Given these observations, it could be concluded that the emphatic palato-alveolar fricative /ʃˤ/ is not typically realised as an ejective.

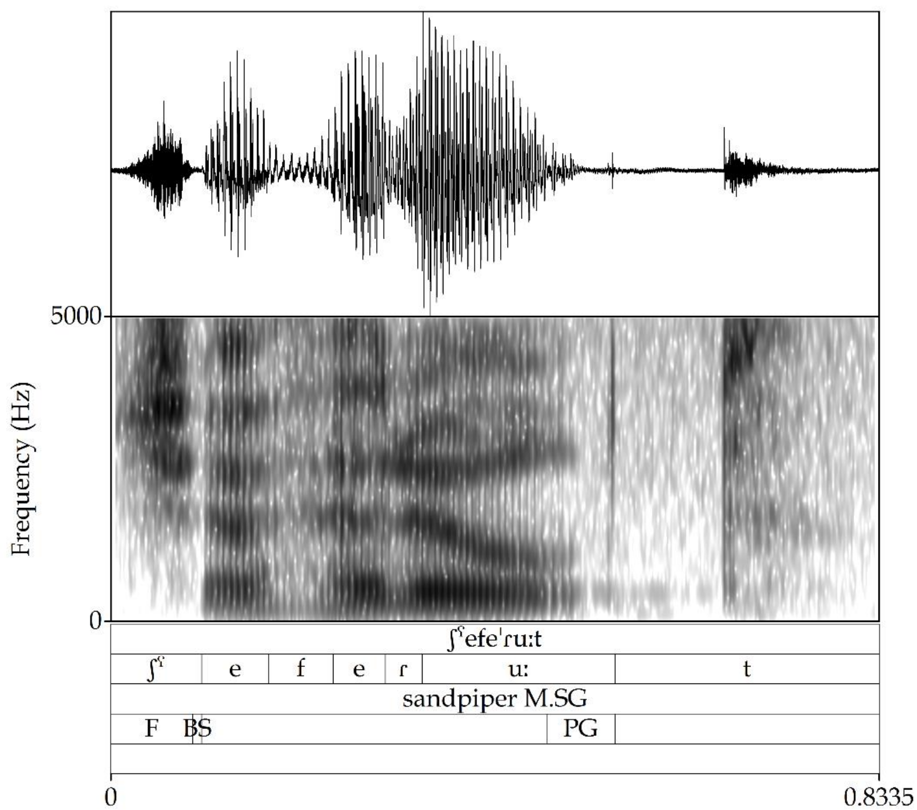

Figure 6.15: Post-frication silent lag (BS) in the emphatic /ʃˤ/ in /ʃˤefeˈɾuːt/ - [ʃˤə.fə.ˈɾuːtʰ] ‘bird M.SG’.

6.3.1.1.4. Alveolar lateral /ɬˤ/

The alveolar lateral /ɬˤ/ has three allophones. In utterance-initial and medial positions it is realised as a 'backed' [ɬˤ], while in utterance-final position it is realised as an ejective [ɬ']. In intervocalic positions, it is realised as a [ɮˤ]. Figure 6.16 and Figure 6.17 below show the emphatic aalveolar-lateral fricative /ɬˤ/ in utterance-initial, medial, and final positions.

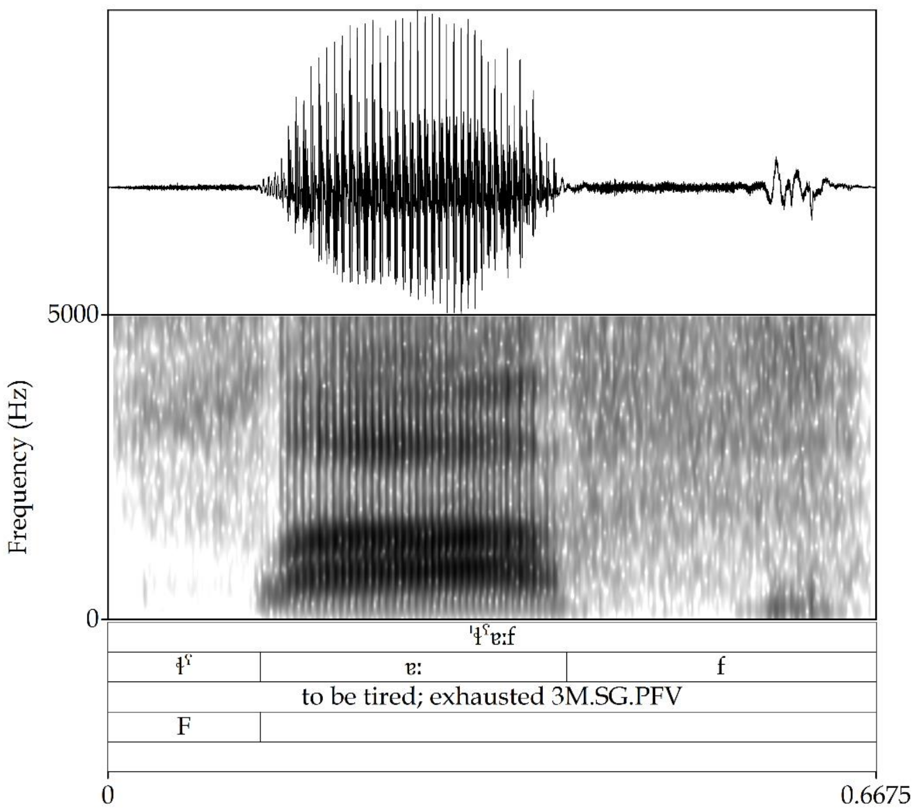

Figure 6.16: Emphatic /ɬˤ/ in /ˈɬˤɐːf/ - [ˈɬˤɑːf] 'to be tired; exhausted 3M.SG.PFV'.

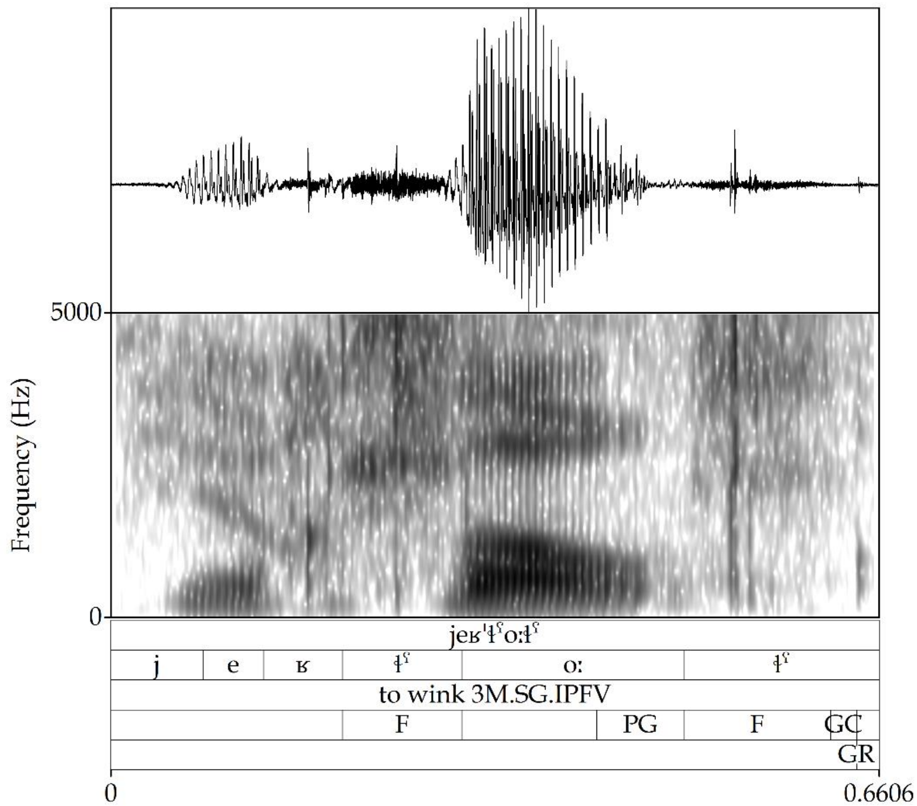

Figure 6.17: Emphatic /ɬˤ/ in /jeʁˈɬˤoːɬˤ/ - [jəʁ.ˈɬˤo̞ːɬ’] ‘to wink 3M.SG.IPFV’.

In both figures above, no acoustic parameters associated with ejective fricatives can be seen to suggest an ejective realisation of the emphatic alveolar-lateral fricative /ɬˤ/ except in utterance-final position. In both utterance-initial and medial positions, the waveforms show aperiodicity throughout the articulation period of the segment. Few tokens in utterance-initial and final positions showed pre- or post-frication silent lags, but these lags were not consistent across the data set (see 6.3.2.4).

In utterance-final position, the emphatic alveolar-lateral fricative /ɬˤ/ is typically realised as an ejective. As can be seen in Figure 6.17 above, the segment is preceded by a short period of pre-glottalisation (PG) and a post-frication silent lag marked as a glottal closure (GC) followed by a glottal release (GR). Similarly, in Figure 6.18 below, a period of pre-frication silent lag precedes the frication period of the emphatic alveolar lateral in utterance-final position. The frication period is followed by a post-frication silent lag suggesting a glottal closure. At the end of the segment, a release can be seen which can be the glottal release. These observations suggest an ejective realisation in this position.

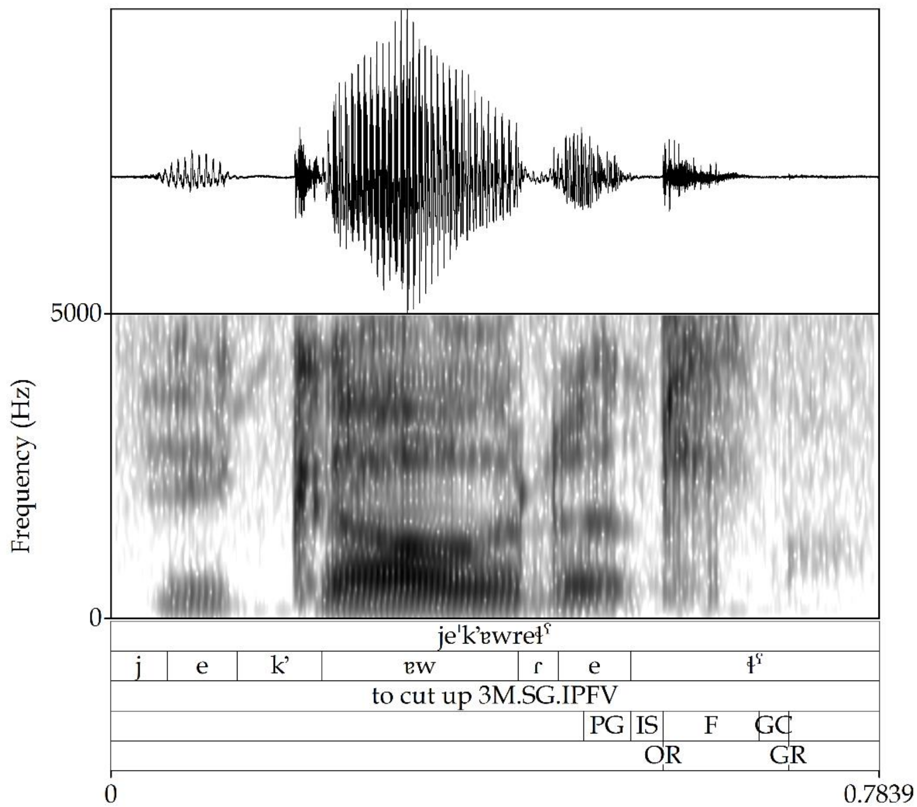

Figure 6.18: Emphatic /ɬˤ/ in /jeˈk'ɐw.ɾeɬˤ/ - [jəˈk'ɑu.ɾəɬ'] 'to cut up 3M.SG.IPFV'.

The emphatic alveolar-lateral fricative /ɬˤ/ is found to be predominantly voiceless in the data. In the positions investigated in this study, it was only voiced in a few tokens in utterance-medial position intervocalically. Figure 6.19 and Figure 6.20 show the spectrograms and waveforms of the same word produced by the same speaker. The emphatic alveolar-lateral fricative /ɬˤ/ is articulated differently in terms of voicing. In Figure 6.19, energy can be seen at the lower formant throughout the segment indicating voicing as a result of voicing assimilation from surrounding segments. In Figure 6.20, the energy at the lower formant can be seen more clearly at the onset and offset of the segment and not throughout the segment indicating voicing assimilation at these two positions. Therefore, the emphatic alveolar-lateral fricative /ɬˤ/ is not voiced intrinsically, but in intervocalic positions it may become voiced through voicing assimilation.

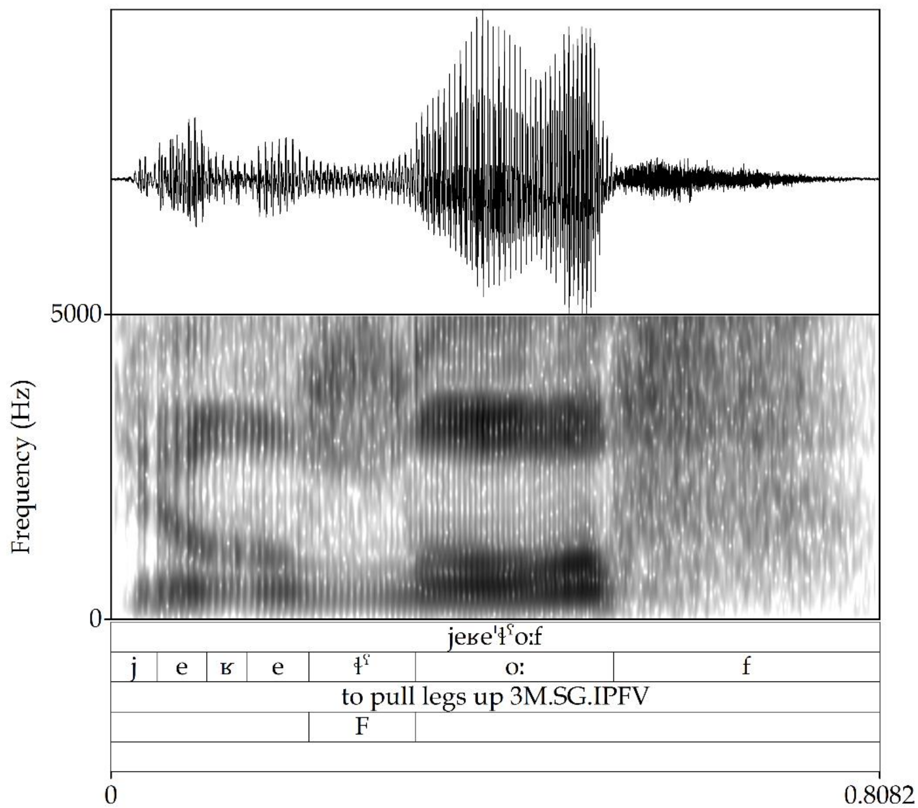

Figure 6.19: Emphatic /ɬˤ/ fully voiced intervocalically in /jeʁˈɬˤoːf/ - [jə.ʁəˈɬˤo̞ːf] ‘to pull legs up 3M.SG.IPFV’.

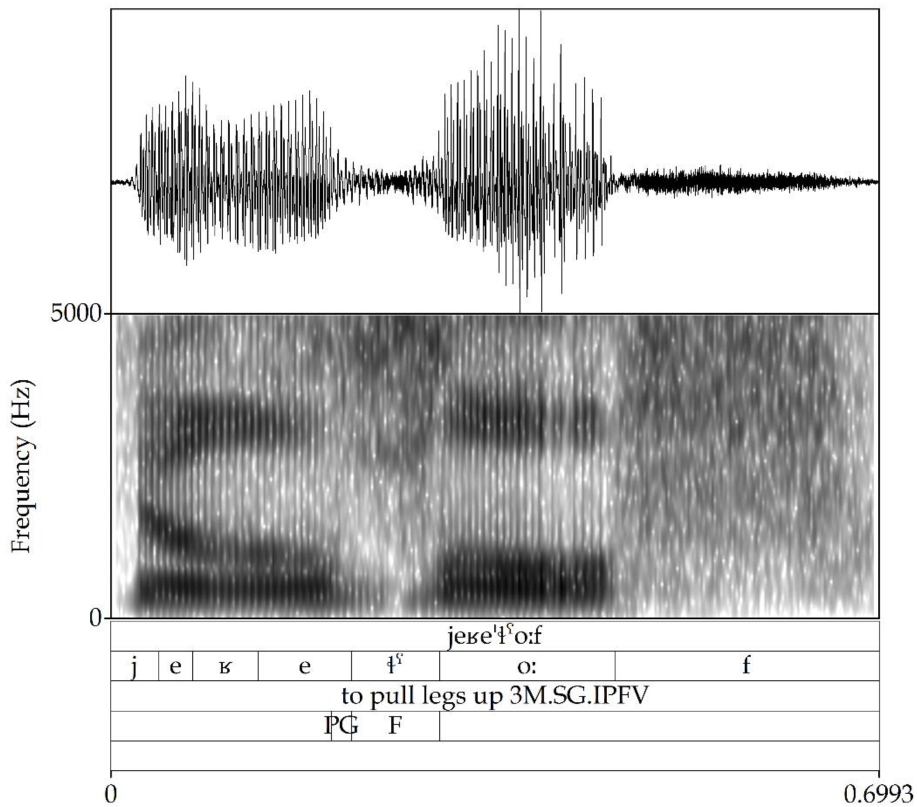

Figure 6.20: Emphatic /ɬˤ/ partially voiced intervocalically in /jeʁˈɬˤoːf/ - [jə.ʁəˈɬˤo̠ːf] 'to pull legs up 3M.SG.IPFV'.

6.3.1.2. Voiced Fricatives

The voiced fricatives in Ḥarsūsi that have emphatic counterparts are the interdental /ð/ and the alveolar /z/. Each of these consonants is investigated in detail in the following sections.

6.3.1.2.1. Interdental /ð/

As mentioned in 4.1.2, the voiced interdental fricative /ð/ has two allophones. In utterance-initial and medial positions it has a voiced allophone [ð], while in utterance-final position it undergoes devoicing. In addition to being devoiced in this position, it is frequently realised as an ejective [θ’] patterning in this position with the emphatic interdental fricative /ðˤ/. As can be seen in Figure 6.21 below, in utterance-initial position, it is articulated with full frication throughout its period and energy is visible in the lower formant indicating glottal activity and voicing.

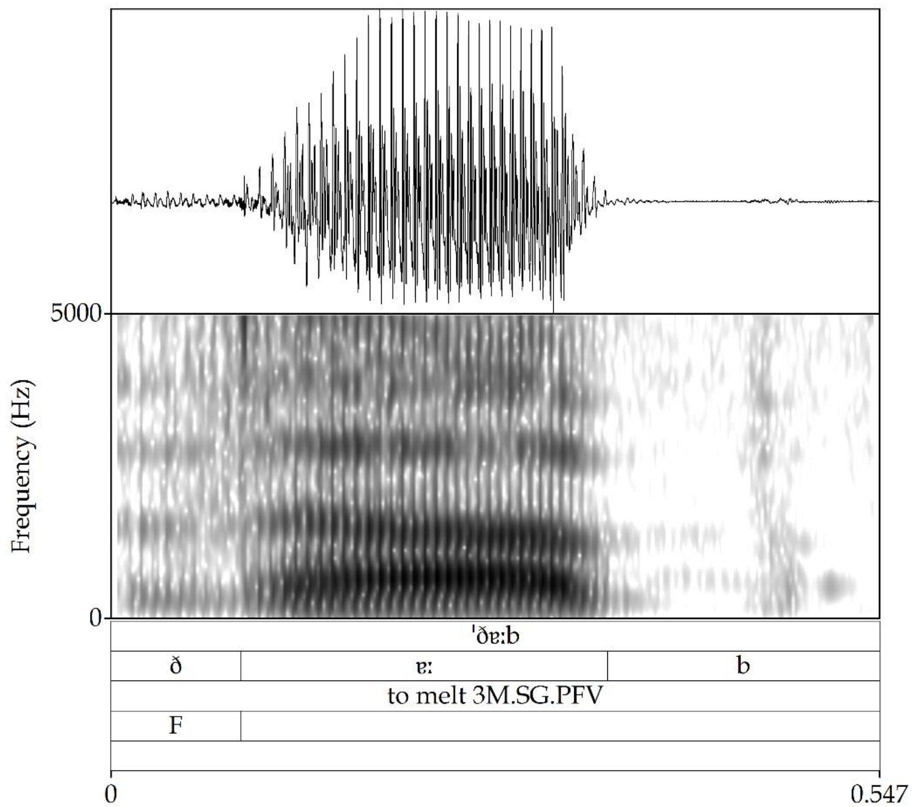

Figure 6.21: Fully voiced /ð/ in /ˈðɐːb/ - [ˈðɑːp’] ‘to melt 3M.SG.PFV’.

In utterance-medial position, the voiced interdental fricative /ð/ is fully voiced regardless of surrounding segments. Figure 6.22 below shows the voiced interdental fricative /ð/ in utterance-medial position. The frication of /ð/ in utterance-medial position is continuous, and it is fully voiced in this position as energy is seen in the lower formant throughout its frication period.

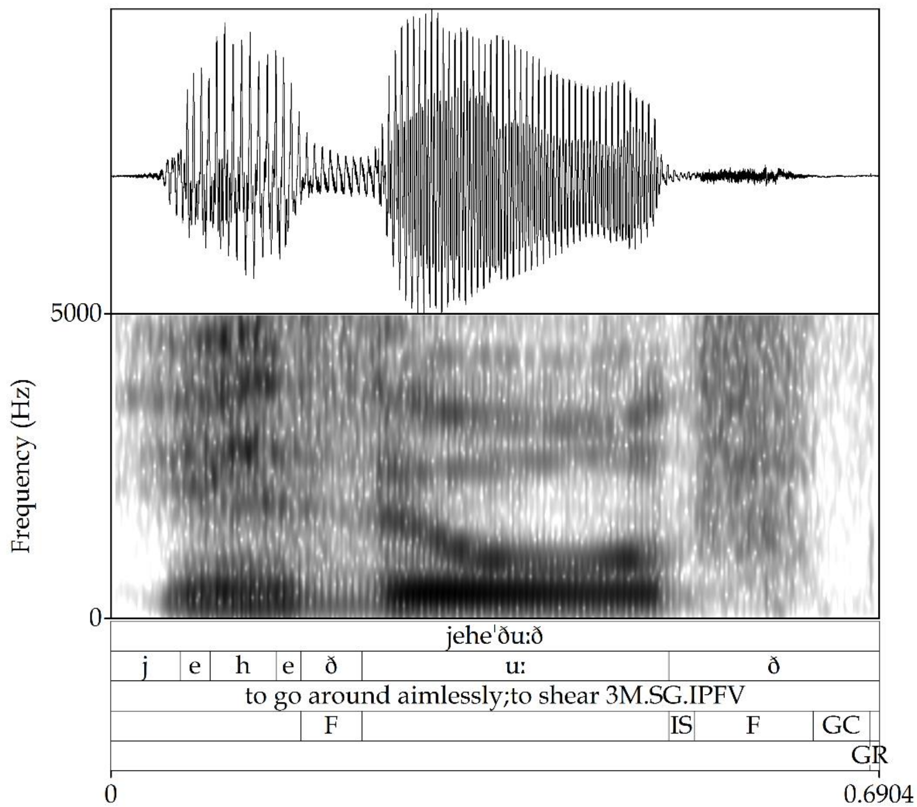

Figure 6.22: Fully voiced medial /ð/ in /jehˈðuːð/ - [jə.hə.ˈðuːθ’] ‘to go around aimlessly; to shear 3M.SG.IPFV’.

In utterance-final position, the voiced interdental fricative /ð/ is devoiced as can be seen in Figure 6.22 above. The lower formants in the spectrogram do not show energy in this position indicating a voiceless realisation. In addition, the frication period of the segment is followed by a silent period followed by a small spike suggesting the glottal release typical of ejective realisation.

A considerable number of utterance-final tokens were preceded by a short period of pre-glottalisation (PG). Figure 6.23 below shows another token of /ð/ in utterance-final position where it is devoiced, realised as an ejective [θ’], and preceded by pre-glottalisation (PG).

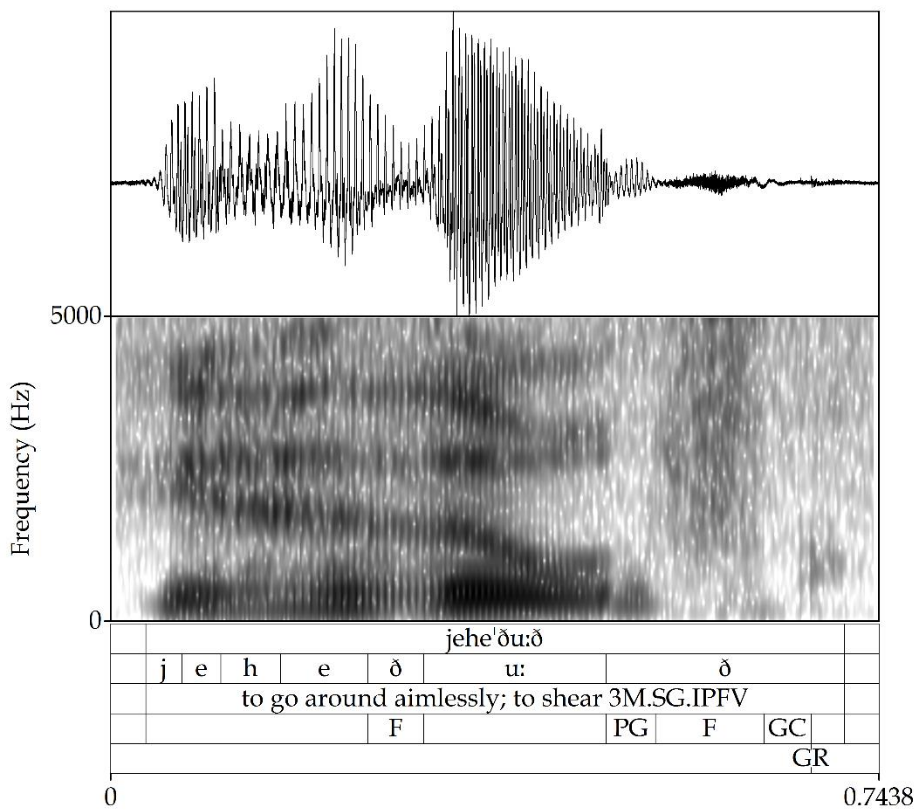

Figure 6.23: Fully voiced medial /ð/ and final /ð/ realised as an ejective in /jeheˈðuːð/ - [jə.hə.ˈðuːθ’] ‘to go around aimlessly; to shear 3M.SG.IPFV’.

6.3.1.2.2. Alveolar /z/

The voiced alveolar fricative /z/ has two allophones. The voiced allophone [z] occurs in utterance-initial and medial positions, and a devoiced allophone frequently realised as [s’] occurs in utterance-final position. Visual inspection of waveforms and spectrograms showed the different realisations for the voiced alveolar fricative /z/. As can be seen in Figure 6.24 and Figure 6.25 below, in utterance-initial and medial positions, the voiced alveolar fricative /z/ is realised as a fully voiced fricative. Frication in these two positions is continuous as periodicity in the waveforms can be seen throughout the segments. In terms of voicing, energy can also be seen in the lower formants in the spectrograms suggesting glottal activity during articulation.

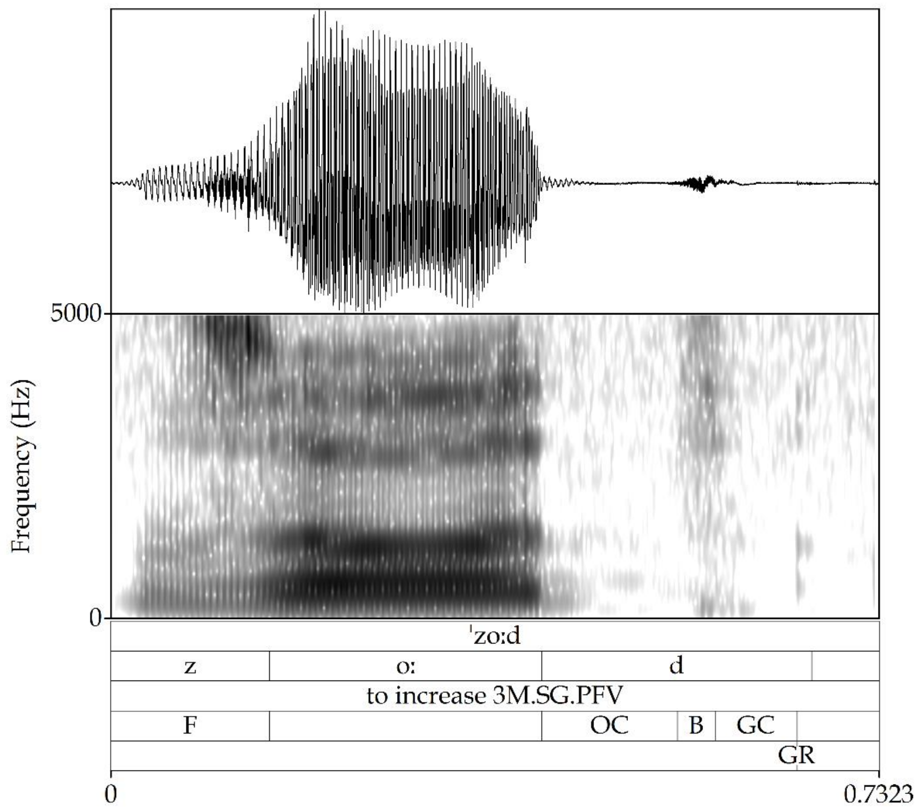

Figure 6.24: Voiced /z/ in /ˈzoːd/ - [ˈzoːt̪ʼ] ‘to increase 3M.SG.PFV’.

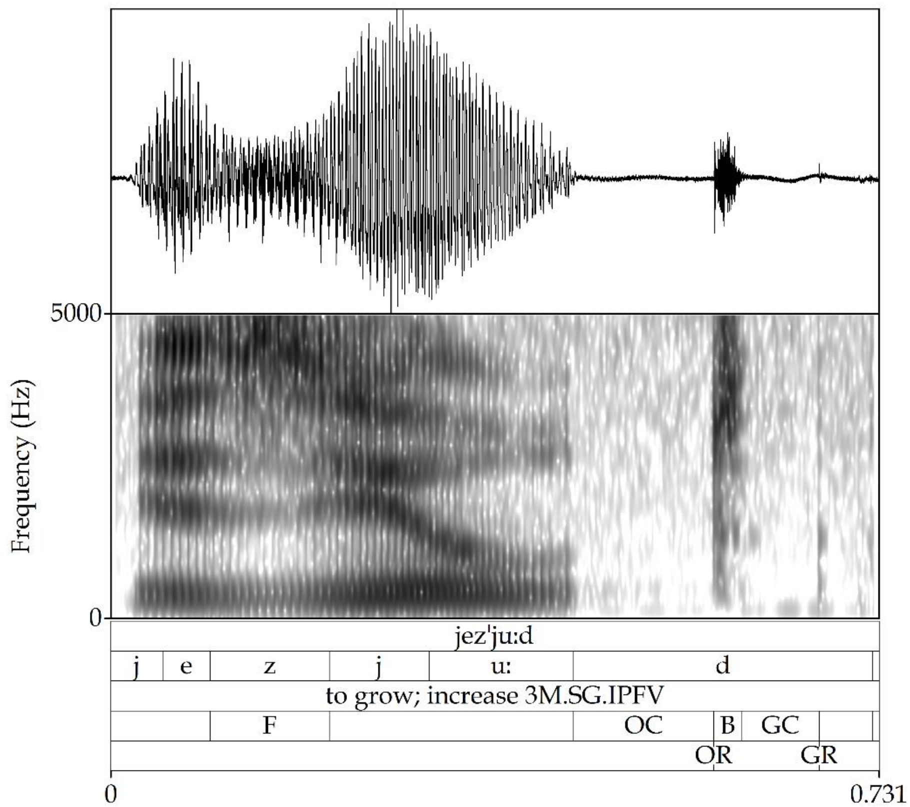

Figure 6.25: Voiced /z/ in /jezˈjuːd/ - [jəz.ˈjuːt̪ʼ] ‘to grow; increase 3M.SG.IPFV’.

In utterance-final position, the voiced alveolar fricative /z/ undergoes devoicing as for other voiced obstruents and is frequently realised as an ejective. The articulation of /z/ in this position is similar to that of the emphatic alveolar fricative /sˤ/. As can be seen in Figure 6.26, /z/ in utterance-final position is devoiced as energy in the lower formants is not visible in the spectrogram. The frication period of the segment is followed by a silent period indicating glottal closure. The closure is followed by a sharp spike indicating glottal release at the end of the segment. The articulation exhibited in Figure 6.26 below is similar to that of the emphatic alveolar fricative /sˤ/ in utterance-final position in Figure 6.11. Some tokens of the voiced alveolar /z/ in utterance-final position were preceded by a short period of pre-glottalisation.

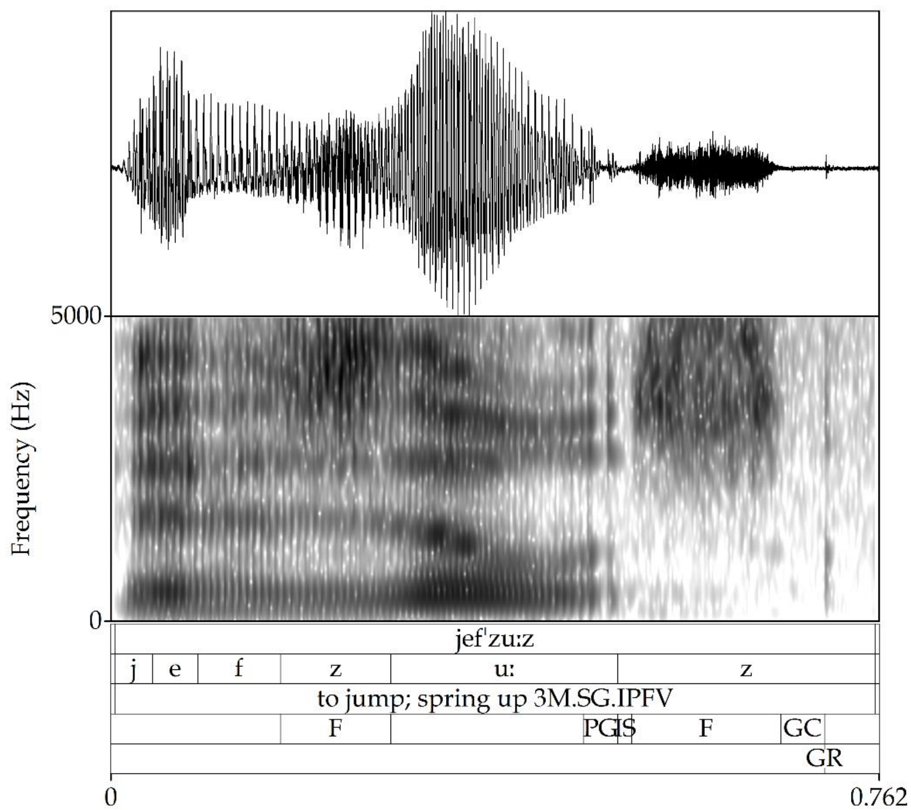

Figure 6.26: Voiced /z/ in /jefˈzuːz/ - [jəf.ˈzuːs’] ‘to jump; spring up 3M.SG.IPFV’.

6.3.1.3. Voiceless Fricatives

The voiceless fricatives that have emphatic fricative counterparts in Ḥarsūsi are interdental /θ/, alveolar /s/, palato-alveolar /ʃ/, and alveolar lateral /ɬ/. The realisation of each of these segments is discussed in turn in the following sections.

6.3.1.3.1. Interdental /θ/

As mentioned in 4.1.2, the voiceless interdental /θ/ has only one allophone that occurs in all environments. It is realised as a voiceless fricative in all the positions investigated in this study. Figure 6.27 and Figure 6.28 below show the voiceless interdental /θ/ in utterance-initial and medial positions, respectively. As can be seen, in these two positions, the interdental /θ/ includes no glottal activity as no energy can be seen in the lower formants in the spectrograms. In terms of frication, the voiceless interdental /θ/ is fully fricated throughout its period and no silent lags can be seen during its articulation in utterance-initial and medial positions.

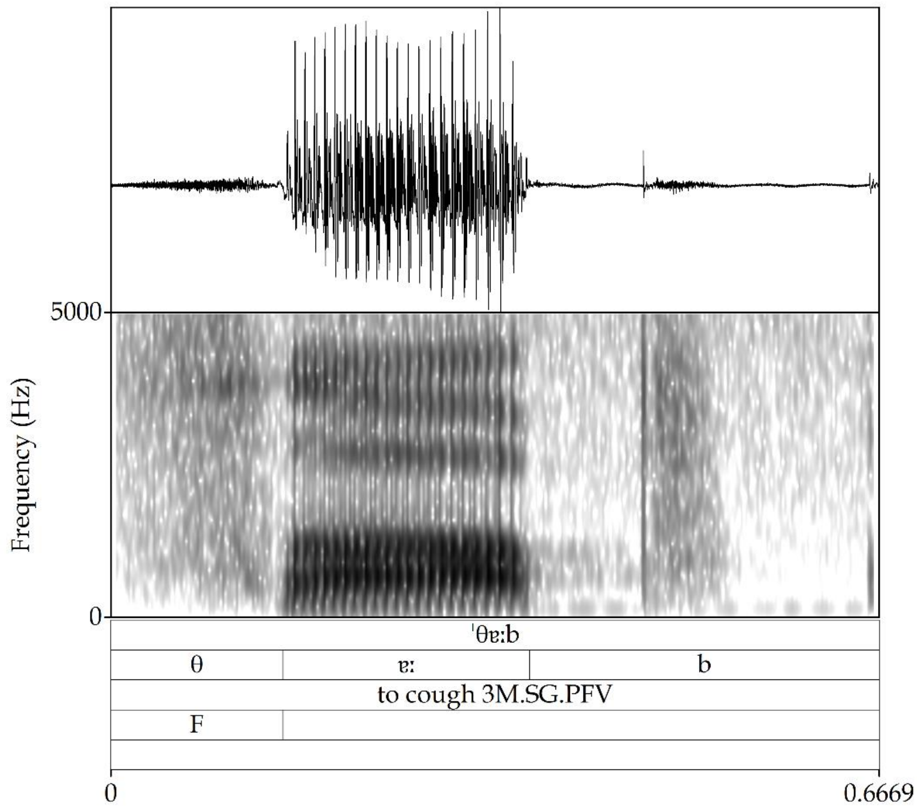

Figure 6.27: Voiceless /θ/ in /ˈθɐːb/ - [ˈθɑːp’] ‘to cough 3M.SG.IPFV’.

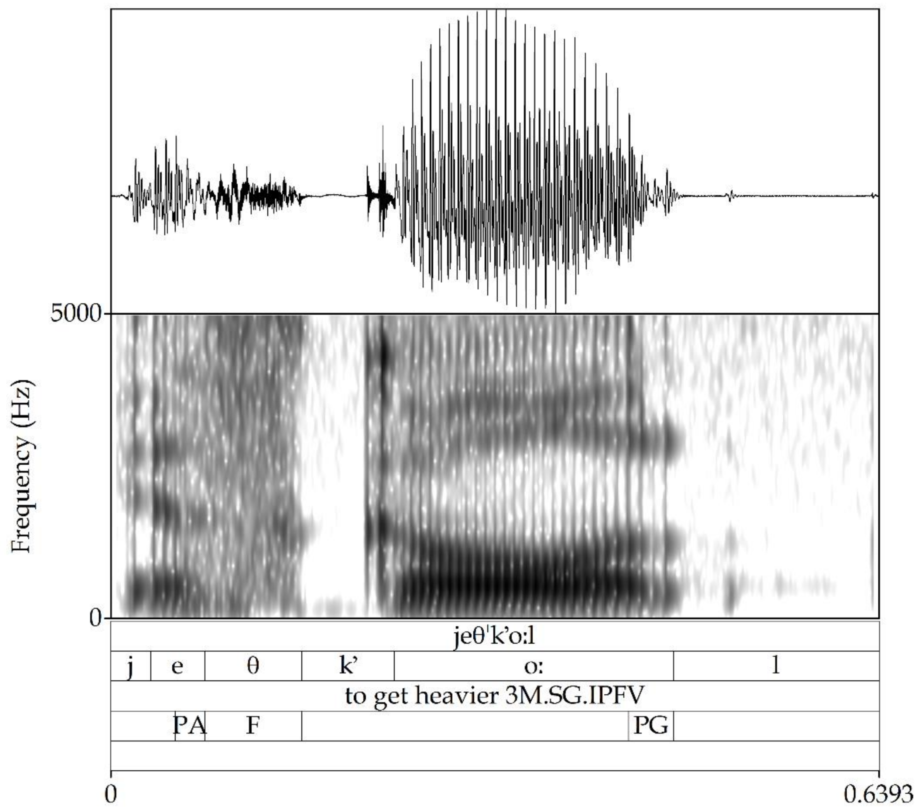

Figure 6.28: Voiceless /θ/ in /jeθˈk’oːl/ - [jəθ.ˈk’o̠ːl] ‘to get heavier 3M.SG.IPFV’.

In utterance-final position, the voiceless interdental /θ/ is realised as a voiceless fricative with full frication. As can be seen in Figure 6.29 below, no silent lags or energy in the lower formants can be seen in the spectrogram suggesting full frication and a voiceless realisation.

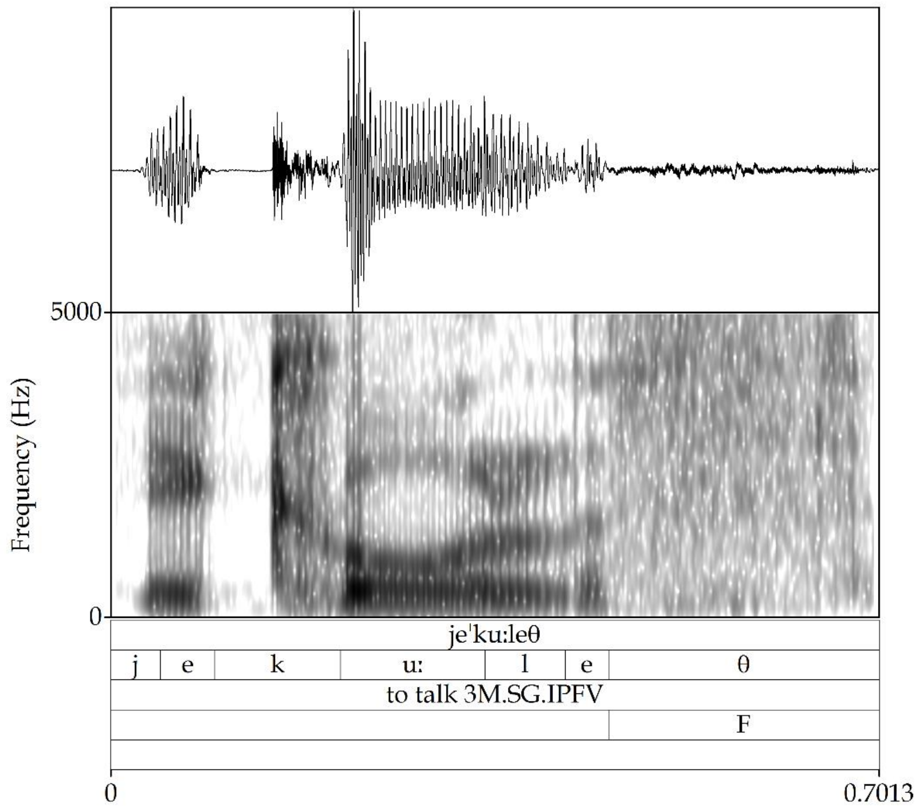

Figure 6.29: Voiceless /θ/ in /jeˈkuːleθ/ - [jə.ˈkuː.ləθ] ‘to talk 3M.SG.IPFV’.

It should be noted here that only three tokens of the voiceless interdental /θ/ included pre- or post-frication silent lags. In addition, few tokens also were preceded with short periods of pre-aspiration (PA).

6.3.1.3.2. Alveolar /s/

The voiceless alveolar fricative /s/ is realised as a voiceless fricative [s] in all positions in the data. None of the tokens investigated in the data showed any other realisation in any position. Figure 6.30, Figure 6.31, and Figure 6.32 below show the voiceless alveolar fricative /s/ in utterance-initial, medial and final positions, respectively. A few tokens showed a short period of "glottal frication" (Hejná, 2023, p. 1876) which were marked as pre-aspiration (PA) as can be seen in Figure 6.32 below.

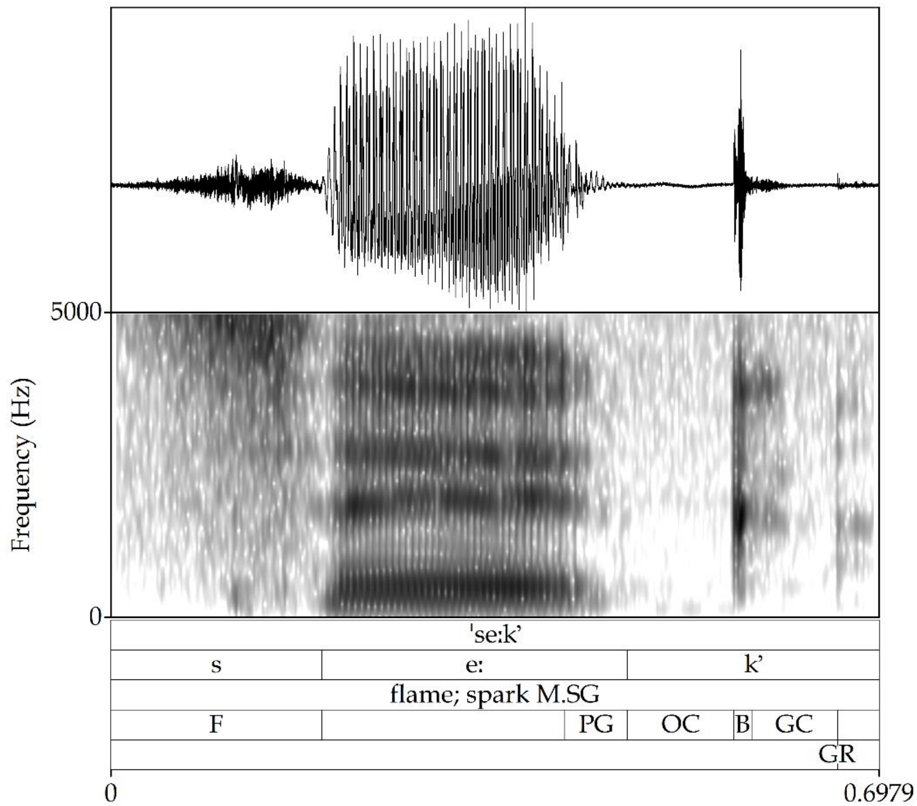

Figure 6.30: Voiceless /s/ in /ˈseːk'/ - [ˈseːk'] 'flame; spark M.SG'.

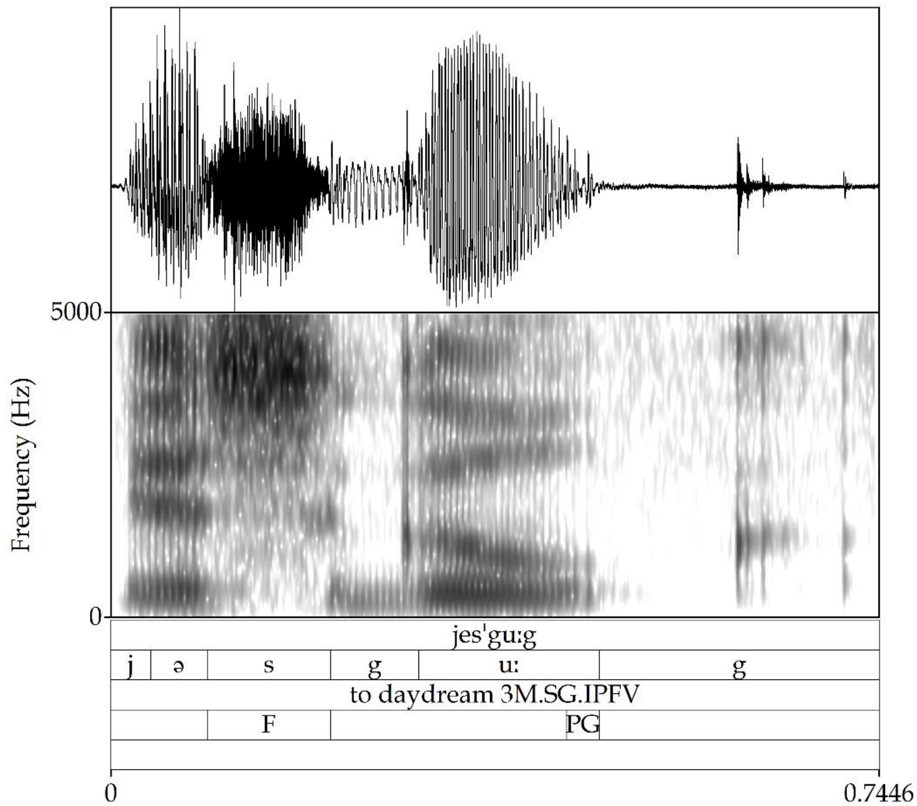

Figure 6.31: Voiceless /s/ in /jesˈguːg/ - [jəs.ˈguːk’] ‘to daydream 3M.SG.IPFV’.

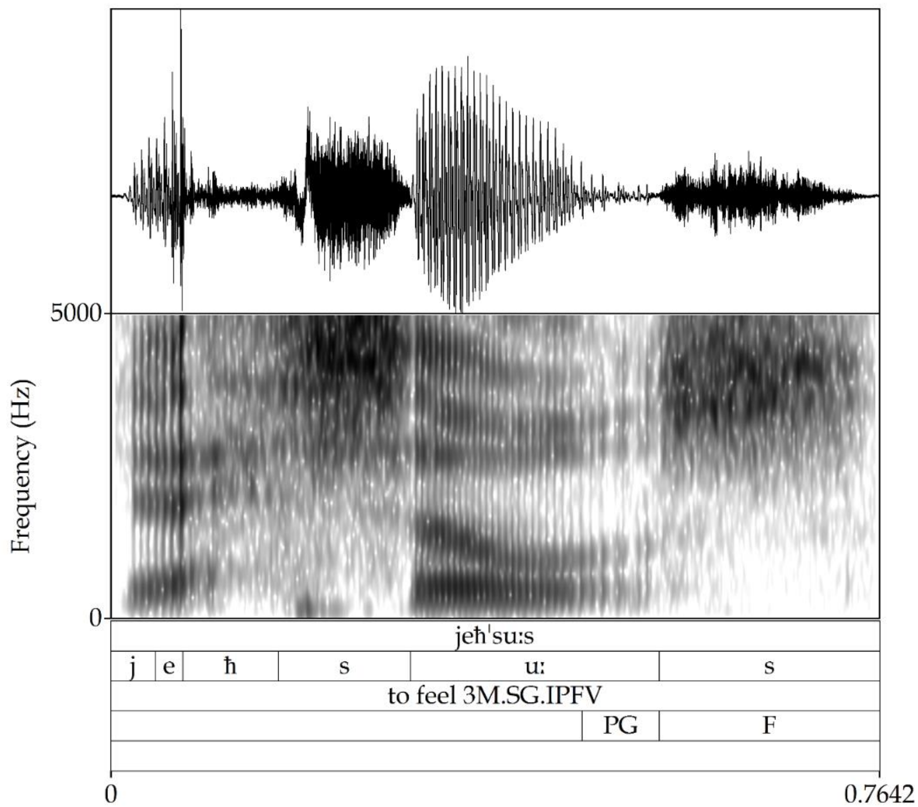

Figure 6.32: Voiceless /s/ in /jeħˈsuːs/ - [jəħ.ˈsuːs] ‘to feel 3M.SG.IPFV’.

In terms of silent lags, 10 tokens in the data included short silent lags but mainly in utterance-initial position. The lags were not fully silent as minor energy could still be seen, as in Figure 6.33 below.

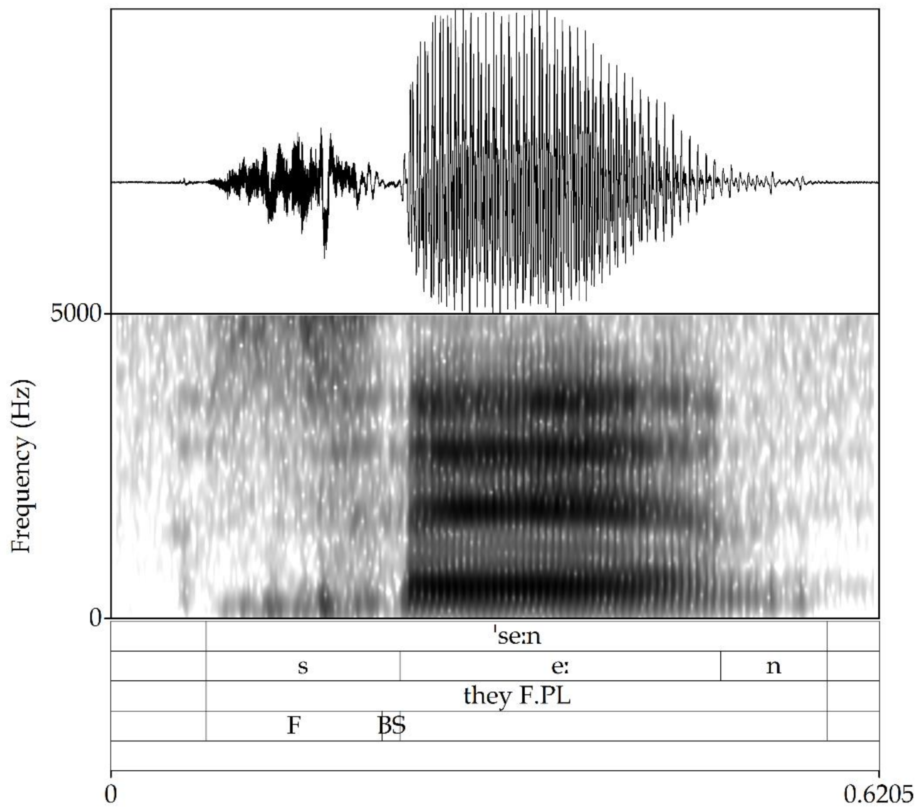

Figure 6.33: Voiceless /s/ in /ˈseːn/ - [ˈseːn] ‘they F.PL’ with lag.

6.3.1.3.3. Palato-alveolar /ʃ/

The voiceless palato-alveolar fricative /ʃ/ has only one allophone that occurs in all environments. It is realised as a voiceless fricative [ʃ] in all positions investigated in this study. In utterance-initial position, as can be seen in Figure 6.34 below, no energy can be seen in the lower formants in the spectrogram indicating lack of glottal activity during its articulation. In addition, frication can be seen to be continuous throughout the segment with no silent lags.

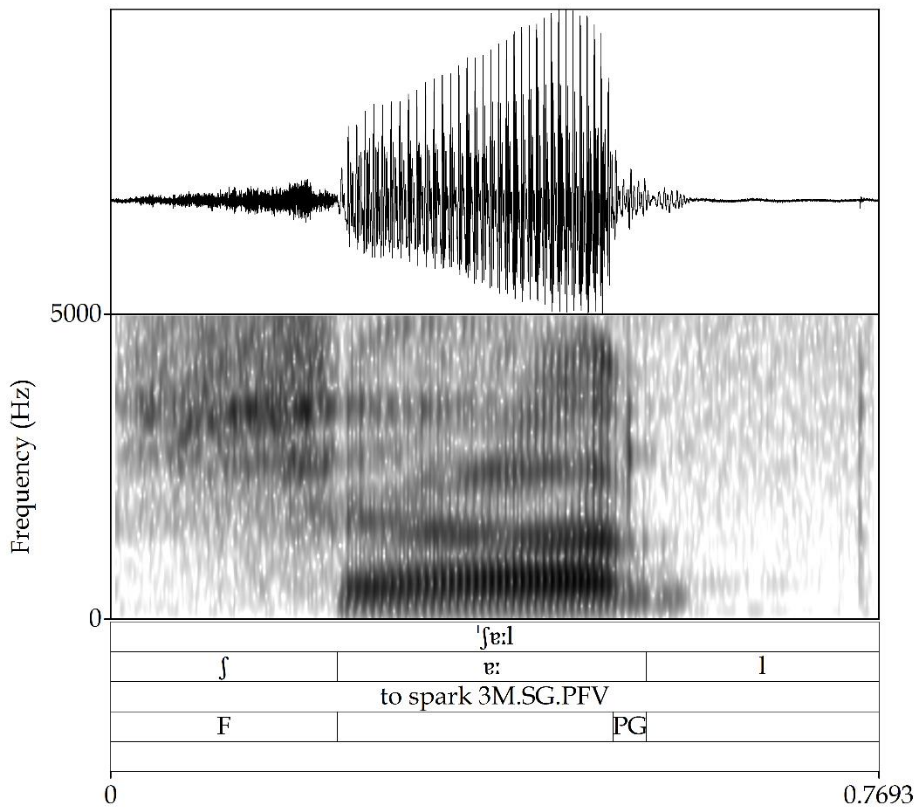

Figure 6.34: Voiceless /ʃ/ in /ˈʃɐːl/ - [ˈʃɐːl] ‘to spark 3M.SG.PFV’.

In utterance-medial and final positions, the voiceless palato-alveolar fricative /ʃ/ is realised as a voiceless fricative with frication continuous throughout the segment as can be seen in Figure 6.35 and Figure 6.36 below.

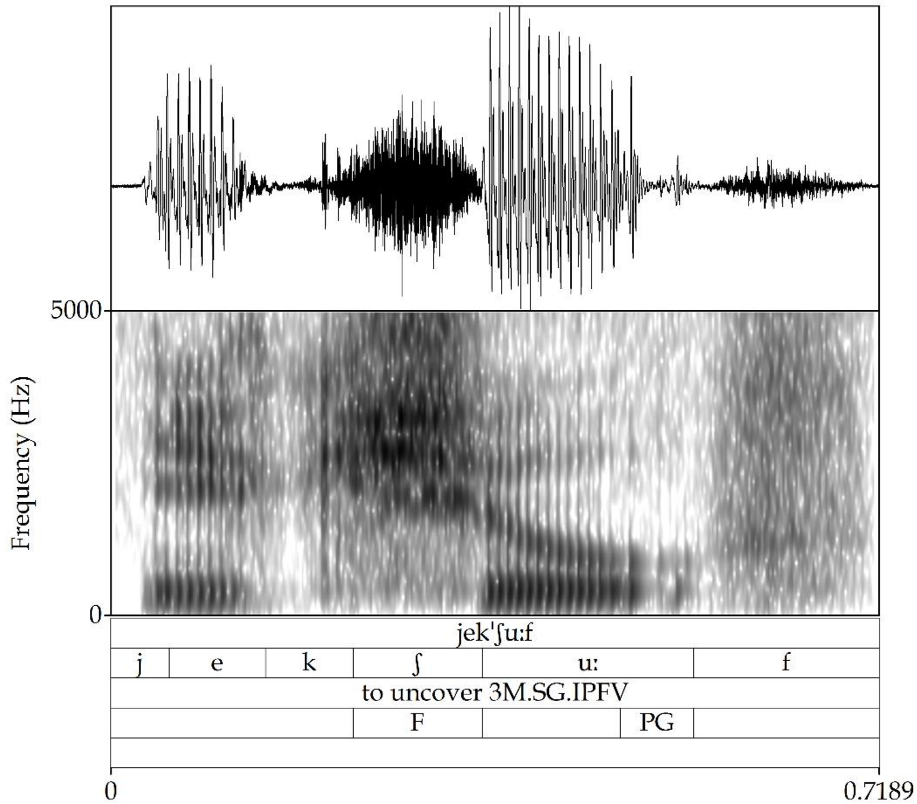

Figure 6.35: Voiceless /ʃ/ in /jekˈʃuːf/ - [jək.ˈʃuːf] ‘to uncover 3M.SG.IPFV’.

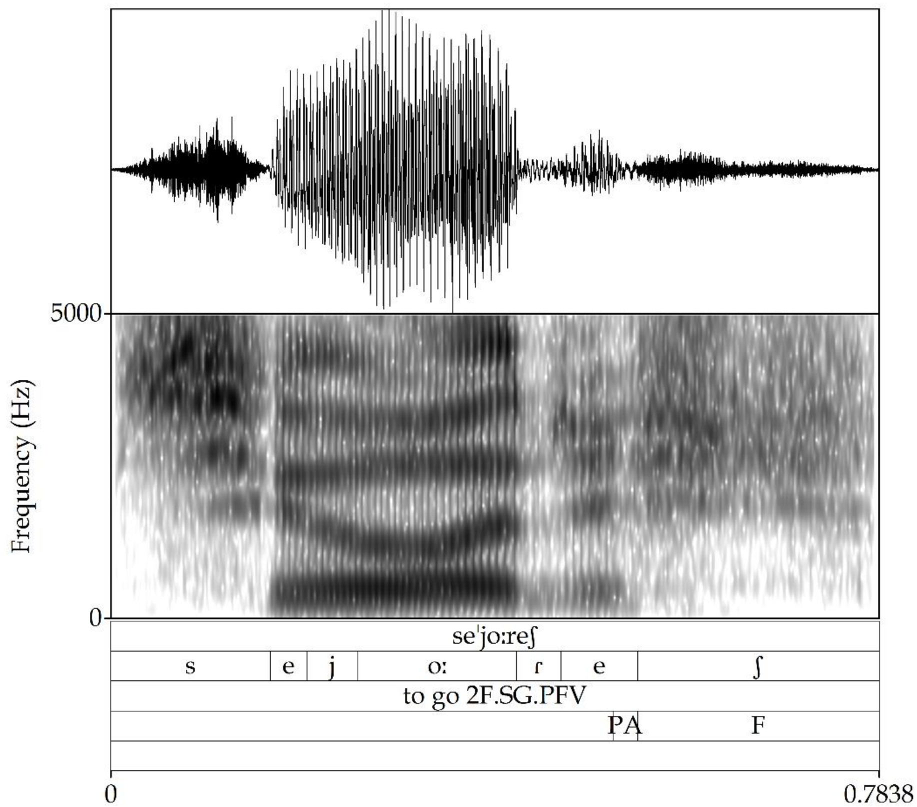

Figure 6.36: Voiceless /ʃ/ in /seˈjoːɾeʃ/ - [sə.ˈjoː.ɾəʃ] ‘to go 2M.SG.PFV’.

Only three tokens in the data included short post-frication silent lags in utterance-initial position.A number of tokens in the data were preceded by short periods of either pre-aspiration (PA) or pre-glottalisation (PG).

6.3.1.3.4. Alveolar lateral /ɬ/

The alveolar lateral /ɬ/ is realised as a voiceless fricative in all environments. Detailed inspection of spectrograms and waveforms showed that it does not become voiced in any position as energy in the lower formants cannot be seen in the spectrogram. However, in some tokens and especially in utterance-initial positions, it is realised with a rather weak initial oral release preceding the full frication period. This release was also found in some tokens in other positions, although it was more common and systematic in utterance-initial position, as can be seen in Figure 6.37 below.

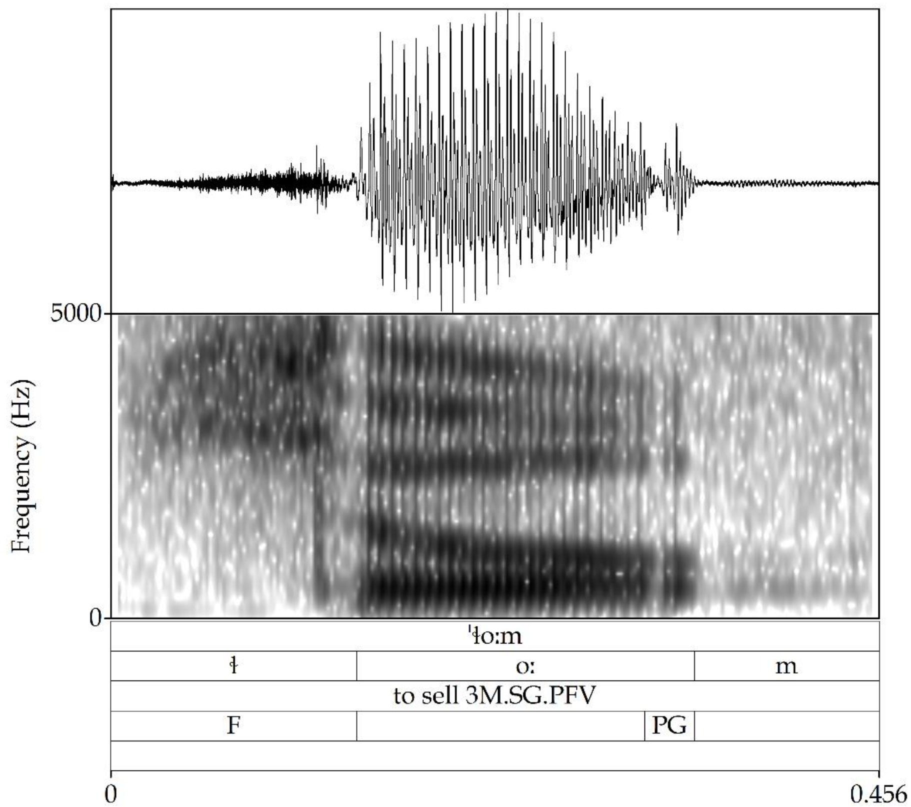

Figure 6.37: Voiceless /ɬ/ in /ˈɬoːm/ - [ˈɬoːm] ‘to sell 3M.SG.PFV’.

Similarly, in utterance-medial and final positions, /ɬ/ is realised as a voiceless fricative with no glottal activity during its articulation as can be seen in Figure 6.38 and Figure 6.39 below.

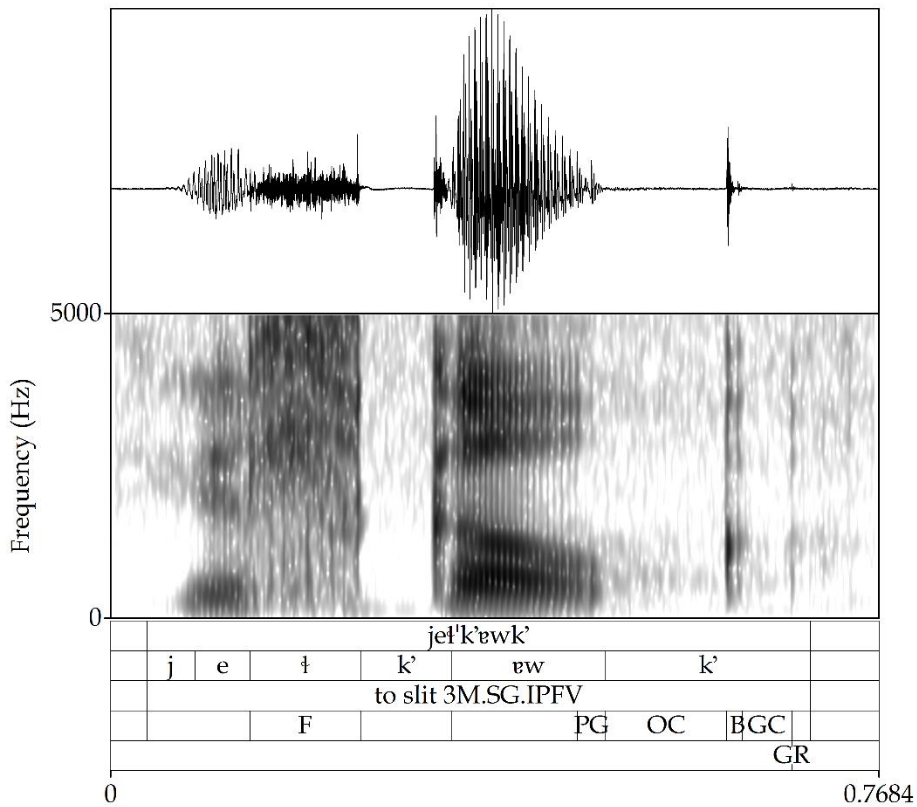

Figure 6.38: Voiceless /ɬ/ in /jeɬˈk’ɐwk’/ - [jəɬ.kˤɑuk’] ‘to slit 3M.SG.IPFV’.

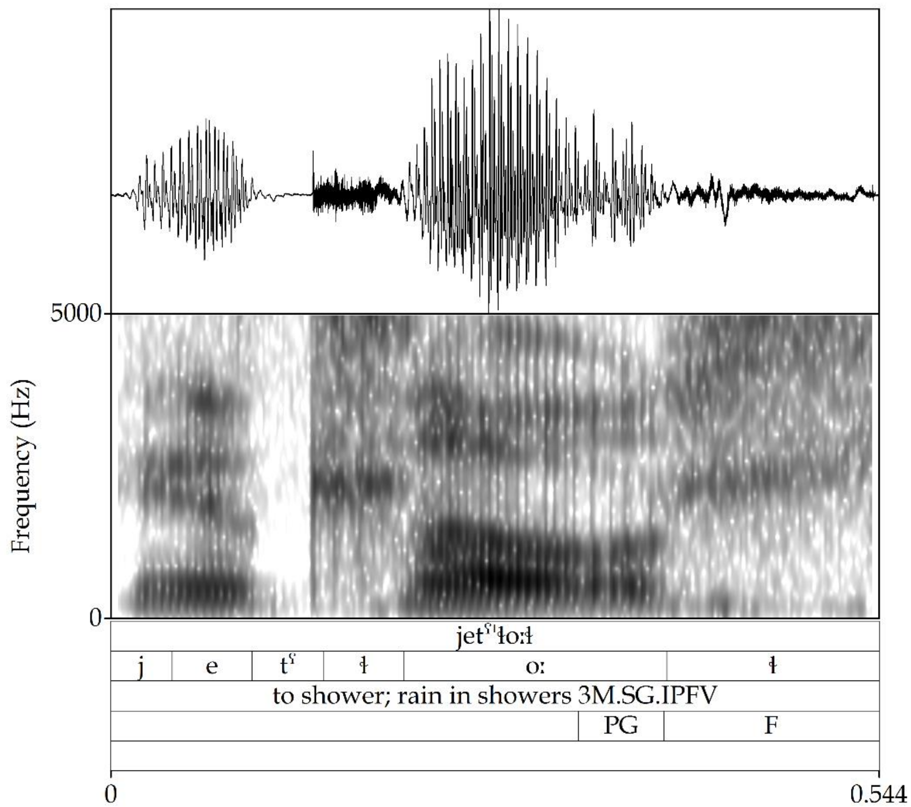

Figure 6.39: Voiceless /ɬ/ in /jetˤˈɬoːɬ/ - [jətˤˈɬoːɬ] ‘to shower; rain in showers 3M.SG.IPFV’.

In terms of silent lags, eight tokens included pre- or post-frication silent lags. In addition, a number of the tokens were preceded with short periods of either pre-aspiration (PA) or pre-glottalisation (PG) mainly, but not exclusively in utterance-final position.

6.3.1.4. Summary

In short, based on the visual inspection of spectrograms and waveforms, it can be speculated that the Ḥarsūsi emphatics are not realised as ejectives except in utterance-final position. The parameters associated with ejectives, and especially the glottal closure and release, were not seen to occur systematically in any Ḥarsūsi emphatics in any other position. Manual comparisons of overall duration and frication duration of emphatics and their plain counterparts from randomly selected samples showed the emphatics to have shorter durations in general.

An interesting observation regarding Ḥarsūsi fricatives was the similar patterning of emphatics and their voiced counterparts in utterance-final position. Both types of segments typically showed a glottal closure followed by a glottal release in this position unlike the voiceless segments which had longer continuous frication durations.

As a result of such observations, further investigations were conducted to get more accurate and reliable results based on statistical evidence. The following section presents the results of the statistical analyses conducted on Ḥarsūsi fricatives.

6.3.2. Statistical Analyses

The results of the Pearson correlation test assessing the linear relationship between the dependent variables showed significant correlations between the various dependent variables. The results are summarised in Table 6.3 below.

Parameter1	Parameter2	r	95% CI	t	df	p
Fricative Duration	*Frication Duration*	0.85	0.84, 0.85	92.10	3381	< .001***
Fricative Duration	*Frication Intensity*	-0.25	-0.28, -0.22	-15.25	3381	< .001***
Fricative Duration	*CoG*	0.35	0.32, 0.38	21.57	3380	< .001***
Frication Duration	*Frication Intensity*	-0.17	-0.20, -0.14	-10.17	3381	< .001***
Frication Duration	*CoG*	0.21	0.17, 0.24	12.27	3380	< .001***
Frication Intensity	*CoG*	-0.77	-0.78, -0.75	-69.90	3380	< .001***

Table 6.3: Dependent variables correlation coefficient results.

The results of the acoustic cues of Ḥarsūsi fricatives - fricative overall duration, frication duration, frication intensity, number of pre- or post-frication silent lags, and CoG, are given below.

6.3.2.1. Fricative Overall Duration

Fricatives overall duration distribution in the data is given below in Figure 6.40.

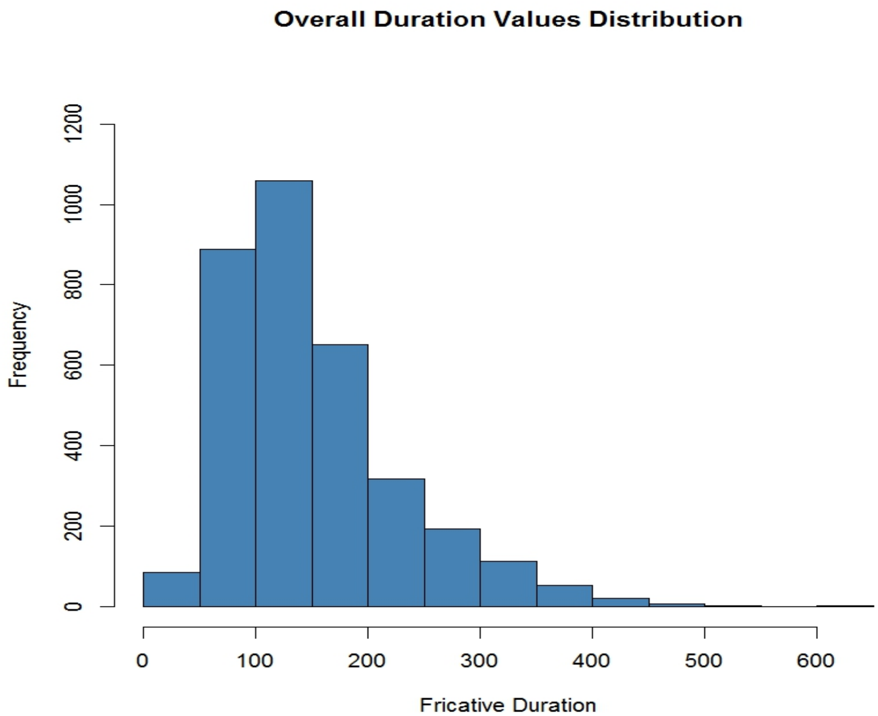

Figure 6.40: Fricative durations distribution.

6.1Impressionistic analysis suggests that the overall duration is shorter in emphatic fricatives compared to their plain counterparts. Figure 6.41 below of target segment overall duration values shows that the observation is robust across the data. The emphatic fricatives had the shortest overall duration (mean = 132.16 ms) followed by the voiced fricatives (mean = 148.5 ms). The voiceless fricatives had the longest overall duration (mean = 165.9 ms).

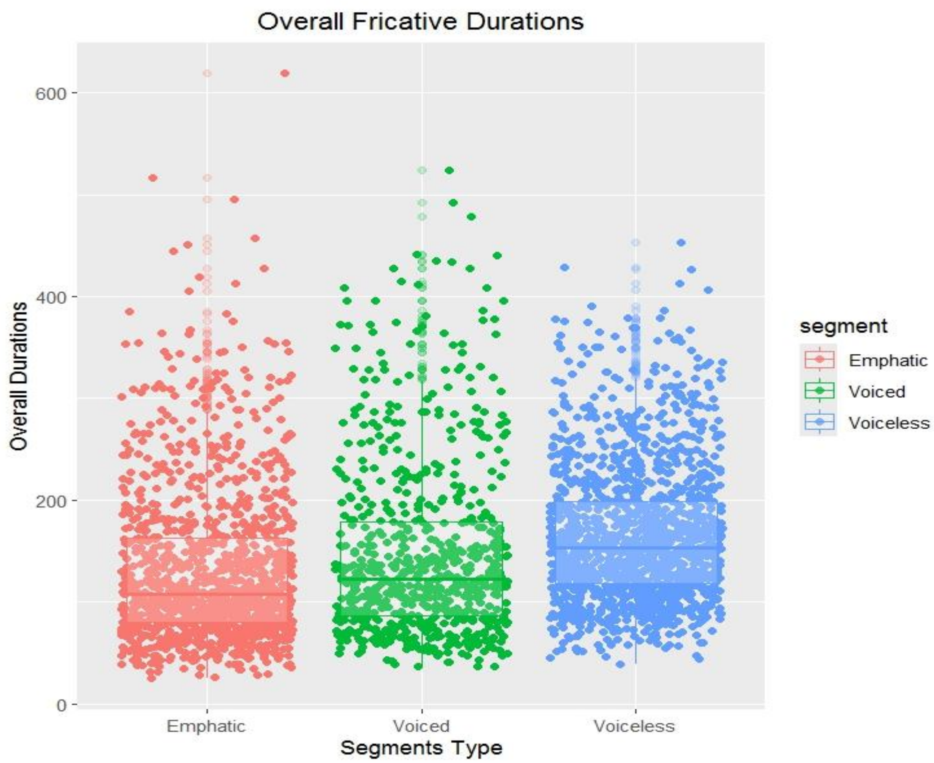

Figure 6.41: Overall duration values by segment type.

Results for the overall duration of fricatives in various positions showed they all had shorter durations in utterance-initial and medial positions compared to utterance-final position. The shortest durations were found in utterance-medial position. Figure 6.42 shows the target segment overall duration values in the various positions.

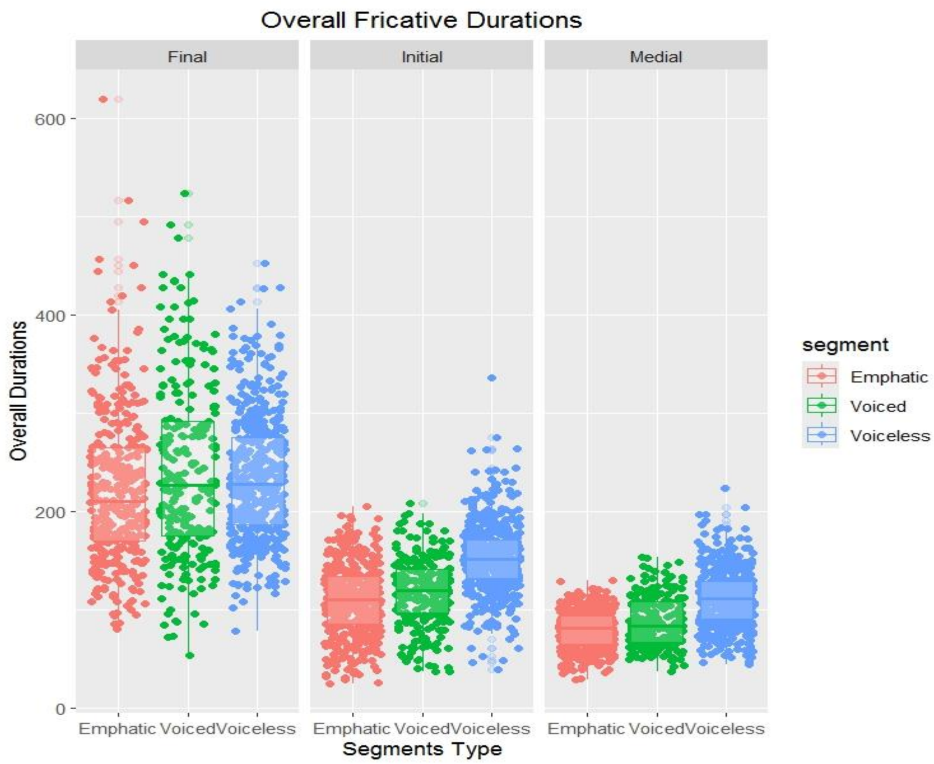

Figure 6.42: Overall duration values by segment type and position.

The mean duration values of the emphatics were shorter than the mean values of the plain counterparts in all positions. In utterance-initial and medial positions, the voiceless fricatives had the longest overall durations, while in utterance-final position, the voiced fricatives had the longest overall durations. This was contrary to the study expectations based on the impressionistic results which expected the emphatics to have the longest duration in utterance-final position, as mentioned in 6.1.

Based on syllable type, the overall duration of fricatives heading stressed syllables was found to be longer for all types of segments than overall durations of fricatives heading unstressed syllables. The distributions of overall durations of segments in both stressed and unstressed syllables are given in Figure 6.43 below. The emphatics had the shortest overall duration in both stressed and unstressed syllables compared to their plain counterparts. The voiceless fricatives had the longest overall duration in both stressed and unstressed syllables.

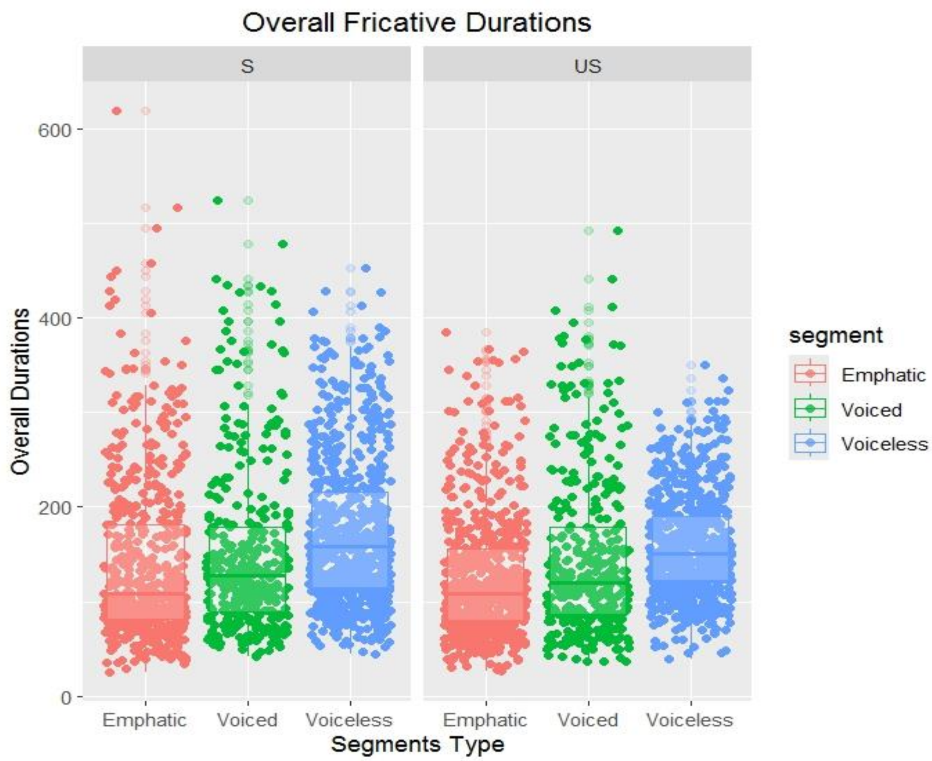

Figure 6.43: Overall duration values by segment and syllable type.

Linear mixed-effects model results for fricative overall duration confirmed the observation of emphatics having a shorter overall duration, but in certain positions only. The results showed a significant effect of segment position, syllable type, and place of articulation on the overall duration of the fricative. The results showed overall duration to be significantly affected by the position of the segment. The overall duration of the segment in initial position was found to be significantly shorter than in final position, b = -108.801, t(125.059) = -13.808, $p<0.001$. Likewise, the overall duration in medial position was significantly shorter than in final position, b = -135.914, t(1094.934) = -25.682, $p<0.001$. For syllable type, overall fricative duration in unstressed syllables was significantly shorter than overall fricative duration in stressed syllables, b = -12.867, t(125.170) = -3.066, $p<0.01$. For place of articulation, overall fricative duration was found to be significantly shorter only in interdental position compared to alveolar position, b = -27.183, t(100.117) = -4.973, $p<0.001$. Figure 6.44 below shows the results of the linear mixed-effects model for fricative overall duration.

	segment_duration		
Predictors	*Estimates*	*CI*	*p*
(Intercept)	237.67	222.76 – 252.58	**<0.001**
segment [Voiced]	15.64	-1.96 – 33.24	0.082
segment [Voiceless]	8.08	-6.36 – 22.51	0.273
position [Initial]	-108.80	-124.25 – -93.35	**<0.001**
position [Medial]	-135.91	-146.29 – -125.54	**<0.001**
stress [US]	-12.87	-21.10 – -4.64	**0.002**
place [alveolar_lateral]	-7.28	-19.82 – 5.26	0.255
place [interdental]	-27.18	-37.90 – -16.47	**<0.001**
place [palato_alveolar]	-3.76	-17.86 – 10.34	0.601
segment [Voiced] * position [Initial]	-6.06	-31.83 – 19.72	0.645
segment [Voiceless] * position [Initial]	31.01	9.82 – 52.21	**0.004**
segment [Voiced] * position [Medial]	2.49	-14.18 – 19.15	0.770
segment [Voiceless] * position [Medial]	26.58	12.23 – 40.93	**<0.001**
Random Effects			
σ^2	1750.01		
$\tau_{00\ word}$	449.40		
$\tau_{00\ participant}$	112.15		
ICC	0.24		
$N_{participant}$	10		
N_{word}	107		
Observations	3382		
Marginal R^2 / Conditional R^2	0.578 / 0.681		

Figure 6.44: Fricative overall duration model: lmer (segment_duration ~ segment * position + place + stress + (1|participant) + (1|word), data = Overall_model, REML = FALSE) summary results.

The post-hoc pairwise comparison test showed overall fricative duration to be significantly different between some of the segments in various positions. Table 6.4 below shows the significant pairwise comparisons in various positions.

Position	Segment Pair	b	DF	t-ratio	P value
Initial	Emphatic*Voiceless	-39.09	122	-4.886	< **0.01**
	Voiced*Voiceless	-29.51	121	-2.936	< **0.05**
Medial	Emphatic*Voiceless	-34.65	168	-4.815	**< 0.001**

Table 6.4: Pairwise comparisons for fricative overall duration by segment type.

As can be seen in Table 6.4 above, overall fricative duration was significantly shorter in utterance-initial position in emphatic and voiced fricatives than in voiceless fricatives. In utterance-medial position, the significant difference was only between emphatic and voiceless fricatives. The differences in overall fricative duration in utterance-final position were not significantly different between the different types of segments.

6.3.2.2. Frication Duration

The distribution of frication duration is given below in Figure 6.45.

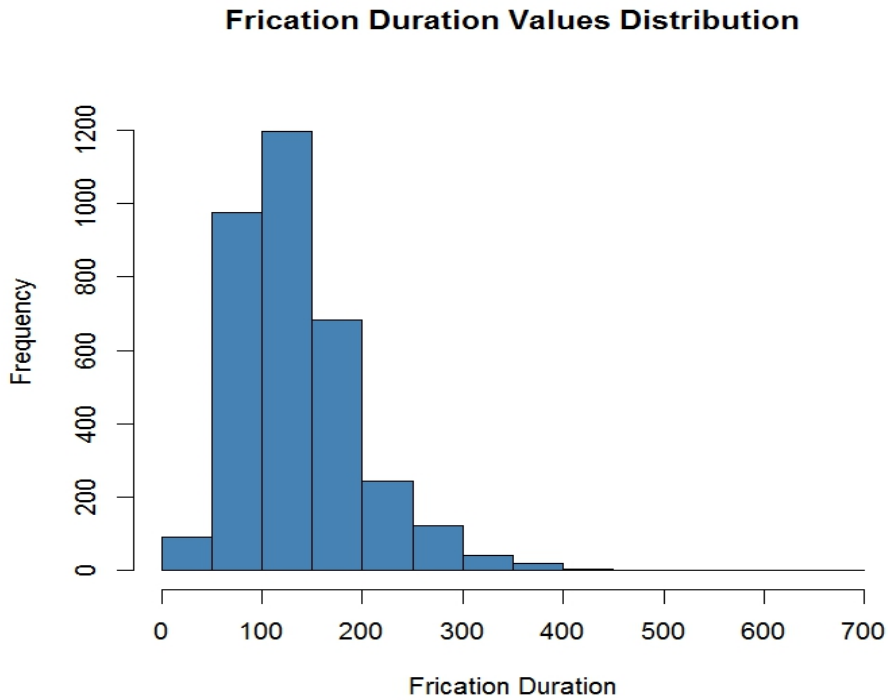

Figure 6.45: Frication durations distribution.

The observation of emphatic fricatives having a shorter frication duration seems to be robust across the data. The emphatic fricatives had the shortest frication durations (mean = 110.11 ms) followed by the voiced fricatives (mean = 122.42 ms), while the voiceless had the longest frication duration values (mean = 162.48 ms). The frication duration values of the emphatic and voiced were closer to each other compared to the voiceless fricatives.

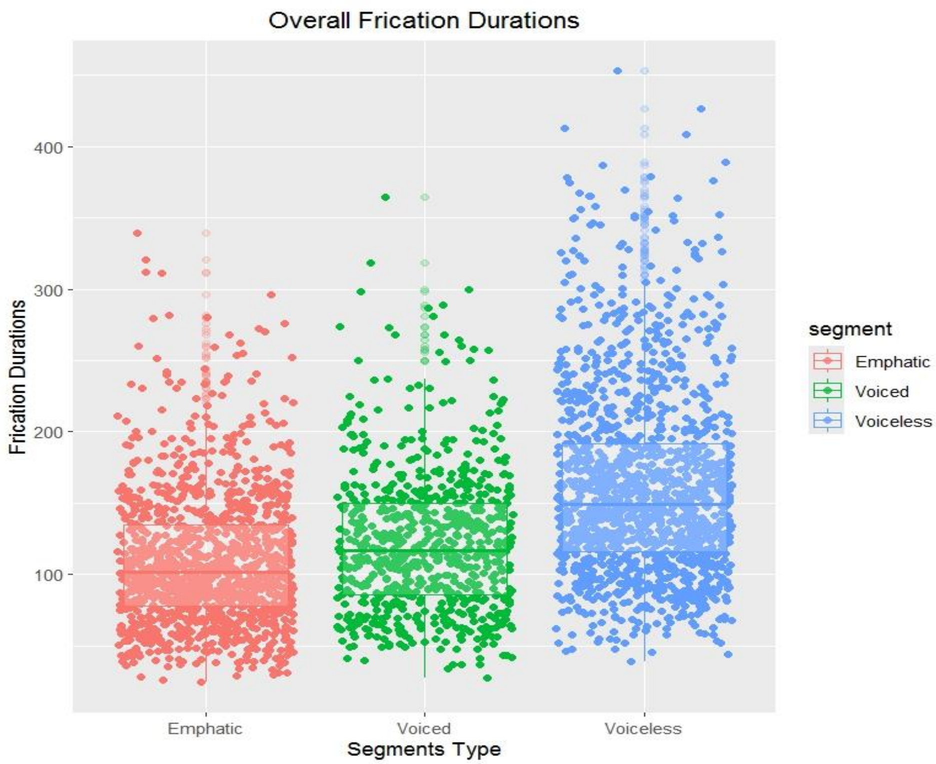

Figure 6.46: Frication duration values by segment type.

When distributed by position, the longest frication durations for fricatives were found in utterance-final position, with the shortest frication durations in utterance-medial position. Figure 6.47 shows the frication duration values of the different types of segments in utterance-initial, medial, and final positions. The emphatic fricatives had the shortest frication durations in all positions. The voiceless fricatives had the longest frication durations in all positions.

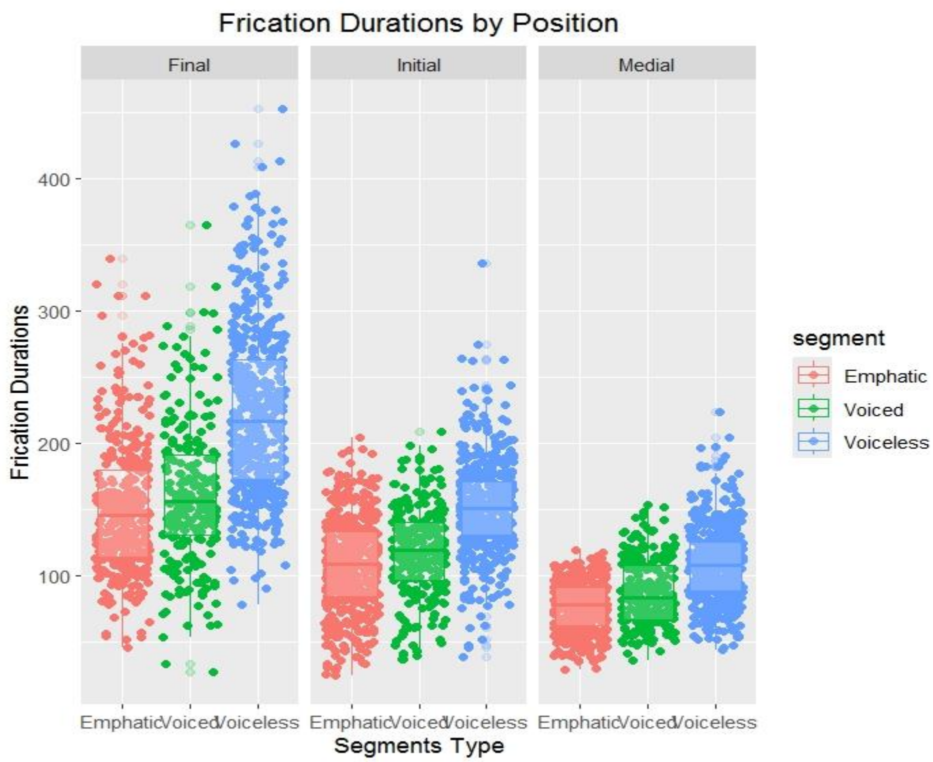

Figure 6.47: Frication duration values by segment and position type.

Figure 6.48 shows the frication duration values of the fricatives in stressed and unstressed syllables. All types of fricatives had longest frication durations in stressed syllables compared to unstressed syllables. Emphatic fricatives had the shortest frication durations followed by voiced fricatives with slightly higher values in both stressed and unstressed syllables, while voiceless fricatives had the longest frication durations.

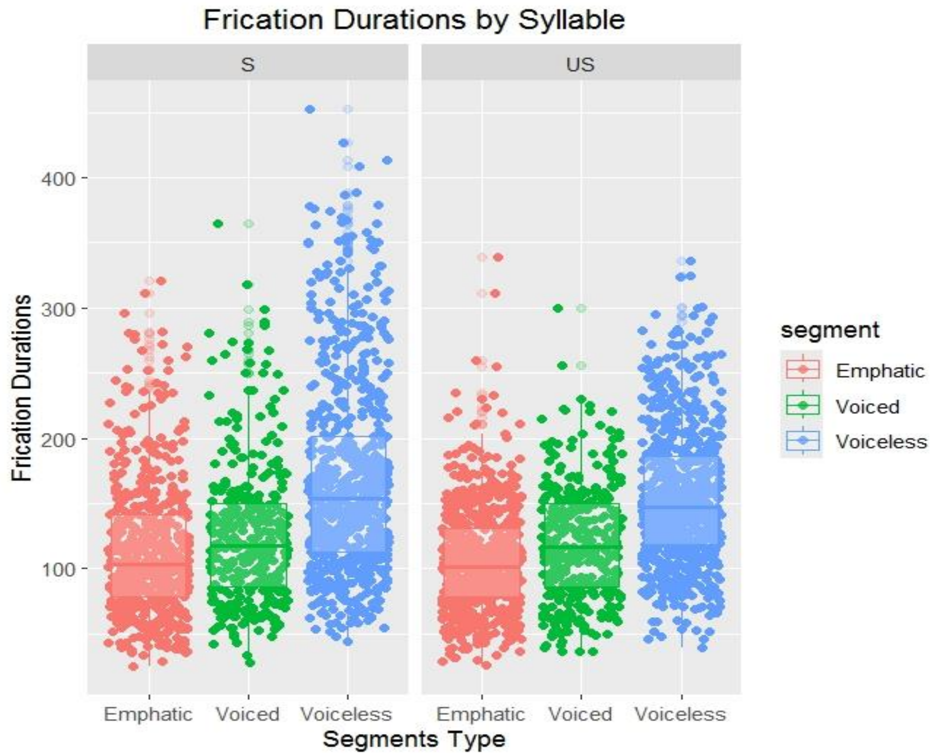

Figure 6.48: Frication duration values by segment and syllable type.

The results of the linear mixed-effects model for frication duration proved the observed patterns to be correct. They showed a significant effect of a number of variables; nonetheless, not all levels of certain variables were found to be significant. For instance, the frication duration of voiceless fricatives was significantly longer than the frication duration of the emphatic fricatives, b = 68.041, t(137.967) = 9.209, $p<0.001$. However, the frication duration of voiced fricatives was not significantly different from the frication duration of the emphatic fricatives, b = 7.087, t(129.525) = 0.782, $p = 0.435$. The results also showed frication duration to be significantly affected by the position of the segment. The frication duration of segments in initial position was found to be significantly shorter than in final position, b = -35.368, t(114.051) = -4.377, *p*<0.001. Similarly, frication duration in medial position was significantly shorter than in final position, b = -59.501, t(1782.127) = -13.026, *p*<0.001. In terms of syllable type, frication duration in unstressed syllables was significantly shorter than in stressed syllables, b = -11.714, t(138.323) = -2.750, *p*<0.01. In terms of place of articulation, frication duration was found to be significantly shorter in interdental position compared to alveolar position, b = -30.677, t(96.188) = -5.343, *p*<0.001. In addition, frication duration was found to be significantly shorter in alveolar lateral position compared to alveolar position, b = -13.774, t(96.851) = -2.053, *p*<0.05. Figure 6.49 shows the results of the linear mixed-effects model for fricative frication duration.

	Fric_duration		
Predictors	*Estimates*	*CI*	*p*
(Intercept)	165.18	150.23 – 180.13	**<0.001**
segment [Voiced]	7.09	-10.69 – 24.86	0.434
segment [Voiceless]	68.04	53.56 – 82.53	**<0.001**
position [Initial]	-35.37	-51.21 – -19.52	**<0.001**
position [Medial]	-59.50	-68.46 – -50.54	**<0.001**
stress [US]	-11.71	-20.07 – -3.36	**0.006**
place [alveolar_lateral]	-13.77	-26.93 – -0.62	**0.040**
place [interdental]	-30.68	-41.93 – -19.42	**<0.001**
place [palato_alveolar]	-6.62	-21.42 – 8.18	0.380
segment [Voiced] * position [Initial]	2.72	-23.84 – 29.27	0.841
segment [Voiceless] * position [Initial]	-25.97	-47.68 – -4.25	**0.019**
segment [Voiced] * position [Medial]	11.97	-2.39 – 26.32	0.102
segment [Voiceless] * position [Medial]	-29.97	-42.42 – -17.52	**<0.001**
Random Effects			
σ^2	1159.49		
$\tau_{00\ word}$	521.11		
$\tau_{00\ participant}$	99.20		
ICC	0.35		
$N_{participant}$	10		
N_{word}	107		
Observations	3382		
Marginal R^2 / Conditional R^2	0.481 / 0.662		

Figure 6.49: Frication duration model: lmer (Fric_duration ~ segment * position + stress + place + (1|participant) + (1|word), data = Frication_model, REML = FALSE) summary results.

The post-hoc pairwise comparison test showed frication duration to be significantly different between some of the segments in various positions. Table 6.5 shows the significant pairwise comparisons according to position.

Position	Segment Pair	b	DF	t-ratio	P value
Initial	Emphatic*Voiceless	-42.08	123	-4.776	< **0.001**
	Voiced*Voiceless	-32.27	120	-2.908	< **0.05**
Medial	Emphatic*Voiceless	-38.07	162	-5.007	< **0.001**
Final	Emphatic*Voiceless	-68.04	169	-8.806	< **0.001**
	Voiced*Voiceless	-60.95	158	-6.573	< **0.001**

Table 6.5: Pairwise comparisons for frication duration by segment type.

Table 6.5 shows frication duration to be significantly shorter in utterance-initial position in emphatic and voiced fricatives than in voiceless fricatives. In utterance-medial position, significant difference was only found between emphatic and voiceless fricatives. The differences in frication duration in utterance-final position were only significant between emphatic and voiceless, and voiced and voiceless fricatives, with emphatic and voiced fricatives showing shorter frication duration than voiceless fricatives. Frication duration of emphatic and voiced fricatives was not significantly different in any position.

6.3.2.3. Frication Intensity

Frication intensity values distribution is given below in Figure 6.50.

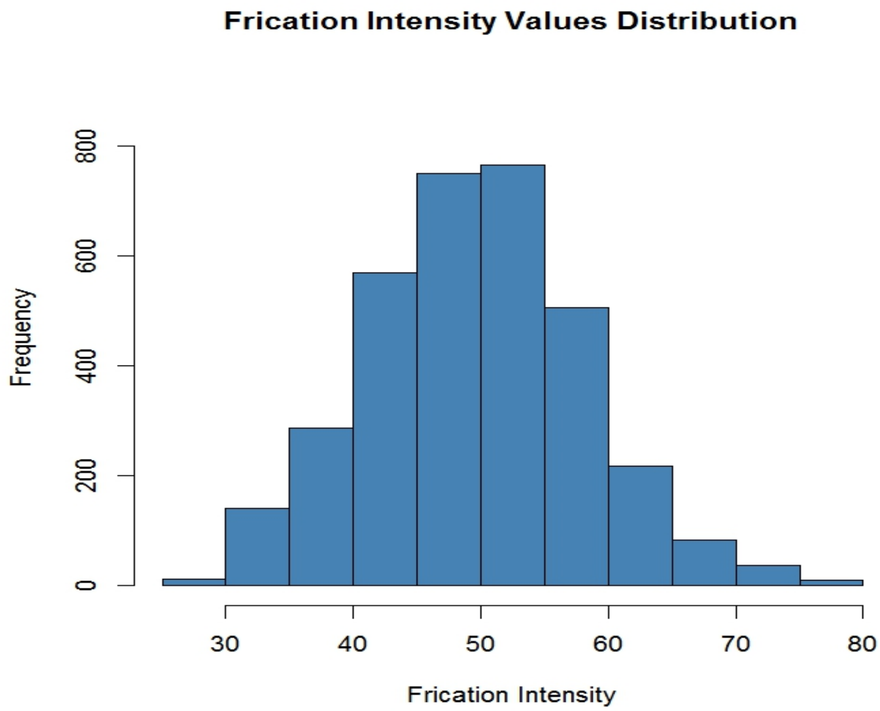

Figure 6.50: Frication intensity values distribution.

The distribution of frication intensity values for all types of fricatives is given in Figure 6.51. The results of frication intensity are in line with the initial observations mentioned above under 6.1 of emphatics having lower intensity values. Even though the values are very close to each other, the emphatics had the lowest frication intensity values among the different types of fricatives.

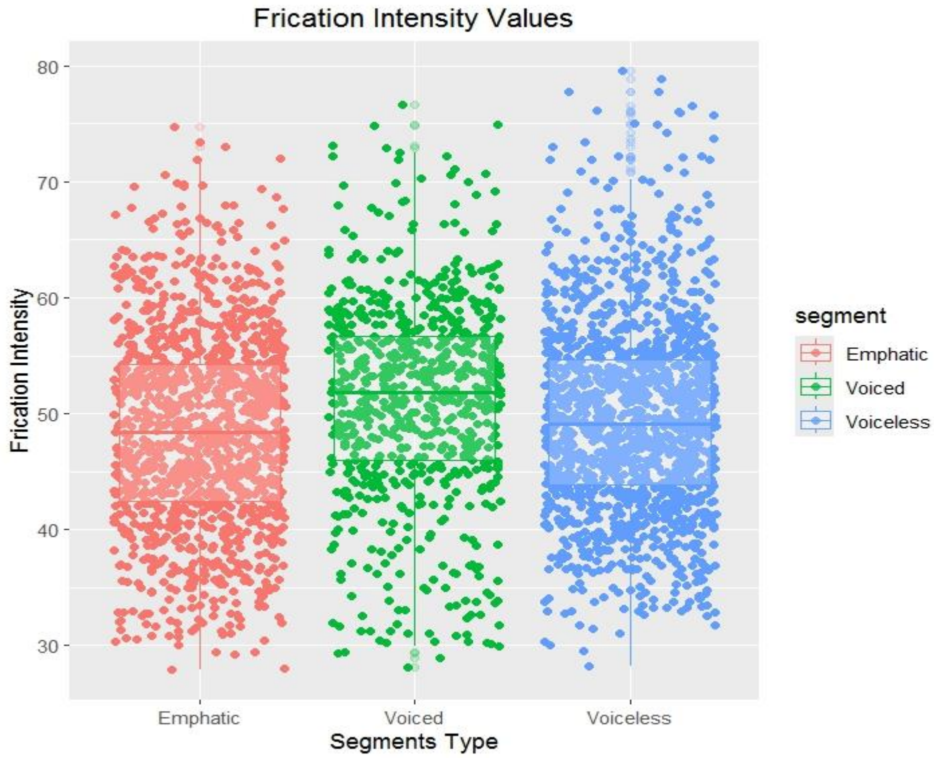

Figure 6.51: Frication intensity values by segment type.

In terms of position, frication intensity of fricatives was found to be higher in utterance-medial position compared to utterance-initial and final positions. The lowest frication intensity was found in utterance-final position for all types of fricatives. Table 6.6 below shows the frication intensity mean values of the different types of fricatives in utterance-initial, medial, and final positions.

Segment	Initial	Medial	Final	Overall
Emphatic	46.52	55.39	42.09	48
Voiced	51.55	57.76	44.35	51.22
Voiceless	48.04	53.96	46.72	49.57

Table 6.6: Frication intensity mean values by segment type.

With regard to syllable type, results showed that the frication intensity of fricatives in stressed syllables was slightly higher than that in unstressed syllables. In both types of syllables, emphatic fricatives had the lowest frication intensity values, while voiced fricatives had the highest frication intensity values. Figure 6.52 shows the frication intensity value distributions in stressed and unstressed syllables.

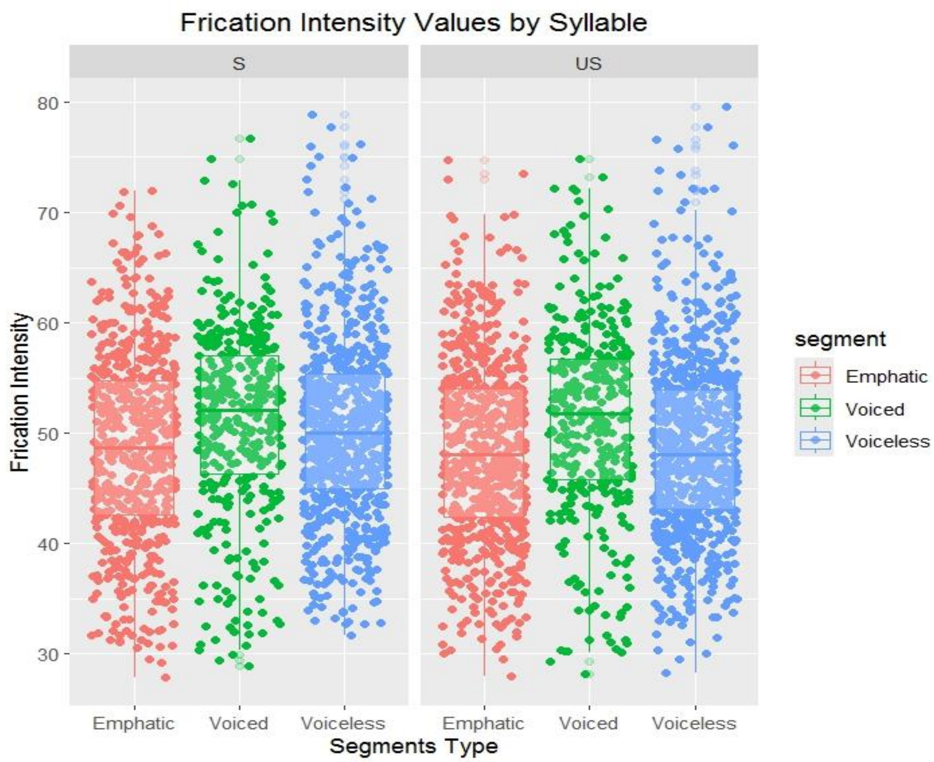

Figure 6.52: Frication intensity values by segment and syllable type.

When examined by place of articulation, results showed that the highest frication intensity values were for alveolars, while the lowest frication intensity values were for alveolar laterals. For all places of articulation, the emphatic fricatives had lower frication intensity values than their plain counterparts, however, in interdental place of articulation, the voiceless fricatives had the lowest frication intensity values. Figure 6.53 shows the target segment frication intensity values according to place of articulation.

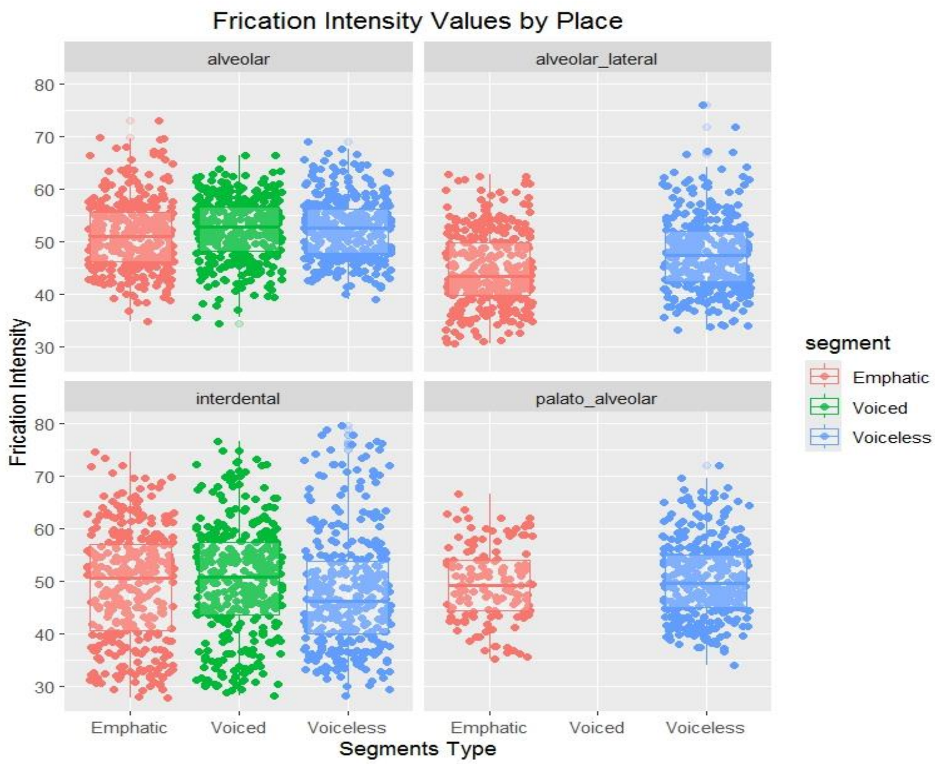

Figure 6.53: Frication intensity values by segment type and place of articulation.

The linear mixed-effects model results for frication intensity confirmed the initial observations of lower intensity values for emphatic fricatives. The results showed a significant effect of all the variables tested, however, not all levels of the variable segment type were found to be significant. For example, while the frication intensity of voiceless fricatives was significantly higher than the frication intensity of emphatic fricatives, b = 4.0464, t(27.4098) = 3.365, $p<0.01$, the frication intensity of voiced fricatives was not significantly higher than the frication intensity of emphatic fricatives, b = 0.2355, t(64.9210) = 0.204, $p = 0.838$. In terms of segment position, frication intensity in initial position was found to be significantly higher than in final position, b = 4.3423, t(125.2667) = 5.186, $p<0.001$. Similarly, frication intensity in medial position was significantly higher than in final position, b = 13.9250, t(800.0249) = 22.851, $p<0.001$. In terms of syllable type, the frication intensity in unstressed syllables was significantly lower than in stressed syllables, b = -0.9850, t(115.5490) = -2.212, $p<0.05$. In terms of place of articulation, the frication intensity was found to be significantly lower in all places of articulation compared to the alveolar place of articulation. The frication intensity of interdental fricatives was found to be significantly lower than the frication intensity of alveolar fricatives, b = -3.1317, t(97.8139) = -5.474, $p<0.001$. Frication intensity of palato-alveolar fricatives was significantly lower than that of alveolar fricatives, b = -2.4721, t(98.5407) = -3.283, $p<0.01$. Frication intensity of alveolar-lateral fricatives was also significantly lower than that of alveolar fricatives, b = -5.3829, t(98.7532) = -8.039, $p<0.001$. Figure 6.54 shows the results of the linear mixed-effects model for fricative frication intensity.

	Fric_intensity		
Predictors	*Estimates*	*CI*	*p*
(Intercept)	45.57	43.26 – 47.87	**<0.001**
segment [Voiced]	0.24	-2.02 – 2.49	0.838
segment [Voiceless]	4.05	1.69 – 6.40	**0.001**
position [Initial]	4.34	2.70 – 5.98	**<0.001**
position [Medial]	13.92	12.73 – 15.12	**<0.001**
place [alveolar_lateral]	-5.38	-6.70 – -4.07	**<0.001**
place [interdental]	-3.13	-4.25 – -2.01	**<0.001**
place [palato_alveolar]	-2.47	-3.95 – -1.00	**0.001**
stress [US]	-0.98	-1.86 – -0.11	**0.027**
segment [Voiced] * position [Initial]	3.47	0.74 – 6.20	**0.013**
segment [Voiceless] * position [Initial]	-2.66	-4.91 – -0.41	**0.020**
segment [Voiced] * position [Medial]	0.86	-1.06 – 2.78	0.381
segment [Voiceless] * position [Medial]	-5.91	-7.56 – -4.26	**<0.001**
Random Effects			
σ^2	25.21		
$\tau_{00\ word}$	4.72		
$\tau_{00\ participant}$	8.53		
$\tau_{11\ participant.segmentVoiced}$	4.01		
$\tau_{11\ participant.segmentVoiceless}$	8.18		
$\rho_{01\ participant.segmentVoiced}$	0.41		
$\rho_{01\ participant.segmentVoiceless}$	0.54		
ICC	0.47		
$N_{participant}$	10		
N_{word}	107		
Observations	3381		
Marginal R^2 / Conditional R^2	0.384 / 0.674		

Figure 6.54: Frication intensity model: lmer (fric_intensity ~ segment * position + place + stress + (1+segment|participant) + (1|word), data = Frication_modal, REML = FALSE) summary results.

The post-hoc pairwise comparison test showed frication intensity to be significantly different between some of the segments in various positions. Table 6.7 below shows the pairwise comparisons in various positions.

Position	Segment Pair	b	DF	t-ratio	P value
Initial	Emphatic*Voiced	-3.704	77.6	-2.884	< **0.05**
Medial	Voiced*Voiceless	2.956	70.1	2.510	< **0.05**
Final	Emphatic*Voiceless	-4.046	30.5	-3.222	< **0.01**
	Voiced*Voiceless	-3.811	70.4	-3.231	< **0.01**

Table 6.7: Pairwise comparisons for frication intensity by segment type.

Table 6.7 shows that the frication intensity was significantly lower in utterance-initial position in emphatic fricatives than in voiced fricatives. In utterance-medial position, the significant difference was only between voiced and voiceless fricatives where the voiced fricatives had higher frication intensities. In utterance-final position, the frication intensity of emphatic and voiced fricatives was significantly lower than the frication intensity of voiceless fricatives. The difference in frication intensity between emphatic and voiced fricatives was not significant in utterance-final position.

6.3.2.4. Number of Pre- or Post-frication Silent Lags

Out of the total 3390 tokens, only 449 tokens included silent lags in the data. The results show that the initial observation made regarding the emphatic and voiced fricatives having pre- or post-frication silent lags seems to be robust across the data. Overall, 281 tokens of the emphatics had silent lags compared to 144 tokens of voiced and 24 tokens of voiceless. With regard to position, silent lags occurred more frequently in utterance-final position compared to utterance-initial and medial positions.

Table 6.8 summarises the total number of silent lags for each segment across the data. An interesting point in this figure is that the majority of silent lags were found in emphatic and voiced fricatives in utterance-final position.

Segment	Initial	Medial	Final	Percentage
Emphatic				
sˤ	20	5	40	18%
ðˤ	0	0	83	23%
ʃˤ	20	8	Not Found	18.6%
ɬˤ	9	5	91	29.16%
Voiced				
z	0	0	82	22.77%
ð	0	0	62	17.2%
Voiceless				
s	7	2	1	2.7%
θ	2	0	1	0.83%
ʃ	3	0	0	0.83%
ɬ	3	0	5	2.22%

Table 6.8: Silent lags by segment and position.

The results of the logistic regression model for pre- or post-frication silent lags confirmed the initial observations. The results showed a significant effect of the variables segment type and position, but not syllable type and place of articulation, on the presence or absence of lags. The presence or absence of silent lags in voiceless segments was significantly lower than their presence or absence in the emphatic segments, b = -0.2716502, SE = 0.0150730, $p<0.001$. On the other hand, silent lag presence or absence in voiced segments was not significantly different from that of the emphatic segments, b = 0.0026809, SE = 0.0163262, $p = 0.869$. In addition, the results of the presence or absence of silent lags were significantly affected by the position of the segment: their presence or absence in initial position was found to be significantly less than in final position, b = -0.1834462, SE = 0.0162957, $p<0.001$. Similarly, silent lag presence or absence in medial position was significantly lower than in final position, b = -0.2425879, SE = 0.0165479, $p<0.001$. Results of the model showed that the presence or absence of silent lags was not affected by the variables of syllable type or place of articulation. Figure 6.55 below shows the results of the logistic regression model for fricative pre- or post-frication silent lags.

Predictors	Estimates	lag CI	p
(Intercept)	0.28	0.25 – 0.31	**<0.001**
segment [Voiced]	0.00	-0.03 – 0.03	0.870
segment [Voiceless]	-0.27	-0.30 – -0.24	**<0.001**
position [Initial]	-0.18	-0.22 – -0.15	**<0.001**
position [Medial]	-0.24	-0.28 – -0.21	**<0.001**
stress [US]	0.00	-0.02 – 0.02	0.911
place [alveolar_lateral]	0.01	-0.02 – 0.03	0.657
place [interdental]	-0.02	-0.04 – 0.00	0.093
place [palato_alveolar]	0.02	-0.01 – 0.05	0.165
segment [Voiced] * position [Initial]	-0.09	-0.14 – -0.04	**0.001**
segment [Voiceless] * position [Initial]	0.20	0.16 – 0.25	**<0.001**
segment [Voiced] * position [Medial]	-0.03	-0.09 – 0.02	0.245
segment [Voiceless] * position [Medial]	0.24	0.19 – 0.28	**<0.001**
Observations	4444		
R^2 / R^2 adjusted	0.149 / 0.146		

Figure 6.55: Pre- or post-frication silent lags model: lm(lag ~ segment * position + stress + place , data = silent_lag) summary results.

The post-hoc pairwise comparison test showed the number of pre- or post-frication silent lags to be significantly different between some of the segments in various positions. Table 6.9 shows the pairwise comparisons in various positions.

Position	Segment Pair	b	DF	t-ratio	P value
Initial	Emphatic*Voiced	0.08821	4431	3.942	< **0.01**
	Emphatic*Voiceless	0.06849	4431	3.862	< **0.01**
Final	Emphatic*Voiceless	0.27165	4431	18.022	< **.0001**
	Voiced*Voiceless	0.27433	4431	16.173	< **.0001**

Table 6.9: Pairwise comparisons for pre- or post-frication silent lags by segment type.

Table 6.9 shows that the number of pre- or post-frication silent lags was significantly lower in utterance-initial position in voiced and voiceless fricatives than in emphatic fricatives. In utterance-final position, the number of pre- or post-frication silent lags of emphatic and voiced fricatives was significantly higher than in voiceless fricatives. The number of pre- or post-frication silent lags was not significantly different between emphatic and voiced fricatives in utterance-final position.

6.3.2.5. CoG

The distribution of CoG values is given in Figure 6.56 below.

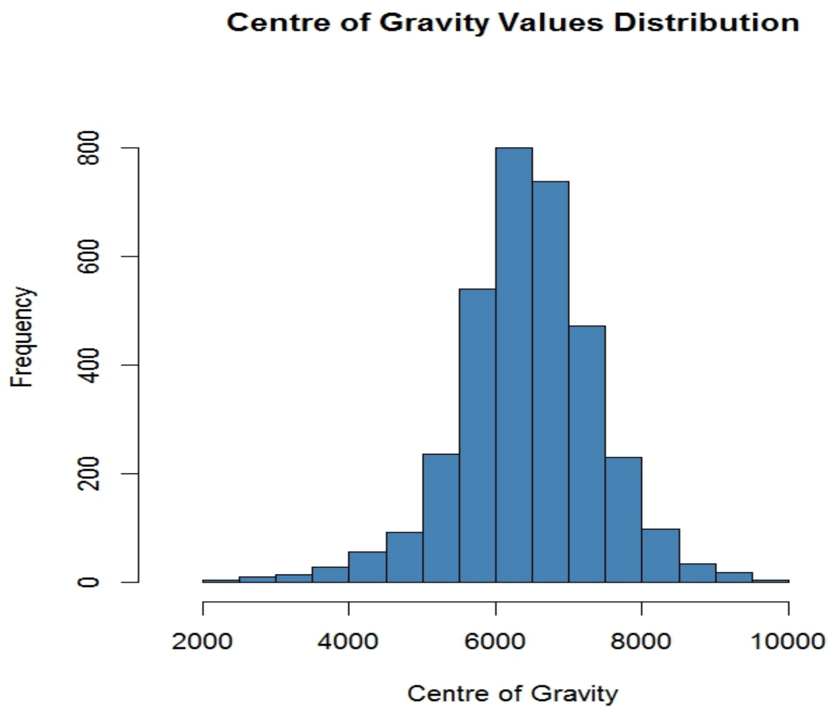

Figure 6.56: CoG values distribution.

Overall, the CoG values of emphatic fricatives were higher than the CoG values of voiced and voiceless fricatives. The voiced fricatives had intermediate CoG values. These results showed that the initial observation regarding CoG was robust across the data set. Figure 6.57 shows the target segment CoG values across the data.

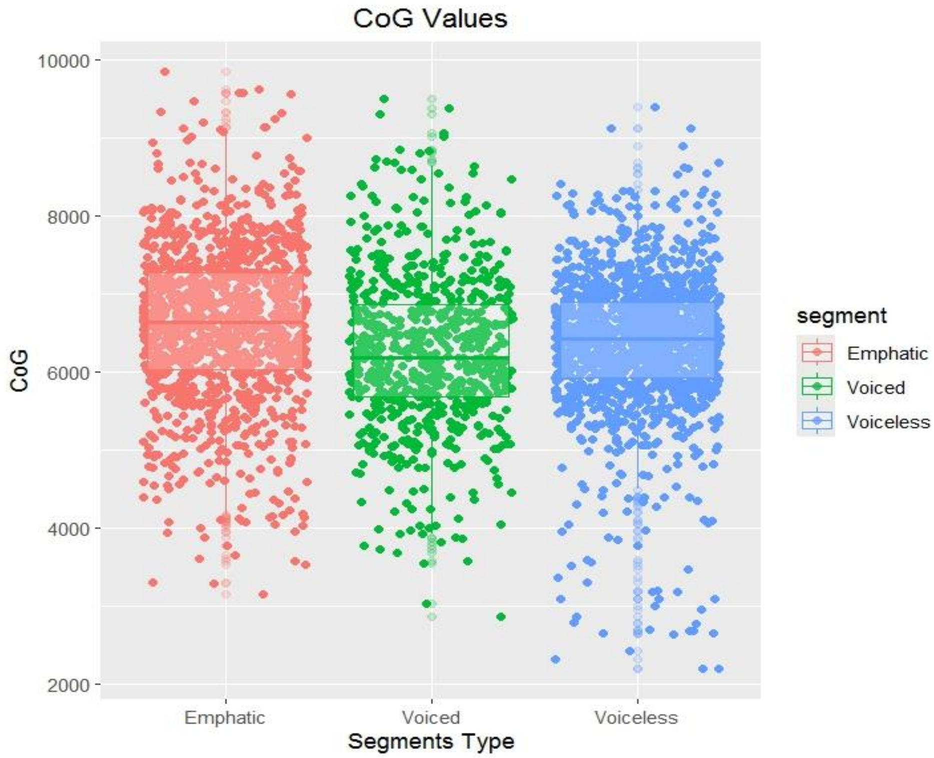

Figure 6.57: CoG values by segment type.

With regard to segment position, the results showed that all types of fricatives had the lowest CoG values in utterance-medial position. The highest CoG values were found in utterance-final position, where the emphatic and voiced fricatives had very close values to each other. Table 6.10 shows the mean values of CoG for the different types of fricatives according to position.

Segment	Initial	Medial	Final
Emphatic	6932.855	6100.804	7611.391
Voiced	5997.124	5691.468	7673.374
Voiceless	6459.185	6100.977	6403.152

Table 6.10: CoG mean values by position and segment type.

In terms of place of articulation, the palato-alveolar fricatives had the lowest CoG values, while the alveolar fricatives had the highest CoG values. Voiceless fricatives had the lowest CoG values in all positions except in interdental where they had higher CoG values than the voiced fricative. Figure 6.58 shows the target segment CoG values according to place of articulation.

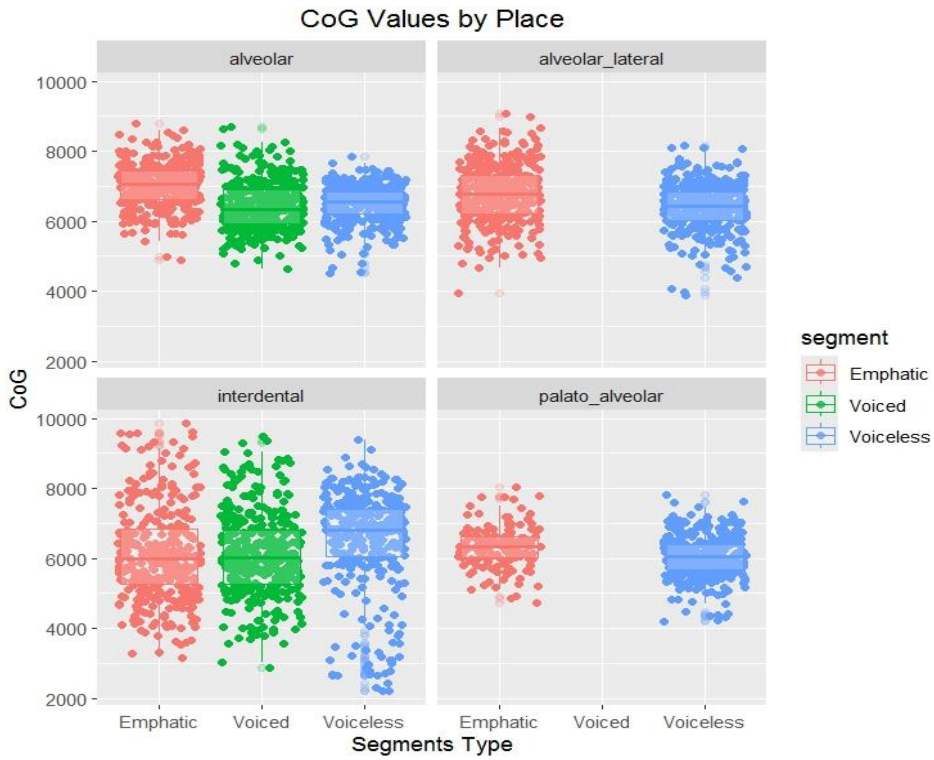

Figure 6.58: CoG values by place of articulation and segment type.

Linear mixed-effects model results confirmed the observations regarding the CoG of emphatics. They showed a significant effect of all the variables except syllable type. The variables of segment type, position, and place of articulation were found to be significant. However, not all the levels of the various variables were found to be significant. The CoG of voiceless segments was significantly lower than the CoG of emphatic segments, b = -457.86, t(50.06) = -3.252, $p<0.01$. However, the difference in the CoG values of voiced segments was not found to be significantly different than that of emphatic segments, b = 32.56, t(68.74) = 0.205, $p = 0.838424$. In terms of segment position, CoG values in initial position were found not to be significantly lower than in final position, b = -196.37, t(143.79) = -1.702, p = 0.091000. However, CoG values in medial position were significantly lower than in final position, b = -891.20, t(772.44) = -10.395, p<0.001. In terms of place of articulation, the CoG of interdental segments was found to be significantly lower than that of alveolar segments, b = -404.06, t(111.17) = -5.107, p<0.001. For palato-alveolar segments, the CoG was significantly lower than that of alveolars, b = -559.97, t(107.54) = -5.233, p<0.001. Figure 6.59 shows the results of the linear mixed-effects model for fricative CoG values.

	CoG		
Predictors	*Estimates*	*CI*	*p*
(Intercept)	7193.89	6951.17 – 7436.62	**<0.001**
segment [Voiced]	32.56	-279.35 – 344.48	0.838
segment [Voiceless]	-457.86	-733.91 – -181.81	**0.001**
position [Initial]	-196.37	-422.64 – 29.90	0.089
position [Medial]	-891.20	-1059.29 – -723.11	**<0.001**
stress [US]	54.73	-67.49 – 176.94	0.380
place [alveolar_lateral]	-170.58	-356.28 – 15.12	0.072
place [interdental]	-404.06	-559.20 – -248.93	**<0.001**
place [palato_alveolar]	-559.97	-769.79 – -350.14	**<0.001**
segment [Voiced] * position [Initial]	-858.30	-1242.45 – -474.14	**<0.001**
segment [Voiceless] * position [Initial]	165.99	-149.54 – 481.52	0.302
segment [Voiced] * position [Medial]	-459.07	-727.18 – -190.96	**0.001**
segment [Voiceless] * position [Medial]	606.46	374.57 – 838.36	**<0.001**
Random Effects			
σ^2	491370.15		
$\tau_{00\ word}$	97906.94		
$\tau_{00\ participant}$	52151.88		
$\tau_{11\ participant.segmentVoiced}$	74567.88		
$\tau_{11\ participant.segmentVoiceless}$	75735.55		
$\rho_{01\ participant.segmentVoiced}$	0.29		
$\rho_{01\ participant.segmentVoiceless}$	0.63		
ICC	0.33		
$N_{participant}$	10		
N_{word}	115		
Observations	3381		
Marginal R^2 / Conditional R^2	0.212 / 0.470		

Figure 6.59: CoG model: lmer (CoG ~ segment * position + stress + place + (1+segment|participant) + (1|word), data = CoG_model, REML = FALSE) summary results.

The post-hoc pairwise comparison test showed CoG values to be significantly different between some of the segments in various positions. Table 6.11 shows the pairwise comparisons according to position.

Position	Segment Pair	b	DF	t-ratio	P value
Initial	Emphatic*Voiced	825.7	82.1	4.606	< **0.001**
	Voiced*Voiceless	-533.9	105.7	-3.107	< **0.01**
Medial	Emphatic*Voiced	426.5	7.2	2.655	< **0.05**
	Voiced*Voiceless	-575.1	104.6	-3.828	< **0.001**
Final	Emphatic*Voiceless	457.9	56	3.123	< **0.01**
	Voiced*Voiceless	490.4	111.1	3.188	< **0.01**

Table 6.11: Pairwise comparisons for CoG by segment type.

As can be seen in Table 6.11, CoG values were significantly higher in emphatic fricatives than in voiced fricatives in utterance-initial and medial positions. For voiced fricatives, CoG values were significantly lower than in voiceless fricatives in utterance-initial and medial positions. In utterance-final position, CoG values were significantly higher in emphatic and voiced fricatives than in voiceless fricatives. However, CoG values were not significantly different between emphatic and voiced fricatives in utterance-final position.

6.4. Discussion

In studying the emphatic fricatives of Ḥarsūsi, this study addressed the following questions:

1. Do the emphatic fricatives in Ḥarsūsi display any known characteristics of ejective fricatives?
2. Do the emphatic fricatives differ from their plain counterparts in terms of their overall duration, frication duration, frication intensity, pre- or post-frication silent lags, and CoG?

3. Do the emphatic fricatives and their plain voiced counterparts pattern together in any position based on acoustic characteristics?

After checking the waveforms and spectrograms of the fricatives, and obtaining the results of the statistical analyses, it can be stated that the emphatic fricatives in Ḥarsūsi are only typically realised as ejectives in utterance-final position, with some ejective tokens in utterance-initial position. Not all the acoustic characteristics known for ejective fricatives in other languages were found in Ḥarsūsi emphatics.

In addition, the results showed a patterning of emphatics and voiced fricatives in utterance-final position. To the exclusion of voiceless fricatives, the emphatic and voiced fricatives showed an ejective realisation in utterance-final position manifested in pre-frication lag, glottal closure and release.

In the sections below, the acoustic parameters of fricative overall duration, frication duration, frication intensity, number of pre- or post-frication silent lags, and CoG are discussed in detail.

6.4.1. Fricative Overall Duration

Fricative overall duration was investigated to check if it showed any acoustical differences between the emphatic fricatives and their plain counterparts. It has not been shown as an acoustic trait for ejectives in specific; nonetheless, it has been examined in a study by Seid et al. (2009) comparing ejectives and their plain counterparts. The investigation of overall fricative duration aimed to answer questions 1 and 2 of the study.

In general, the results came with an affirmative answer for question 1 and were in line with the study's expected hypothesis of emphatics having shorter overall durations. As for question 2, the difference in overall duration between the emphatic fricatives and their plain counterparts was significant in certain positions only. In addition, the second observation regarding emphatics having longer overall durations in utterance-final position was not supported by the results.

Adding the interaction in the model between the variables of segment type and position increased the model fit and showed more significant interaction effects, nonetheless, it reduced the significance of certain variables such as segment type. For example, segment type was not found to be a significant factor in the overall duration of the fricatives. The linear mixed-effects model results showed the overall duration of the emphatics not to be significantly different than the overall duration of their plain counterparts, which looks to be in line with Ridouane & Gendrot (2017) study on Mehri. Ridouane & Gendrot (2017) stated that there were no differences in Mehri fricatives when their total durations were compared. The pairwise comparisons of the post hoc test of the current study, by contrast, showed that the difference in overall fricative duration in Ḥarsūsi was significant between emphatic and voiceless fricatives in utterance-initial and medial positions.

In terms of duration, the emphatics had the shortest overall duration in all positions. This is in line with the results of a previous study on Amharic. Seid et al. (2009) found that the Amharic alveolar ejective fricative had shorter overall durations than its plain counterpart. Given such results, it could be speculated that the emphatic fricatives in Ḥarsūsi display one characteristic known of ejective fricatives in Amharic, namely shorter overall duration.

With regard to syllable structure, all types of fricatives had longer overall durations in stressed syllables compared to non-stressed syllables. An interesting point here is that the emphatic fricatives had shorter overall durations in comparison to their plain counterparts in both types of syllables.

In terms of place of articulation, significant difference was found only in the interdental position compared to the alveolar position. All other positions did not affect the overall duration of the fricatives.

In summary, as was expected, the emphatic fricatives in Ḥarsūsi have a shorter overall duration than their plain counterparts even in utterance-final position where they were expected to have longer durations due to glottal closure in this position. Moreover, the results showed that the longest duration for all types of fricatives was in utterance-final position. However, the results showed that fricative overall duration in Ḥarsūsi cannot be taken as an acoustic parameter distinguishing between the different types of fricatives in all positions: the post hoc test showed no significant results in utterance-final position between emphatic and voiced fricatives.

6.4.2. Frication Duration

The investigation of frication duration of the fricatives had two purposes. First, to check if the emphatic fricatives in Ḥarsūsi had a shorter frication duration compared to their plain counterparts, as was found in ejective fricatives of some other languages. Secondly, to examine if frication duration served as an acoustical parameter to distinguish between the different types of fricatives. Thus, the investigation of frication duration aimed to answer questions 1 and 2.

The results provided an affirmative answer to question 1 as the emphatic fricatives had shorter frication durations compared to their plain counterparts. As for question 2, the difference in frication duration was not significant between all types of segments: frication duration was significantly different between the emphatic and voiceless fricatives, but not between the emphatic and voiced fricatives. Therefore, frication duration turned out to be a good acoustic parameter to distinguish between emphatic and voiceless fricatives, but not between emphatic and voiced fricatives.

Similar to the results of previous studies on ejective fricatives, the emphatic fricatives in Ḥarsūsi had shorter frication durations than their plain counterparts and specifically the voiceless fricatives. This is consistent with the results in previous studies on ejective fricatives such as (Gordon & Applebaum, 2006; Shosted & Rose, 2011; Ridouane & Gendrot, 2017), and contrary to the results of pharyngealised emphatic fricatives (Gasparini, 2017). Based on the shorter frication durations of the emphatics compared to their plain counterparts, it could be speculated that the emphatics in Ḥarsūsi might be ejectives. However, frication duration alone cannot be relied upon as a cue for ejective realisation. It can also be possible that 'backed' emphatic fricatives might have a shorter frication duration compared to their plain counterparts given that they require additional effort during articulation. As mentioned in 2.4, the emphatics involve a secondary place which requires the backing of the tongue root; therefore, they require extra articulatory effort compared to their plain counterparts. As a result, shorter frication duration might be a correlate of 'backed' emphatic fricatives. In a study of Arabic fricative acoustic characteristics, the pharyngealised dental /dˤ/ was found to have the shortest frication noise duration, while the alveolar /sˤ/ had a longer duration (Al-Khairy, 2005, p. 56). The results of the current study, in addition to the varying results of previous studies and especially the results of Gasparini (2017) on Baṭḥari raise an interesting question in this regard.

As the difference in frication duration is only significant between emphatic and voiceless fricatives, frication duration only distinguishes emphatics from their voiceless counterparts. The fact that the difference in frication duration is insignificant between emphatic and voiced fricatives suggests similar acoustic patterning between these two types of segments.

The results also showed the frication duration of the various types of target segments to be affected by syllable type. Fricatives in stressed syllables had longer frication duration than fricatives in unstressed syllables. Such a result is not surprising given that the stressed syllables are more prominent, having a longer duration in general, which can translate into longer segment durations.

With regard to segment position, utterance-final segments had the longest frication duration. In all positions, emphatics had the shortest frication durations followed by their voiced counterparts. Voiceless fricatives had the longest frication duration.

In sum, results of the frication duration showed emphatics to behave similarly to ejective fricatives in other languages; however, this alone is insufficient to indicate ejective realisation especially that the difference is not significant among all types of segments. Based on these results, it can be said that frication duration can be a differentiating acoustic parameter between the emphatic and voiceless fricatives, but not between emphatic and voiced fricatives.

6.4.3. Frication Intensity

Frication intensity is one of the non-durational acoustic parameters which was considered in this study. A number of previous studies on other related and unrelated languages to Ḥarsūsi found frication intensity to distinguish ejective fricatives from their plain counterparts. Thus, frication intensity was investigated to answer questions 1 and 2.

The results on frication intensity values of the various types of fricatives led to an affirmative answer to question 1 as the emphatics had lower frication intensity values compared to their plain counterparts. With regard to question 2, the differences in frication intensity values were not significant among all segment types suggesting that frication intensity was not a robust acoustic parameter to distinguish between the various types of fricatives in Ḥarsūsi.

Frication intensity results in Ḥarsūsi were unlike what was found by previous studies in the related languages Mehri and Baṭḥari; however, they were consistent with the results of Turkish Kabardian (Gordon & Applebaum, 2006). Results showed that emphatic fricatives had lower frication intensity values in all positions compared to their plain counterparts. It should be noted, however, that not all the levels of segment type were found to have significant differences in terms of frication intensity. Although frication intensity mean values of the various types of fricatives exhibited differences, the difference among these types was not significant. The difference in intensity values between emphatic and voiced fricatives was found in utterance-initial position only, while the difference between emphatic and voiceless fricatives was found in utterance-final position only. The non-significant difference in intensity values between emphatic and voiced fricatives in utterance-final position is suggestive of acoustic patterning in this position.

In comparison, Ridouane & Gendrot (2017) found that in Mehri frication intensity was significantly affected by segment type in initial position. In addition, Ridouane & Gendrot (2017) found the frication intensity of ejective fricatives in Mehri to be higher than their pulmonic counterparts. In Ḥarsūsi, the situation is the opposite. Based on mean values of frication intensity, the emphatic fricatives had the lowest frication intensity values except in utterance-medial position. Similarly, the results of frication intensity in Ḥarsūsi contradict the results of Baṭḥari. Initial emphatics in Baṭḥari were found to have higher frication intensity values except for the alveolar lateral /ɬˤ/. However, such differences can be attributed to both inter-language and methodological differences. For example, the number of tokens, number of speakers, and recording procedures differed in both studies of Mehri and Ḅaṭḥari from that followed in this current study. In their Mehri study, Ridouane & Gendrot (2017) analysed 397 tokens in total which were recorded in a carrier sentence and did not include the voiced counterparts of the emphatics, /z/ and /ð/. In addition, they did not investigate the fricatives in final position. In the Baṭḥari study, Gasparini (2017) analysed a small data of fricatives (65 tokens in total) which occurred in natural speech recordings. In comparison, this study included a total of 3240 tokens elicited from a word list in which various factors such as syllable type and position were constant for all fricatives.

In terms of segment position, frication intensity results showed it to be a significant factor in Ḥarsūsi. The lowest frication intensity values for all types of fricatives were found in utterance-final position, while the highest frication intensity values were found in utterance-medial position. Lower intensity values in utterance-final position are expected, however, an interesting point is that utterance-medial fricatives in Ḥarsūsi had the highest frication intensity values.

Frication intensity values based on syllable structure were as expected. Frication intensity values in stressed syllables were higher than their values in unstressed syllables. This will be due to syllable prominence. In stressed syllables, the fricatives have a higher intensity rate due to the articulation being more prominent compared to non-stressed syllables.

With regard to place of articulation, alveolar fricatives had the highest frication intensity values compared to other places of articulation.

In summary, the results show that the emphatic fricatives in Ḥarsūsi show a similar behaviour to ejective fricatives in Turkish Kabardian (Gordon & Applebaum, 2006) in terms of frication intensity. In contrast to Mehri (Ridouane & Gendrot, 2017) and Baṭḥari (Gasparini, 2017), the emphatic fricatives in Ḥarsūsi have lower frication intensity values compared to their plain counterparts. Moreover, the results of the significance of differences in frication intensity among the various types of fricatives show that frication intensity can be a differentiating acoustic parameter between some fricatives in some positions: in utterance-final position, it does not differentiate between emphatic and voiced fricatives.

6.4.4. Number of Pre- or Post-frication Silent Lags

Pre- or post-frication silent lag is an acoustic parameter taken into consideration in this study as it was found to be associated with ejective segments in other languages. It was investigated in this study to serve three purposes. First, to see if the emphatic fricatives exhibited any silent lags during their articulation in various positions suggesting an ejective realisation.

Secondly, to see if there was a difference in terms of the presence or absence of pre- or post-frication silent lags among different types of fricatives. Thirdly, to see if voiced fricatives patterned with emphatic fricatives in any position by exhibiting silent lags which could translate into glottal closures as found to be the case in the stops (see Chapter 5). Hence, the investigation of pre- or post-frication silent lags aimed to answer questions 1, 2, and 3.

The results obtained regarding pre- or post-frication silent lags were consistent with the hypothesis and came with an affirmative answer for question 1. The emphatic fricatives exhibited pre- or post-frication lags, and the lags were found mostly in utterance-final position. As for question 2, the results showed emphatic fricatives to differ from their voiceless counterparts only since voiced fricatives showed a post-frication silent lag in utterance-final position. With regard to question 3, the results showed a negative answer as pre- or post-frication silent lags can only differentiate between emphatic and voiceless fricatives and not between emphatic and voiced fricatives.

The visual inspection of waveforms and spectrograms showed that a few tokens of certain emphatic fricatives exhibited short silent lags in non-final utterance position, but they were not found consistently in the same position throughout the data. In utterance-final position, silent lags were found to occur more frequently and consistently across the data.

The number of emphatic fricative tokens with silent lags was minimal compared to the total number of tokens in utterance-initial and medial positions (120 tokens in each), except for the emphatic palato-alveolar fricative /ʃˤ/ which had only 90 tokens in utterance-initial, 60 tokens in utterance-medial, and 0 tokens in utterance-final position. In utterance-final position, the number of tokens with silent lags increases considerably for some of the emphatic fricatives. In addition, the results of the linear mixed-effects model showed the difference in silent lag was significantly affected by position. These results differ from what was found in some previous works of some MSALs. Ridouane & Gendrot (2017) found that 60 out of 98 (61%) tokens of emphatic fricatives exhibited silent lags in initial position. This compares with 49 out of 450 (10.8%) tokens that showed a silent lag in utterance-initial position in the Ḥarsūsi data.

As can be seen in Table 6.8 above, silent lags mostly occurred in emphatic and voiced fricatives. For voiced fricatives, all the silent lags occurred in utterance-final position. For emphatic fricatives, the majority of silent lags were found in utterance-final position. The results of the linear mixed-effects model showed the presence or absence of silent lags to be significantly different between voiceless and emphatic fricatives, but not between voiced and emphatic fricatives. These results suggest that emphatic and voiced fricatives follow a similar pattern with regard to the occurrence of silent lags in utterance-final position.

Overall, the results show that the emphatic fricatives in Ḥarsūsi systematically exhibit pre- and post-frication silent lags in utterance-final position which translates into a glottal closure in this position suggesting an ejective realisation. In other positions, the silent lags are fewer and do not show systematically in all the emphatic fricatives. As for segment type, the results show that pre- or post-frication silent lags can be taken as a parameter to distinguish some of the fricatives in some positions. However, it does not differentiate the emphatic and voiced fricatives in utterance-final position where both types of fricatives pattern together.

6.4.5. CoG

CoG is another non-durational acoustic parameter investigated in this study. It was investigated in this study as Ridouane & Gendrot (2017) showed CoG to be significantly different between ‘ejective’ and voiceless fricatives. The investigation of CoG served three purposes. First, to see if the emphatic fricatives exhibited similar traits as found in Mehri suggesting an ejective realisation. Secondly, to see if CoG served as an acoustic parameter distinguishing between the different types of fricatives in Ḥarsūsi. Thirdly, to see if voiced fricatives patterned with emphatic fricatives in any position by exhibiting similar CoG values. Therefore, the investigation of CoG values aimed to answer questions 1, 2, and 3.

The results for CoG values were consistent with the hypothesis of emphatic fricatives having higher CoG values and came with an affirmative answer for question 1. As for question 2, the results gave a negative answer, and the CoG was not a clear acoustic parameter to distinguish between all types of fricatives. The voiced fricatives showed similar high CoG values in utterance-final position suggesting a patterning with the emphatic fricatives in this position as was hypothesised, giving an affirmative answer to question 3.

The CoG of emphatic fricatives was higher in utterance-initial position than the CoG of voiced and voiceless fricatives. In utterance-medial position, the CoG of emphatics was higher than voiced, but very close to the voiceless. On the other hand, in utterance-final position, the CoG of emphatics was higher than voiceless fricatives, but close to the CoG of voiced fricatives (see Table 6.10 above). Moreover, the results of the linear mixed-effects model showed that segment type was a significant factor on CoG value especially between the emphatic fricatives and their voiceless counterparts. This higher CoG in emphatic fricatives in Ḥarsūsi is in line with the results of Ridouane & Gendrot (2017) on Mehri fricatives. According to Ridouane & Gendrot (2017, pp. 155-156)the higher CoG is suggestive of a narrower constriction during the articulation of Mehri ‘ejective’ fricatives compared to their pulmonic counterparts. Based on this, it could be speculated given the high CoG values of Ḥarsūsi emphatic fricatives that they are articulated with a narrower constriction compared to their voiced and voiceless counterparts. Hence, they exhibit a trait of ejective fricatives as found in other languages such as Tlingit (Maddieson, Smith, & Bessell, 2001)and Mehri (Ridouane & Gendrot, 2017) in this regard. The difference in CoG values was significant between emphatic and voiced fricatives in utterance-initial and medial position, and between emphatic and voiceless fricatives in utterance-final position.

The other interesting point in the results is the CoG of voiced fricatives. The voiced fricatives had considerably lower CoG values than the emphatic fricatives in utterance-initial and medial positions. However, in utterance-final position, the difference between the CoG values of the emphatic and voiced fricatives became minimal. Such results are suggestive of a similar patterning of these types of segments in final position, which is reflected in close spectral values. Indeed, the pairwise comparisons for CoG values showed that the difference between emphatic fricatives and their voiced counterparts was significant in all positions except in utterance-final position. These results confirm the similar patterning of emphatic and voiced fricatives in utterance-final position.

6.5. CONCLUSION

In conclusion, this study addressed three main questions regarding the fricatives in Ḥarsūsi. It aimed to examine whether the emphatic fricatives were typically realised as ejectives or not, drawing evidence from a number of acoustic parameters, and whether the acoustic parameters served as a cue to distinguish between the various types of fricatives. In addition, it aimed to investigate if the emphatic and voiced fricatives patterned together in any position based on acoustic parameters results.

Five temporal and non-temporal acoustic parameters were examined for the ejectivity of emphatic fricatives: fricative overall duration, frication duration, frication intensity, the number of pre- or post-frication silent lags, and CoG.

The results of the fricative overall duration study showed that Ḥarsūsi emphatic fricatives had shorter overall durations compared to their plain counterparts; however, this shorter duration was not significant between all types of fricatives and in all positions. In terms of frication duration, even though Ḥarsūsi emphatic fricatives exhibited shorter frication durations similar to ejective fricatives in other languages such as Turkish Kabardian (Gordon & Applebaum, 2006), Tigrinya (Shosted & Rose, 2011), and Mehri (Ridouane & Gendrot, 2017), this acoustic parameter was not significantly different between all types of fricatives in Ḥarsūsi. In addition, from an articulatory phonetics point of view, it is quite possible for ‘backed’ emphatic fricatives to have shorter frication durations as well. As for the frication intensity of fricatives, the results were in line with results of some previous studies on ejective fricatives (Gordon & Applebaum, 2006) and differed from others (Ridouane & Gendrot, 2017). Ḥarsūsi emphatic fricatives had a lower frication intensity compared to their non-emphatic counterparts; however, the difference in intensity values was not found to be significant among the different types of fricatives in all positions. In terms of the pre- or post-frication silent lags, the majority were found in utterance-final position compared to the other positions examined in this study, and the difference was not significant between all types of fricatives in all positions. With regard to CoG values, the emphatic fricatives in Ḥarsūsi did show higher CoG values compared to their voiced and voiceless counterparts, but the results were statistically significant only between some types of fricatives in some positions.

Overall, the emphatic fricatives in Ḥarsūsi did show signs of ejective realisation when compared to known ejectives in other languages in terms of having a shorter frication duration, lower frication intensity, higher number of pre-or post-frication silent lags, and higher CoG values. In addition, based on the CoG values, it can also be speculated that the emphatic fricatives, similar to Mehri(Ridouane & Gendrot, 2017), might be realised with a narrower constriction, which is a mechanism to produce ejective fricatives as suggested by Maddieson et al. (2001). However, the post-hoc test results showed that the differences in terms of the measured acoustic parameters are not statistically significant in all positions for all types of fricatives and this makes it hard to claim the Ḥarsūsi emphatic fricatives as being ejectives. The only position where the Ḥarsūsi emphatic fricatives can be claimed to be realised as ejectives is utterance-final position based on the results of pre- or post-frication silent lags. In this position, they are realised with a clear glottal closure which translates into silent lags found in this position mainly followed by a clear glottal release.

As for distinguishing the emphatic fricatives from their plain counterparts, the results showed that among the temporal and non-temporal acoustic parameters examined, fricative overall duration did not distinguish between the different types of fricatives in Ḥarsūsi. The post-hoc test showed the difference in overall duration to be significant only between emphatic and voiceless fricatives in utterance-initial and utterance medial positions. As for frication duration, frication intensity, number of pre- or post-frication silent lags, and CoG, they distinguished mainly between the emphatics and their voiceless counterparts. The results of post-hoc tests showed that each acoustic parameter served as a cue to differentiate between certain types of fricatives in certain positions. However, the difference between the emphatic and voiced fricatives in utterance-final position was not found to be significant following any acoustic parameter.

As for the patterning of emphatic and voiced fricatives together in utterance-final position, the results showed that it can be supported based on acoustic parameters. As was seen in the results, the emphatic fricatives and their voiced counterparts have closely related values in utterance-final position with regard to the various acoustic parameters investigated. The closely related results and the non-significant difference between these two types of fricatives in utterance-final position are suggestive of a similar patterning of these two types of fricatives in Ḥarsūsi. Such a patterning was also seen in MSAL Mehri (Bellem & Watson, 2014). As was mentioned above in chapter 5, such statistical results based on instrumental phonetic analysis can support the view of grouping the emphatic and voiced segments together in one group. Previous studies on Arabic and MSAL Mehri suggested such a grouping based on phonological patterning of emphatic and voiced segments (Heselwood & Maghrabi, 2015; Watson & Heselwood, 2016). Based on the results of this study on Ḥarsūsi fricatives, such a grouping can also be suggested for emphatic and voiced fricatives in Ḥarsūsi. The emphatic and voiced fricatives can be labelled as

‘Unbreathed’ (Heselwood & Maghrabi, 2015, p. 159) and the voiceless fricatives as ‘Breathed’ (Heselwood & Maghrabi, 2015, p. 159).

7. Chapter Seven: Discussion and Conclusion

7.1. General Discussion

This study is a first step towards the description and documentation of the endangered MSAL Ḥarsūsi in Sultanate of Oman based on first-hand field data. It provided background information about the linguistic situation in Sultanate of Oman and the current status of Ḥarsūsi after more than 40 years since the publication of *Ḥarsūsi Lexicon* by Johnstone (1977). In addition, given the debate about the class of emphatic sounds in MSAL, it explored the nature of emphatics in Ḥarsūsi through instrumental experiments. In the investigation of the class of emphatics, it tried to find out which acoustic correlates could distinguish the emphatics from their plain counterparts. Finally, and based on the results of acoustic correlates, it tried to suggest one of the possible laryngeal categorisations that could be in line with the phonetic details.

In the phonological system, the findings came generally in line with the results of previous works on Ḥarsūsi such as Johnstone (1977) and Swiggers (1981) except the diphthongs. Based on phonological analysis, the number of consonants and their classes in Ḥarsūsi were the same as found in previous works. However, the study concluded that Ḥarsūsi has no phonemic diphthongs that could be established based on minimal pairs as discussed in 4.4.3. The diphthongs found in Ḥarsūsi are either allophonic variants of long vowels or vowel and glide clusters. This different conclusion on diphthongs than previous works could be due to the approach followed in analysing the diphthongs and relying on minimal pairs and the consonantal root of words to find the vowel and glide combinations.

In terms of the nature of emphatic sounds in Ḥarsūsi, the study relied mainly on visual cues in addition to some other acoustic correlates to investigate their phonetic realisation. As discussed in 2.4, studies on MSAL (Johnstone, 1977; Watson & Bellem, 2010, 2011; Ridouane et al., 2015;

Gasparini, 2017; Ridouane & Gendrot, 2017; Heselwood & Watson, 2018) showed that the class of emphatics in these languages is of great interest and needs further investigation. Based on visual cues and mainly on the presence or absence of glottal closure and release, the study concluded that the class of emphatics in Ḥarsūsi could be of a mixed system which includes consonants realised as ejectives and non-ejectives labelled as 'backed' since the exact place of articulation is not clear. This is in line with the findings of some recent works in other MSAL languages such as Watson & Bellem (2010, 2011); Watson & Heselwood (2016); Gasparini (2017). It is worth mentioning here that the study did not investigate the nature of emphatics termed 'backed' in terms of their place of articulation. Nonetheless, there are certain acoustic cues that could be used to investigate the place of articulation such as spectral tilt, formant frequencies, and voice quality as was done in J. Al-Tamimi (2017).

The study investigated what acoustic correlates distinguished the class of emphatics from their plain counterparts. The results discussed in 5.3 6.3 showed that different acoustic correlates could be used to distinguish between the emphatics and their plain counterparts in different positions. An important finding in this area was that none of the acoustic correlates investigated in this study could be used to distinguish between emphatics and their plain voiced counterparts in utterance-final position. Such a finding, in addition to the similar phonetic realisation of emphatics and voiced counterparts in utterance-final position by being devoiced and realised as ejectives is indicative of a phonological patterning for these two classes in this environment. Some of the previous works also showed such phonetic and phonological patterning in voiced and emphatic stops in other MSAL languages (Johnstone, 1975; Watson & Bellem, 2010; Watson et al., 2020).

Finally, and based on the patterning of emphatics and voiced stops, the study tried to suggest a laryngeal categorisation for Ḥarsūsi. Different approaches could be followed to establish the phonological representations of phonetic details in Ḥarsūsi. For instance, the laryngeal realism approach could be employed to establish the phonological representations that specify the laryngeal contrast in Ḥarsūsi, as was suggested for Najdi Arabic by Al-Gamdi et al. (2019, p. 2054). As mentioned by Bahrani & Kulikov (2024, p. 5), the ‘traditional approach’ using binary features for phonological representation might be problematic in case of some languages. Therefore, other approaches such as laryngeal realism could be used to represent certain phonetic details as was shown in J. Al-Tamimi (2017). Nonetheless, the study proposed following the approach set and forward by Watson & Heselwood (2016), which suggests using (open) and (closed) glottis to account for the phonetic details of MSAL consonants, since it was mapped on other related languages.

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7.2. Summary

This PhD thesis aimed to provide an analysis of the sound system of the endangered MSAL Ḥarsūsi based on first-hand data recorded in the field after more than 40 years since the works of Johnstone which were based on field data. It is an initial step towards a comprehensive linguistic analysis of the language aiming to document and preserve the endangered language. The data collected will be used for future descriptive works on other areas of the language. The overreaching goal of the study was to analyse the sound system of Ḥarsūsi in specific, and better understand the phonology of MSAL in general. Through an interdisciplinary approach, this study has achieved several significant contributions in the area of MSAL linguistics.

The first contribution of the study was in the provision of a thorough literature review outlining the linguistic context of Oman, providing known and new information on Ḥarsūsi, and explaining the interesting facts in MSAL phonology. The literature review provided sufficient summaries for each of the languages spoken in the Sultanate of Oman to better understand the linguistic context where Ḥarsūsi is spoken. It also provided some information about the Ḥarsūsi language, its speakers, culture, lifestyle, environment, and geography. In addition, it focused on the phonology of MSAL on the group of sounds known as 'Emphatics', and raised some of the interesting facts and ongoing debates among Semitic scholars regarding this group of sounds.

The other significant contribution of the project was the detailed description of the sound system of Ḥarsūsi. Based on both, elicited and natural language data, the study described all the phonemes of Ḥarsūsi and their various allophones in various positions. Relying on instrumental phonetics, the study considered all the consonant phonemes. It showed that the class of emphatic sounds in Ḥarsūsi can be articulated in different ways, and that their realisation is context dependent. In addition, it demonstrated that the emphatic and voiced segments in Ḥarsūsi patterned together phonologically to the exclusion of voiceless segments by being realised in a similar manner in utterance-final positions.

In addition, given the phonological patterning of emphatic and voiced segments, the study contributed to the field of Semitic studies by conducting an acoustic analysis of these sounds to establish to what extent the phonological patterning is reflected in acoustic phonetics. Based on quantitative data, the study looked at: a) how the emphatics were realised in various positions; b) how the emphatics differed from their plain counterparts in various positions; and c) to what extent the phonological patterning of emphatic and voiced segments was reflected in acoustic phonetics.

One of the major results is that the class of emphatics in Ḥarsūsi seems to be of a mixed group that includes ejectives and 'backed' segments. In specific, the emphatic stops of Ḥarsūsi include both ejective and 'backed' segments based on the acoustic cues investigated in this study. The emphatic velar /k'/ is realised as an ejective in most contexts, while the emphatic alveolar /tˤ/ is realised as an ejective mainly in utterance-final positions. On the other hand, the emphatic fricatives showed acoustic cues related to ejectives in other languages, but they were not significant except in utterance-final position where ejective realisation was clearly evident.

Another result is that there are a number of acoustic parameters that can be taken into consideration to differentiate between the emphatic segments and their plain counterparts. Nonetheless, this differentiation is only possible between certain groups in certain positions. For instance, the parameter of glottal closure can differentiate between emphatic stops and their plain counterparts in all positions. On the other hand, VOT can differentiate between the various types of stops in utterance-initial and medial positions. However, oral closure duration cannot differentiate between the different types of stops. Similarly, the durational and non-durational acoustic parameters of: fricative duration, frication duration, frication intensity, silent lags, and

CoG mainly differentiated between emphatic fricatives and their voiceless counterparts. The voiced fricatives were only differentiated from the emphatic fricatives by the parameters of frication intensity and silent lags in utterance-initial position, while CoG differentiated between them in utterance-initial and medial positions only. It was not possible to differentiate between the emphatic fricatives and their voiced counterparts using any other parameter in any position.

A final contributing result of the study is the support for a laryngeal categorisation of Ḥarsūsi consonants as one based on the air flow rather than voicing, which is proposed by Heselwood (2020) and Watson & Heselwood (2016) for Semitic languages. This support in Ḥarsūsi is mainly based on the acoustic characteristics of the emphatics and their plain counterparts since the results showed that the emphatics and their voiced counterparts pattern together acoustically with the exclusion of voiceless counterparts.

7.3. Limitations

In the process of documenting and providing a comprehensive description of the phonetics and phonology of Ḥarsūsi language, a number of challenges and difficulties arose.

First, all the data used in the analyses of this project come from male speakers of Ḥarsūsi only. It was not possible to record data from female speakers for cultural reasons. Thus, the study does not cover the differences in Ḥarsūsi speech, if any, which are due to gender differences.

Second, the majority of the participants were young speakers of Ḥarsūsi except three who were above 40 years old (see 3.3). As it is a known fact in linguistics, age is a significant factor affecting language. Therefore, any language differences due to age in Ḥarsūsi are not covered by the results of this project.

Third, in the analyses of Ḥarsūsi emphatics, a number of other acoustic parameters could also have been taken into consideration such as stop overall duration, creaky voice on following vowels, and oral burst intensity. Due to time limitations, it was not possible to consider these parameters in this project, and these parameters can also suggest the nature of emphatics.

Fourth, the elicited data used in chapters 5 and 6 was recorded in isolation rather than in carrier sentences. Therefore, it was not possible to analyse certain acoustic parameters in certain positions. For instance, oral closure was not measured in utterance-initial position. Similarly, VOT was not measured in utterance-final position.

7.4. FUTURE RESEARCH

Given the fact that Ḥarsūsi is an understudied language, there are many areas that can be investigated for Ḥarsūsi in specific and the MSAL in general. From an ethnolinguistic point of view, more research needs to be done on the history of Ḥarsūsi and the Ḥarāsīs. Since Ḥarsūsi is an endangered language, documenting its cultural knowledge is a priority as it includes knowledge about life in a harsh environment. The Ḥarāsīs managed for so long to tame a very harsh environment and find means to live. Thus, this accumulated knowledge of many generations needs to be documented and preserved as soon as possible.

In addition, one of the major original contributions of this project is the detailed analyses of Ḥarsūsi emphatics and their plain counterparts. Based on acoustic analyses, the project proposes that Ḥarsūsi emphatics are of a mixed system as they include both ejective and non-ejective 'backed' consonants. Thus, more research is needed in this area to study other acoustic parameters not studied in this project and compare the results with the ones this project found.

For instance, short periods of pre-aspiration (PA) and pre-glottalisation (PG) found preceding some of the segments need to be investigated further. Other cues such as: voice quality, spectral tilt, and formant transitions also need to be studied. In addition, articulatory phonetics studies are also a potential area of investigation for the emphatics of Ḥarsūsi.

Another area of exploration in Ḥarsūsi is the effect of the class of emphatic sounds on surrounding segments. A number of studies on the emphatics of other Semitic languages have shown they have an effect on preceding and following vowel segments. It will be of great interest to explore the nature of such effect of Ḥarsūsi emphatics on surrounding segments. Furthermore, other areas of the language also need exploration as very little is known about Ḥarsūsi until now. For instance, the morphology of the language needs to be investigated and specially the verbal morphology as the MSAL are rich with various verb templates. Also, the syntax and the semantics of the language need to be studied and documented. The lexical semantics of this language will be a very interesting area of exploration to analyse the relation between the words and their meanings.

Appendices

SEGMENTATION PROTOCOL

A. Stops

1. Onset of Plosive

In utterance-initial position, the onset of oral closure was set at the point where the waveform crossed zero and energy started showing in the spectrogram, as can be seen in Figure 0.1 below. Since it is not possible to identify the start of the oral closure in initial position, as words were not recorded in a carrier sentence, the analyses only took into consideration oral closures in utterance-medial and final positions.

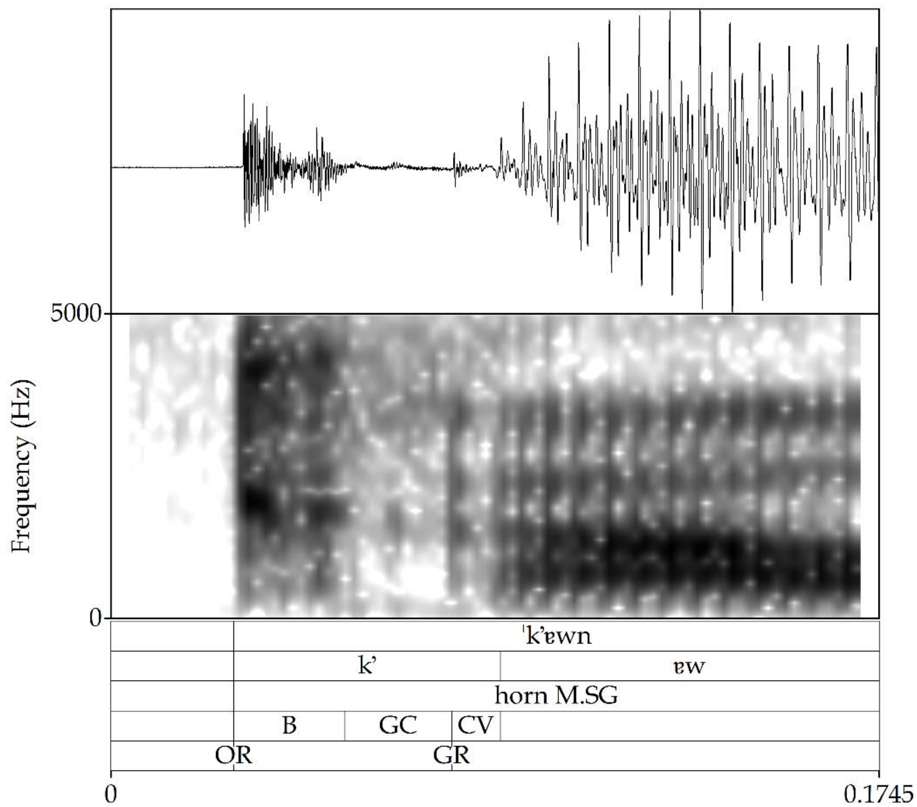

Figure 0.1: Onset of stop utterance-initially.

In other positions, the occlusion point of the stop was set at the offset of all higher frequency components of preceding segment where there was a drop in energy in the spectrogram and a damped signal in the waveform. As can be seen in Figure 0.2 below, the boundary was set where the homogenous F1-F4 formant structure disappeared (J. Al-Tamimi & Khattab, 2018, p. 310) suggesting oral closure for the stop.

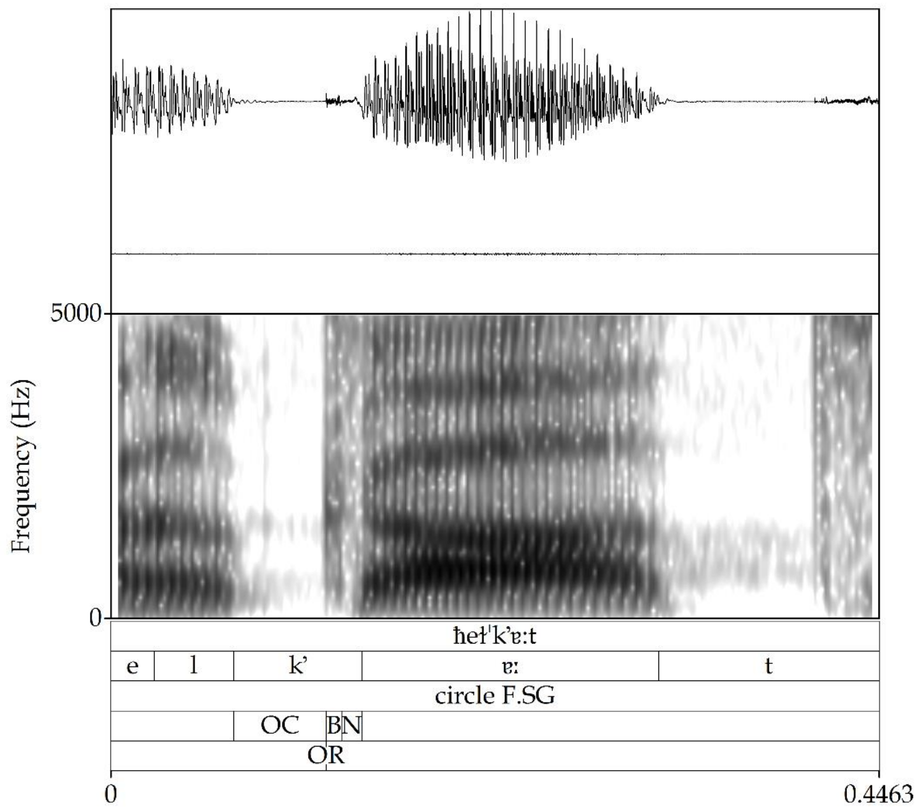

Figure 0.2: Onset of stop non-initially.

2. Offset of Plosive

The stop offset was set at the onset of the following vowel (J. Al-Tamimi & Khattab, 2018, p. 310). It was the point where the waveform crossed zero at the first regular glottal cycle of the following segment, as can be seen in Figure 0.3. In some tokens, the first cycle looked weaker than the following cycles, but it was still kept as part of the following segment and not as part of the preceding plosive as long as the cycle was regular.

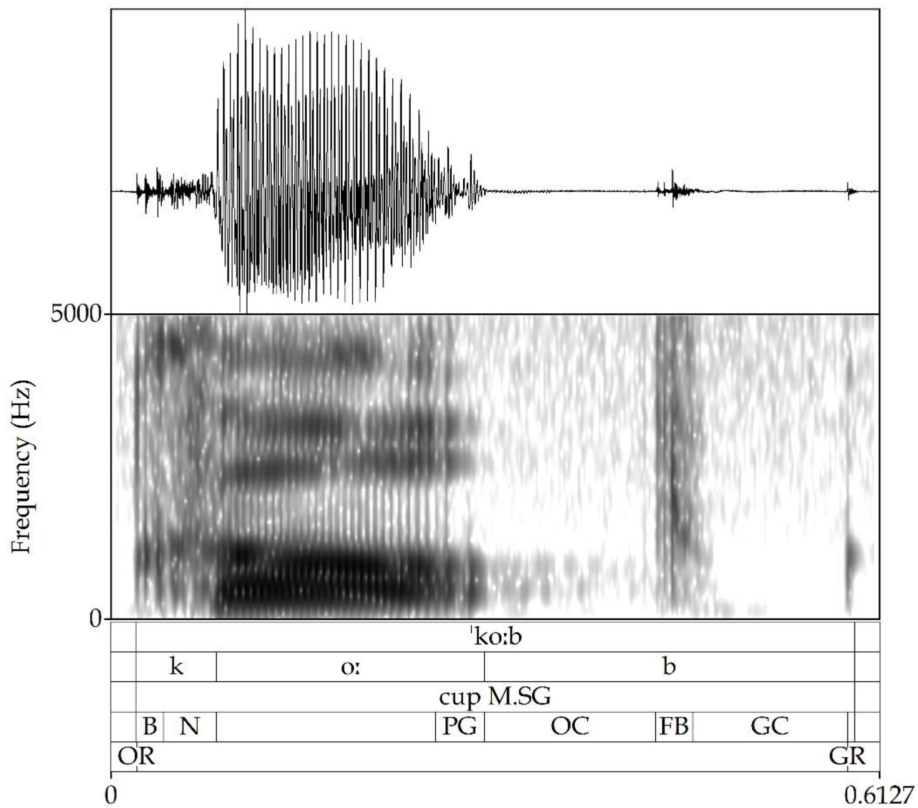

Figure 0.3: Offset of stop.

In case of following fricatives in some items, stop offset was set at the point where a change appeared in spectrogram structure and intensity suggesting the onset of frication period of the following segment as can be seen in Figure 0.4 below.

It should be noted here that some emphatic and utterance-final voiced tokens, mainly but not exclusively, were preceded by short periods where the waveform cycles got irregular, some higher formants dampened, and striations could be seen in the spectrogram and especially after long vowels. Such periods of irregular vocal fold vibration and sudden drop of f0 were labelled as PG (Pre-glottalisation) (Hejná, 2023, p. 1876). Similarly, some of the voiceless segments were preceded with short periods of aperiodicity or "glottal friction" (Hejná, 2023, p. 1876). These periods were included as part of the preceding vowels in this study and the onset of oral closure for the stop was set as was explained above at the offset of higher frequency components. These periods were not included as part of the consonant because it was difficult to identify their onsets as some of the preceding vowels were almost fully breathed or glottalised. Since oral closure duration was one of the cues being analysed, the onset of it was carefully marked where there was a drop in energy in higher formants in the spectrogram and a damped signal in the waveform. Figure 0.4 below shows the segmentation for a voiceless velar stop which included a short period of aperiodicity in the waveform and dampened energy in the spectrogram which looks like a pre-aspiration period in this token.

3. Oral Closure

It is not possible to identify the start of an oral closure in utterance-initial positions; therefore, closure duration was measured only for utterance-medial and utterance-final stops. Closure duration was measured from the stop occlusion point until its burst point as can be seen in Figure 0.4 below.

4. Burst

The burst point was set at the start of noise in both waveform and spectrogram (Al-Gamdi et al., 2019, p. 2052) where there was visible energy in the spectrogram and a high spike in the signal in the waveform. The onset of burst was set as the first visible burst in the waveform where there was a high spike and the offset was set as the last visible burst that was separated by less than 5ms from the previous burst (J. Al-Tamimi & Khattab, 2018, p. 310). The first high spike in this noise was set as the oral release point as can be seen in Figure 0.4.

5. Noise

The label (N) was used for the short period of aperiodicity following the oral burst. When followed by a vowel, the offset of the noise period was set where the waveform started showing regular constant cycles indicating modal voicing for the following vowel segment. When followed by a fricative, the offset of the noise period was set at the point where a change appeared in spectrogram structure and intensity suggesting the onset of fricaion period of the following segment as can be seen in Figure 0.4.

6. Pre-aspiration

The label (PA) was used to mark the period of glottal frication (Hejná & Kimper, 2018; Hejná, 2023) which showed as frication noise in the waveform mainly, but not exclusively, at the end of long vowels as seen in Figure 0.4 below. This period was not included in the statistical analyses, as it was beyond the scope of this study.

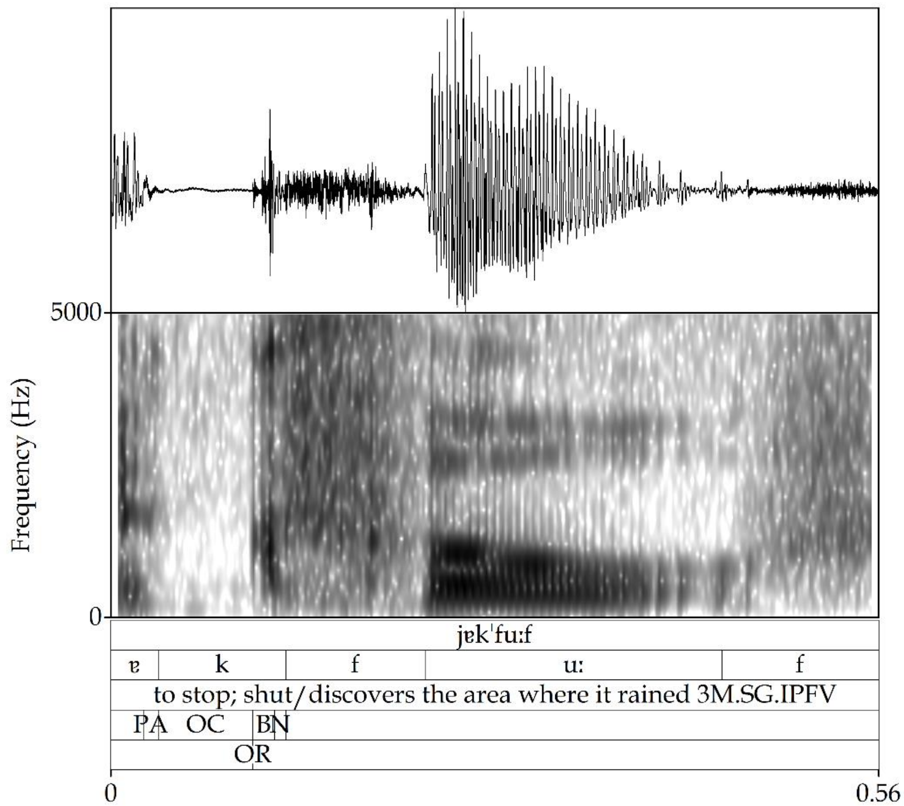

Figure 0.4: A token of voiceless velar /k/ showing pre-aspiration period.

7. Pre-glottalisation

The last period of long vowels mainly, but not exclusively, which showed irregular glottal pulses and a sudden drop in F0 (Hejná & Kimper, 2018; Hejná, 2023) was labelled as (PG). This period showed irregular cycles in the waveform and striations pulled apart from each other in the spectrogram as seen in Figure 0.5 below. This period was not included in the statistical analyses, as it was beyond the scope of this study.

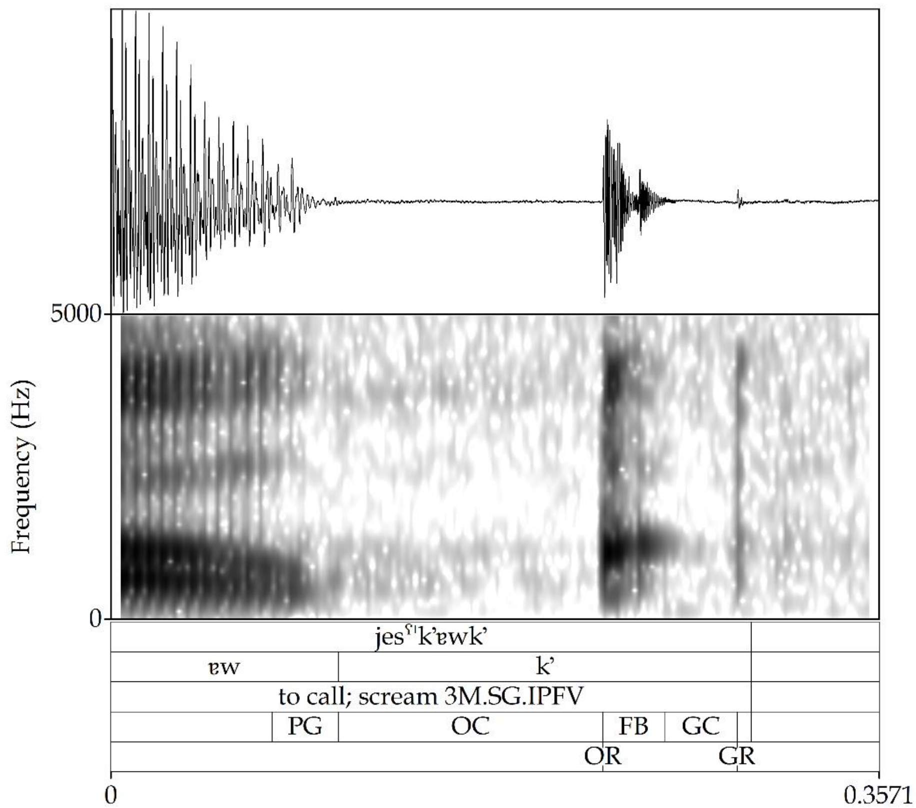

Figure 0.5: Pre-glottalisation period.

8. VOT Duration

VOT was measured for utterance-initial and medial stops only. Positive VOT was measured from the start of the oral release burst to the first glottal pulse of the following vowel (Hajek & Stevens, 2005; Gallagher & Whang, 2014; Al-Gamdi et al., 2019). In voiced stops, negative VOT was measured from the start of pre-voicing until the release burst of the segment.

9. Glottal Closure

The presence of glottal closure was expected from the presence of a silent period following the initial burst period which was considered as an oral release in addition to impressionistic auditory analysis of the data. Glottal closure was set as the period following the first burst period where there was a significant drop in amplitude. The onset of glottal closure was set as the offset of all higher frequency components where there was a break-in of energy in the spectrogram and a damped signal in the waveform as seen in Figure 0.6 below.

10. Glottal Release

Glottal release was marked as the first spike following the glottal closure duration where the waveform crossed zero, as seen in Figure 0.6 below. It should be noted here that some of the glottal releases in the data were weaker than others, but the first spike crossing the zero line after the glottal closure was marked as a glottal release. In addition, the glottal release in all tokens was marked as the spike which was not followed by a long burst period, differentiating it from oral release (see 4 above).

11. Creaky Voice

It is worth mentioning here that some tokens showed voice quality change in form of creaky voice which is seen in some of the figures. The period with irregular glottal cycles which showed as striations in the spectrogram following assumed glottal release was labelled as (CV) as seen in Figure 0.6 below. It should be noted here, however, that this period was not included in the statistical analyses.

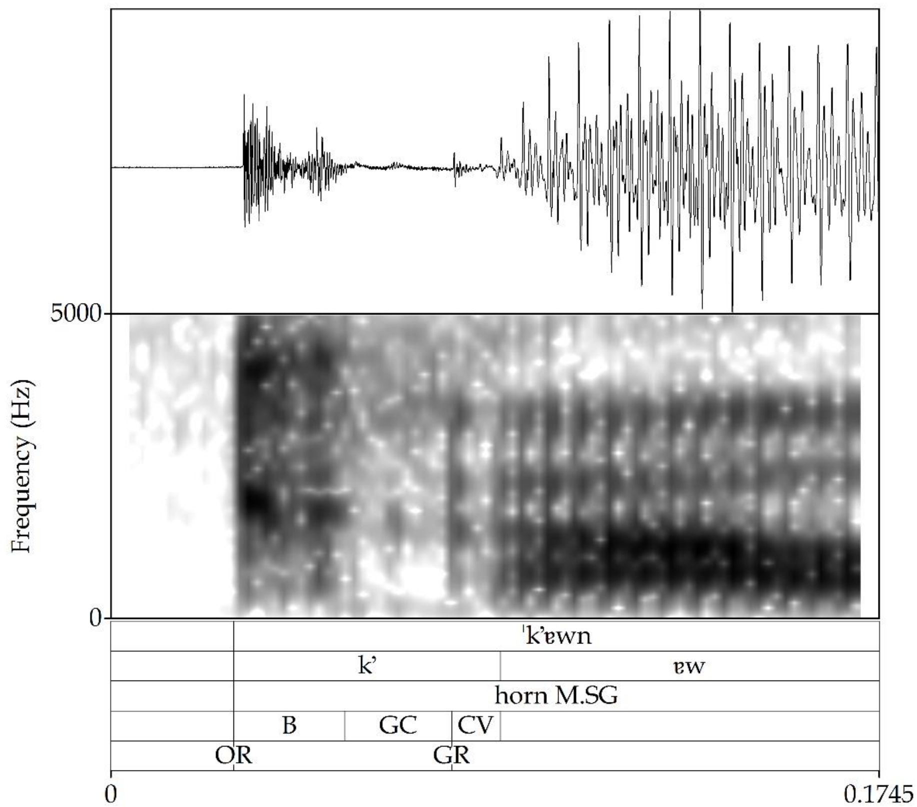

Figure 0.6: Onset and offset of glottal closure.

12. Silent Lag

The label (SL) was used for the short period of silence where no activity was visible in both the waveform and the spectrogram as seen in Figure 0.7 below. The offset of this silent period was set where the waveform started showing either aperiodicity or constant cycles and energy started showing in the spectrogram.

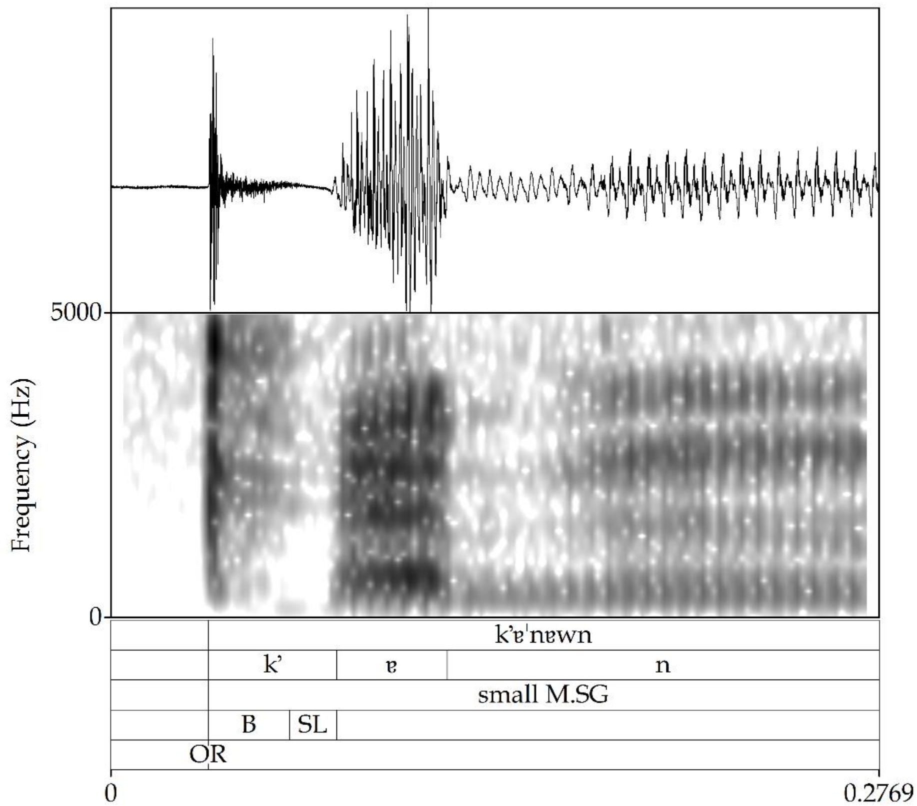

Figure 0.7: Period of Silent-lag.

B. Fricatives

1. Onset of Fricatives

In utterance-initial position, the onset for fricatives was set at the start of frication where the yellow intensity line and/or higher energy showed at higher frequencies in the spectrogram and the waveform became aperiodic. For voiced fricatives, the onset was set at the start of voicing where energy showed in the voicing bar if there were any instances of pre-voicing. Figure 0.8 below shows the onset boundary for the emphatic alveolar fricative /sˤ/ in utterance-initial position.

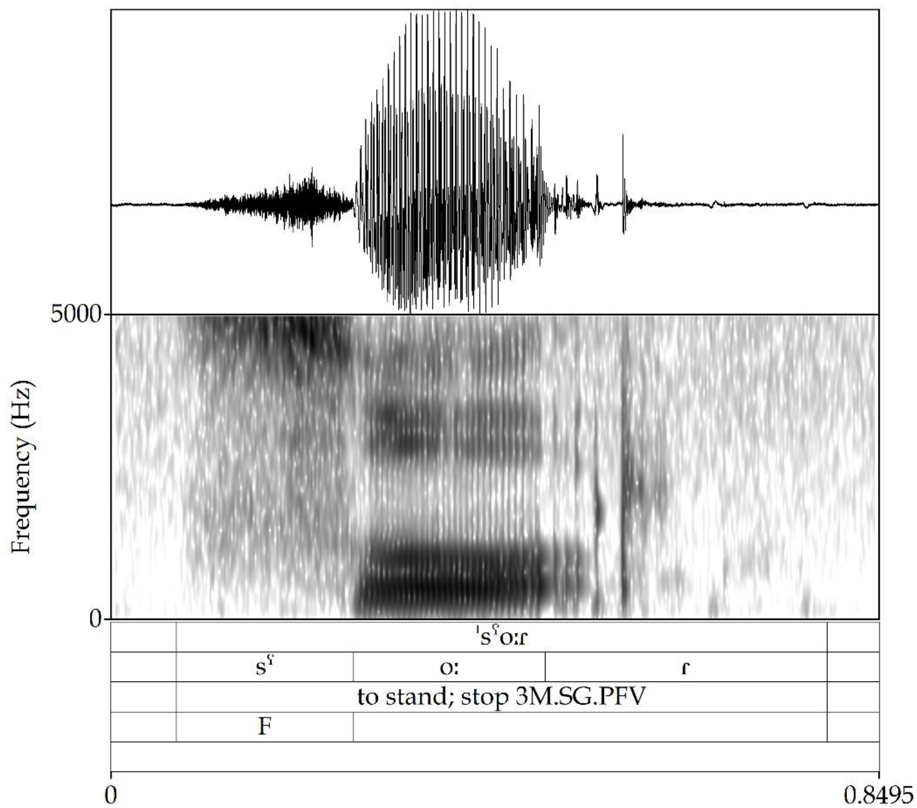

Figure 0.8: Onset of fricative initially.

In other positions, the onset of frication was set at the offset of the previous segment where frication started as the waveform became aperiodic and energy started showing in higher frequencies in the spectrogram, as seen in Figure 0.9 below.

When preceded by a fricative, setting the target fricative onset became more challenging. Nonetheless, considering the spectrogram with a higher view range, the onset of the target fricative was set at the points where a change appeared spectrogram structure and intensity. For instance, the onset of the target fricative when preceded by another fricative was set at the point of a sudden increase or decrease of intensity and spectrogram structure change as seen in Figure 0.10 below.

2. *Offset of Fricatives*

The offset of the fricatives was set at the point where the waveform became periodic and did not show any jerky or jagged parts signalling the onset of the following segment, as seen in Figure 0.9 below. When followed by a fricative, the offset was defined at the points where a change appeared in spectrogram structure and intensity as seen in Figure 0.10 below. In case of a following stop, the offset of the fricatives was defined at the offset of all higher frequency components in the spectrogram where there was a damped signal in the waveform suggesting an occlusion as seen in Figure 0.11 below.

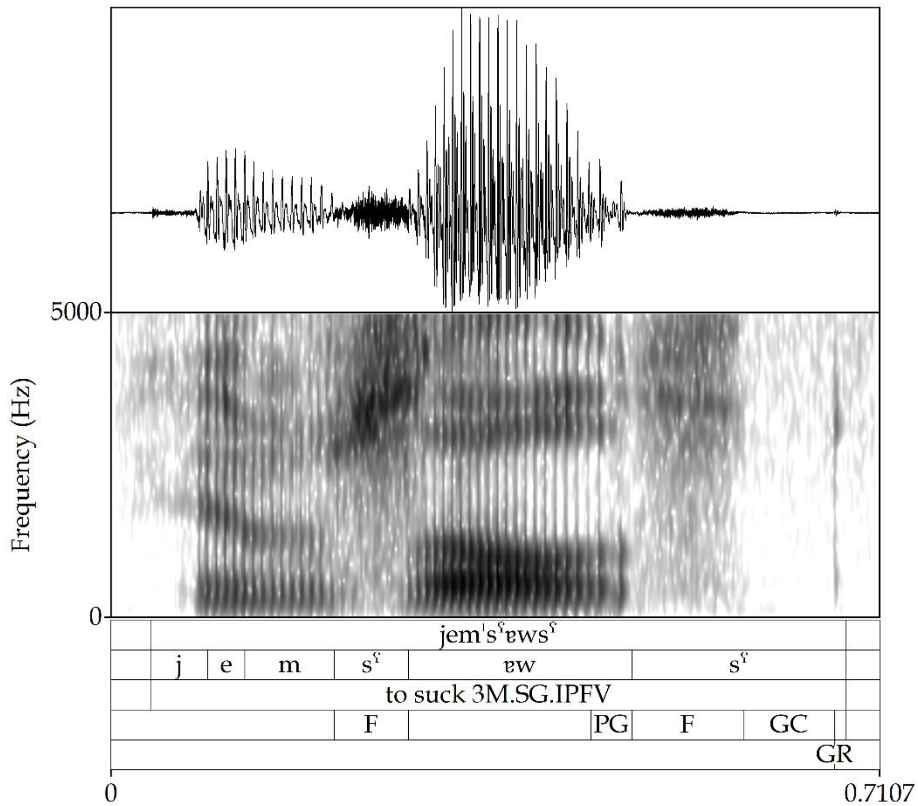

Figure 0.9: Onset of fricative non-initially.

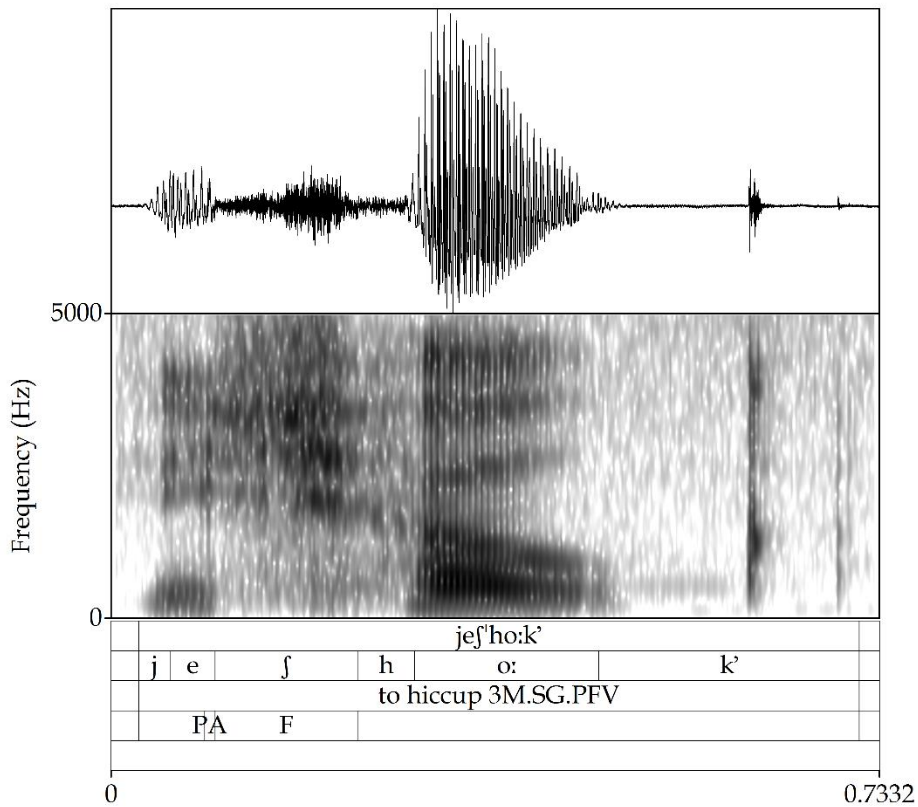

Figure 0.10: Fricative followed by another fricative.

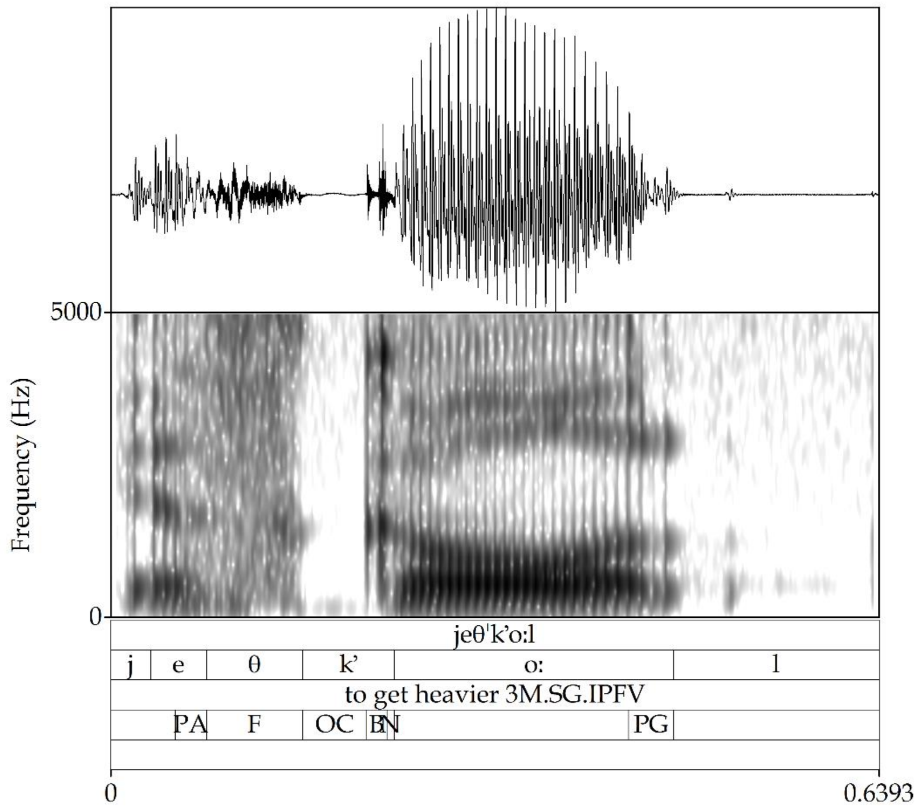

Figure 0.11: Fricative followed by a stop.

3. *Pre and Post-frication Silent Lags*

The labels (IS) for initial silence and (BS) for back silence were used to mark silent periods in the articulation of the fricatives. Similar to the segmentation process of stops, a silent period was defined as the short period of silence where no activity was visible in both the waveform and the spectrogram as seen in Figure 0.12 and Figure 0.13 below. Both the waveform and the spectrogram were used to define periods of no activity, and any activity, even weak, was not considered as a silent gap. The onset of the silent period was set as the point were no energy was visible in the spectrogram and the sine line in the waveform showed no activity. The offset of the silent period was set at the point where the waveform crossed zero showing either aperiodicity or constant glottal cycles and energy started showing on the spectrogram.

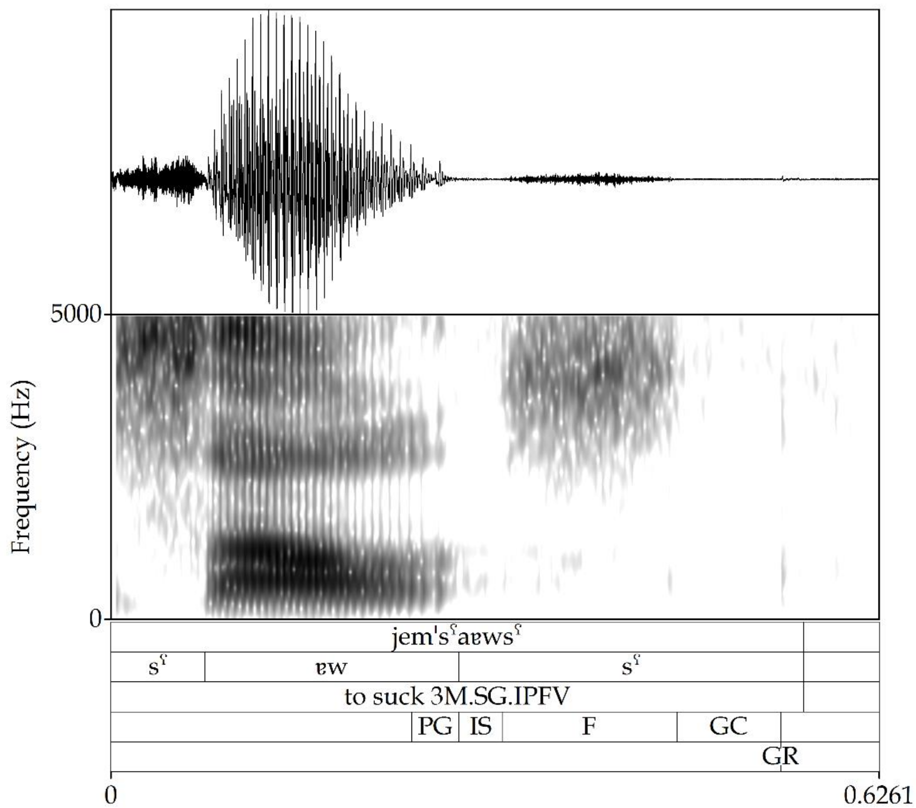

Figure 0.12: Pre-frication silence in fricative.

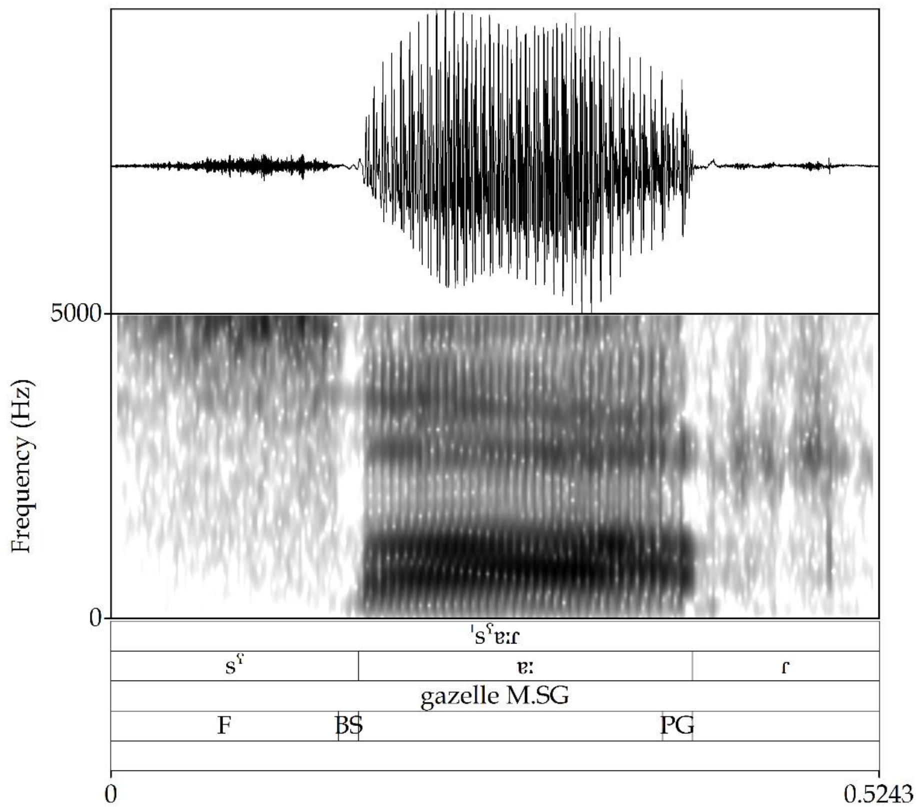

Figure 0.13: Post-frication silence in fricative.

4. Pre-aspiration

The same criteria mentioned in 6 above was followed to mark any periods of pre-aspiration.

5. Pre-glottalisation

The same criteria mentioned in 7 above was followed to mark any periods of pre-glottalisation.

6. Glottal Release

The first spike of a burst, if any, following a silent period was marked as glottal release regardless of its intensity. As mentioned above in 10 above, some of the glottal releases were weaker than others.

VOWEL PLOTTING ITEMS

The items used to plot the vowels of Ḥarsūsi are given in the table below. The vowel chart is given in 4.4.

Each one of these items was repeated three times by each participant. Only five speakers of Ḥarsūsi participated in recording the items.

Vowel Phoneme	Item	Gloss
ɐː	/tɐːb/	‘to weary, become tired 3M.SG.PFV’
eː	/ʔɐteːn/	‘you 2F.PL’
iː	/θiːt/	‘sheep F.SG’
oː	/ʔɐtoːm/	‘you 2M.PL’
uː	/ħɐːduːten/	‘hand F.PL’
ɐ	/tɐw/	‘now ADV’
e	/tek’/	‘to drink 3M.SG.PFV’

PROTOCOLS

To run the analyses required for chapter five on the Phonetic Realisation of Emphatics in Ḥarsūsi a number of steps and procedures were taken to prepare the raw data and run the required analyses.

In addition, a number of programmes and software were used to help in preparing the data and running the analyses such as PRAAT, R, and Microsoft Excel.

Below are the step-by-step procedures which were followed in the process of data analyses:

1. The recorded WAV files were renamed following this criteria: *Date(YearMonthDay)_Language country and name(OHarsusi)_Village code and speaker code(AM000)_Phoneme(phonemic symbol)*, and saved separately for each speaker.
2. All the WAV files were converted from stereo into mono in PRAAT. A PRAAT script was modified and used to convert the files and save the original files and the converted ones in separate folders.
3. The files were saved in three separate places: OneDrive of University of Leeds, External password protected personal Hard-Drive, and personal password protected laptop.

4. Using a modified PRAAT script textgrids with same WAV files names were created for all files with six tiers *(Transcription – Segments – Translation – Stress – VOT – Releases)*. The WAV and textgrid files were saved in the same folders.
5. Using another modified PRAAT script, pauses were marked individually for each WAV file and boundaries were added to the first five interval tiers. These boundaries were later hand-corrected for every segment which working on the textgrids.
6. Using another modified PRAAT script, Transcription and Translation labels were added to each textgrid individually.

DATA MANAGEMENT

Discarded tokens:

- One token of /defuːɾ/ from speaker (id 024) was not voiced and had a negative VOT (item ID 16).
- One token of /doːɾ/ from speaker (id 002) was not voiced and had a negative VOT (item ID 2).
- One token of /doːɾ/ from speaker (id 014) was not voiced and had a negative VOT (item ID 6).
- One token of /jesguːg/ from speaker (id 020) was not voiced and had a negative VOT (item ID 28).
- One token of /gofficial heːm/ form speaker (id 022) was not voiced and had a negative VOT (item ID 24).
- One token of /ʃˤefˈɾuːt/ from speaker (id 014) was missed out during recording as only the second syllable was found in the recording.
- One token of /ʃˤefˈɾuːt/ from speaker (id 011) was missed out during recording as only the second syllable was found in the recording.
- One token of /jek’foːd/ from speaker (id 022) was miss-pronounced.

Consent Form

Consent for Participation in Research

Title: The Modern South Arabian Harsusi Language of Oman

Introduction

The purpose of this form is to provide you with information that may affect your decision as to whether or not to participate in this research study. The person performing the research will answer any of your questions. Read the information below and ask any questions you might have before deciding whether or not to take part. You will have one week to make your decision whether to participate in this research or not. If you decide to be involved in this study, your verbal consent will be recorded before collecting any data.

Purpose of the Study

You have been asked to participate in a research study about the Harsusi language, a Modern South Semitic (Southern Arabian) language indigenous to Oman. The purpose of this study is to document the Harsusi language, including its speech sounds, morphology, and sentence structures. It tries to provide a comprehensive record of the language.

What will you be asked to do?

If you agree to participate in this study, you will be asked to:

- Listen to recordings of words or sentences in Arabic or English and say them in Harsusi.
- Provide us with names of objects in your own environment or objects we ask you about.
- Listen to words and sentences in Harsusi and judge their correctness or provide us with your own way of saying the same words or sentences.
- Pronounce words and sentences several times slowly in order for the researcher to write them down and record them as audio or video if you agree to video recording in this consent form.
- Allow yourself to be recorded in audio and, if you agree to it, in video (see below) in different settings such as formal interviews or casual everyday conversations.
- Tell stories in your own language and allow yourself to be audio-recorded and, if you agree to it, video-recorded (see below).

This study will require at least one session of two hours, with two breaks of 10 minutes. There will be the option to participate in further sessions, also lasting two hours each with two 10 minute breaks. There may be as many as 8 participants in this study.

Your participation will be audio recorded, and it may also be video recorded if you consent to video recording.

What are the risks involved in this study?

The risks associated with this study are no greater than everyday life; nonetheless:

- Linguistic work is challenging intellectually and may cause you some minor fatigue;
- We will do our best to protect your privacy and confidentiality unless you allow or require your participation to be made public, but there is still a slight risk of loss of privacy or confidentiality if you decide to talk about your personal life, or give information known only in the community or culture;
- Although we will do our best to acknowledge your intellectual contributions to us if you ask us to, there is a slight risk of misattribution or non-attribution of your contribution.

What are the possible benefits of this study?

You will receive no direct benefit from participating in this study; however, this study will be the first of its kind on Harsusi language. This will help to keep the language alive and make it known. This study will allow you to:

- Learn to write and analyze your language;
- Learn to teach others to write and analyze your language;
- Be involved in the support and preservation of your language;
- Provide your community with documentation of its language and oral traditions and contribute to the revitalization of the language.

Do you have to participate?

No, your participation is voluntary. You may decide not to participate at all or, if you start the study, you may withdraw at any time before 01/03/2022. Withdrawal or refusing to participate will not affect your relationship with the researcher or The University of Leeds in any way.

If you would like to participate, you will receive a copy of this form.

Will there be any compensation?

You will not receive any type of payment for participating in this study.

How will your privacy and confidentiality be protected if you participate in this research study?

Your privacy and the confidentiality of your data will be protected as follows:

- the records of your participation in this study will be stored securely and kept confidential, except if you allow or require that they be made public;
- Sound and video recordings of your data, and any associated recording media, will be coded so that no personally identifying information is visible on them, except if you allow or require that it be made public;
- Authorized persons from the University of Leeds, including members of the Ethical Review Committee, have the legal right to review your research records and will protect the confidentiality of those records to the extent permitted by law.
- All publications will exclude any information that will make it possible to identify you as

a subject, except as you request or require.

- Throughout the study, the researchers will notify you of new information that may become available and that might affect your decision to remain in the study.
- The data resulting from your participation may be made available to other researchers in the future for research purposes not detailed within this consent form. In these cases, the data will contain no identifying information that could associate it with you, or with your participation in any study, except if you require acknowledgment of your data by those researchers.

If it becomes necessary for the Ethical Review Committee to review the study records, information that can be linked to you will be protected to the extent permitted by law. Your research records will not be released without your consent unless required by law or a court order. The data resulting from your participation may be made available to other researchers in the future for research purposes not detailed within this consent form. In these cases, the data will contain no identifying information that could associate it with you, or with your participation in any study.

If you choose to participate in this study:

- You will be audio recorded and, if you consent to it, also video recorded. Any audio and/or video recordings will be stored securely and only the research team will have access to the recordings, except as you request or require.
- Recordings will be stored at:
  University of Leeds OneDrive/ M or N Drives.

- Recordings may be archived at:

- Endangered Language Archive:
  http://www.elar-archive.org/index.php
- Endangered Languages Documentation Program:
  http://www.eldp.net

  The archives will respect your wishes regarding privacy, confidentiality, and the dissemination of your data.

- If you find that you have accidentally said something embarrassing in a recording, please tell us, and we can erase it.

- If you wish for us to stop recording at any time, we will stop recording.

Uses of your data

There are other ways that we may want to use your data in the future. Please let us know which of the following ways you permit us to use the words, sentences, and recordings from our work with you. You can freely decide whether or not you would like this information used in these ways. If you decide that you would not like this

information to be used in these ways, this will not affect whether or not you are allowed to participate in the research study.

1. Today it is common practice to put language documentation data in a digital language archive. We may wish to archive your data at:
- Endangered Language Archive:
http://www.elar-archive.org/index/php

When data is put in a digital archive, it is preserved permanently and is made accessible to registered archive visitors, except if you place conditions on access. Is this permissible with regard to: Audio recordings___ ; Video recordings ___ ; still photographs___; written notes by you or by us___ ? (State yes; yes with conditions; or no; if there are conditions, please state).

2. We may wish to present your data at an academic conference or in a classroom. Is this permissible with regard to: Audio recordings___ ; Video recordings ___ ; still photographs___; written notes by you or by us___ ? (Yes or no?)

3. We may wish to use your data in creating language learning materials. Is this permissible with regard to: Audio recordings___ ; Video recordings ___ ; still photographs___; written notes by you or by us___ ? (Yes or no?)

4. We may wish to use your data in academic publications. Is this permissible with regard to: Audio recordings___ ; Video recordings ___ ; still photographs___; written notes by you or by us___ ? (Yes or no?)

If you answered yes to 1, 2, 3, or 4: When linguists present the results of their work to the public, it is customary for them to name and say thank you to language speakers for their contributions. May we use your name in public for that purpose? (Yes or no?)

If your answer was 'no' just above, we will not associate your name with the your data, and all uses of your data will exclude any information that will make it possible to identify you as a subject.

Whom to contact with questions about the study?

Prior, during or after your participation you can contact the researcher Hammal Saleh Al Balushi at +968 97772141 ; +66 7810538801 or send an email to mlhsab@leeds.ac.uk for any questions or if you feel that you have been harmed. This study has been reviewed and approved by The University of Leeds Ethical Review Committee and the study number is [].

Whom to contact with questions concerning your rights as a research participant?

For questions about your rights or any dissatisfaction with any part of this study, you can contact, anonymously if you wish, Ethical Review Committee by phone at +66 113 34 34873 or email at ResearchEthics@leeds.ac.uk.

You will be given a copy of this information to keep for your records.

Statement of Consent: (Audio or Video recorded)

I have been informed about this study's purpose, procedures, possible benefits and risks, and I have received a copy of this form. I have been given the opportunity to ask questions before giving consent, and I have been told that I can ask other questions at any time. I voluntarily agree to participate in this study.

ARABIC CONSENT FORM (TRANSLATED)

الموافقة على المشاركة في بحث
العنوان: اللغة الجنوبية العربية الحديثة الحرسوسية

مقدمة:
الهدف من هذا الاستمارة هو توفير معلومات قد تؤثر على خيارك في المشاركة في هذا البحث من عدمه. الباحث سيجيب على جميع التساؤلات لديك. اِقرأ المعلومات أدناه واسأل الباحث ان كانت لديك اسئلة قبل الموافقة على المشاركة في هذا البحث. لديك اسبوع واحد لاتخاذ قرار المشاركة من عدمه. ان وافقت على المشاركة في البحث، سيتم تسجيل موافقتك عن طريق الصوت او الفيديو.

الهدف من البحث:
تم الطلب منك للمشاركة في هذا البحث عن اللغة الجنوبية العربية الحرسوسية والتي تتواجد في موطنها سلطنة عمان. الهدف من هذا البحث هو توثيق اللغة الحرسوسية بما فيها الأصوات والكلمات والبناء اللغوي. يحاول البحث توفير سجل شامل للغة.

ما الذي سيطلب منك؟
إن وافقت على المشاركة في هذا البحث، سيتم الطلب منك بأن:

- تستمع الى تسجيلات لكلمات وجمل باللغة العربية او الانجليزية ومن ثم ترجمتها الى الحرسوسية.
- توفّر أسماء أشياء في بيئتك أو أسماء أشياء نسألك عنها.
- تستمع الى كلمات وجمل باللغة الحرسوسية وتحكم على صحتها أو توفر لنا على طريقة قولك لنفس الأسماء والجمل.
- تنطق كلمات وجمل لعدة مرات ببطء حتى يتسنى للباحث كتابتها وتسجيلها صوتيا وصوريا كفيديو إن وافقت على التسجيل كفيديو.
- تسمح بالتسجيل صوتيا وكفيديو إن وافقت على التسجيل كفيديو في مختلف الأماكن مثل المحادثات اليومية الروتينية والمقابلات.
- تقص قصصا في لغتك وتسمح بالتسجيل صوتيا وكفيديو إن وافقت على ذلك.

ستحتاج هذه الدراسة على جلسة واحدة على الاقل لمدة ساعتين يتخللها استراحة لمدة عشرة دقائق. سيكون لك الخيار للمشاركة لجلسات أخرى. سيكون هناك حوالي 8 مشاركين في هذا البحث.
مشاركتك سيتم تسجيلها صوتيا كما من الممكن أن يتم تسجيلها كفيديو إن وافقت عل ذلك.

ما هي المخاطر المحتملة في هذا البحث؟
المخاطر المحتملة في هذه الدراسة لا تتعدى المخاطر اليومية العادية ولكن:

- العمل اللغوي يعتبر تحديا ومن الممكن ان يكون مرهقا قليلا.
- سنبذل ما بوسعنا للحفاظ على سريتك الا ان تسمح أو تطلب بأن يتم الإعلان عن مشاركتك ولكن مع ذلك فهناك إحتمالية بسيطة لفقد السرية إن تحدثت عن حياتك الشخصية أو أعطيت معلومات يعلم عنها فقط في ثقافتك أو مجتمعك.
- على الرغم من أننا سنبذل قصارى جهدنا بأن نعترف ونذكر مشاركاتك العلمية في هذا البحث إن أردت منا ذلك ولكن هناك احتمالية بسيطة لسوء إسناد او عدم اسناد مساهماتك.

ما هي الفوائد المحتملة من هذا البحث؟
لن تتلقى أي فائدة مباشرة من المشاركة في هذا البحث ولكن هذا البحث سيكون الاول من نوعه على اللغة الحرسوسية وهذا سيساعد على إبقائها حية ومعروفة. هذا البحث سيمكنك من:

- تعلم كتابة وتحليل لغتك.
- تعلم تعليم الاخرين الكتابة وتحليل اللغة الحرسوسية.
- المشاركة في دعم وحفظ اللغة.
- توفر للمجتمع حفظ اللغة والقصص المروية والمشاركة في إعادة إحيائها.

هل يجب عليك المشاركة؟
لا، مشاركتك تعتبر تطوعية. يمكنك ان تقرر بأن لا تشارك بتاتا وإن بدأت المشاركة في البحث فيمكنك الإنسحاب في أي وقت تشاء قبل 2022/03/01. الإنسحاب أو رفض المشاركة لن تؤثر على علاقتك مع جامعة ليدز او الباحث بأي شكل من الأشكال. إن أردت المشاركة فستحصل على نسخة من هذه الاستمارة.

هل سيكون هناك تعويضات؟
لن تستلم على أي نوع من التعويضات للمشاركة في هذا البحث.

كيف سيتم الحفاظ على سريتك إن شاركت في هذا البحث؟
سيتم الحفاظ على سريتك وسرية المعلومات حسب التالي:

- سجلات مشاركتك في هذا البحث سيتم تخزينها بشكل آمن وسيتم حفظها بشكل سري إلا إن سمحت أو طلبت أن يتم الإعلان عنها.
- الملفات الصوتية والفيديو وأي ملفات أخرى سيتم تشفيرها ولن تحمل أي معلومات شخصية متصلة بك إلا إن سمحت أو طلبت أن يتم الإعلان عنها.
- الأشخاص المخولون من جامعة ليدز وأعضاء مجلس المراجعة الاخلاقية لديهم الحق القانوني لمراجعة سجلات البحث وسيحافظون على سرية هذه السجلات حسب ما يسمح له القانون.
- جميع المنشورات لن تحتوي على أي معلومات شخصية متصلة بك تمكن من التعرف عليك إلا أن سمحت أو طلبت بذلك.
- على طول مدة البحث سيبلغك الباحثون عن معلومات جديدة يمكن ان تتوفر وتؤثر على قرارك في البقاء في الدراسة.
- المعلومات الناتجة عن مشاركتك يمكن ان يتم مشاركتها مع باحثين اخرين في المستقبل من أجل الأغراض العلمية ولكنها لن تحمل أي معلومات شخصية متصلة بك أو بمشاركتك في هذا البحث إلا إن سمحت أو طلبت أن يتم الإعلان عنها.

اذا لزم الامر لمجلس المراجعة الاخلاقية بأن يراجعوا سجلات هذا البحث فسيتم الحفاظ على سرية المعلومات التي يمكن ان تعرف عليك حسب ما يسمح به القانون. لن يتم الإفصاح عن سجلات معلوماتك إلا بموافقتك أو بطلب من القانون وأمر قضائي. والمعلومات المتوفرة من مشاركتك يمكن أن يتم مشاركتها مع باحثين آخرين في المستقبل من اجل الأغراض العلمية ولكنها لن تحمل أي معلومات شخصية متصلة بك أو بمشاركتك في هذا البحث.

إن قررت المشاركة في هذا البحث:

- سيتم تسجيلك صوتيا وكفيديو إن وافقت على التسجيل كفيديو. أي مواد صوتية وفيديو سيتم تخزينها بشكل آمن وفريق البحث فقط يستطيع العمل بها إلا إن سمحت أو طلبت غير ذلك.

- سيتم حفظ الملفات في:
موقع رفع وحفظ الملفات لجامعة ليدز OneDrive/M or N Drives
- قد يتم أرشفة الملفات على:
سجل اللغات المهددة بالإنقراض
http://www.elar-archive.org/index.php

برنامج حفظ اللغات المهددة بلإنقراض
http://www.eldp.net

ستحافظ هذه الأرشيفات على سريتك وعلى نشر معلوماتك.

- إن وجدت بأنك قلت بدون دراية شيئا مخجلا في التسجيلات فيمكنك اخبارنا لنقوم بمحوها كليا.
- سنوقف التسجيل في أي وقت ترغب به.

استخدام معلوماتك.
هنالك طرق أخرى يمكن أن نرغب في استخدام المعلومات بها في المستقبل. نرجوا ان تخبرنا بأي الطرق التالية يمكننا أن نستخدم الكلمات والجمل والتسجيلات بعد العمل معك. يمكنك أن تختار بشكل حر إذا تريد ان يتم استخدام المعلومات بهذه الطريقة أم لا. إن قررت بأنك لا تريد إسخدام هذه المعلومات بهذه الطريقة فإن هذا لن يؤثر على مشاركتك في هذا البحث.
1. من الممارسات الشائعة هذه الأيام بأن توضع المعلومات المستمدة من حفظ اللغات في أرشيفات إلكترونية. يمكن أن نرغب بأرشفة المعلومات في
أرشيف اللغات المهددة بالإنقراض
http://www.elar-archive.org/index/php
عندما يتم وضع المعلومات في الأرشيف فإنها تصبح محفوظة بشكل دائم ويتم توفيرها للمسجلين من زوار الأرشيف إلا إن وضعت شروطا للدخول. هل هذا مسموح بالنسبة للتسجيلات الصوتية____للفيديو____الصور الثابتة____الكتابات والمذكرات المكتوبه منك او منا____؟ (اكتب نعم، نعم بشروط، او لا، ان كانت هناك شروط معينة يجب كتابتها).
2. من الممكن أن نرغب في تقديم المعلومات في المؤتمرات الأكاديمية أو في المحاضرات الصفية. هل هذا مسموح بالنسبة للتسجيلات الصوتية____للفيديو____الصور الثابتة____الكتابات والمذكرات المكتوبه منك او منا____؟ (اكتب نعم، نعم بشروط، او لا، ان كانت هناك شروط معينة يجب كتابتها).
3. من الممكن أن نرغب في استخدام المعلومات في خلق مواد لغوية تعليمية. هل هذا مسموح بالنسبة للتسجيلات الصوتية____للفيديو____الصور الثابتة____الكتابات والمذكرات المكتوبه منك او منا____؟ (اكتب نعم، نعم بشروط، او لا، ان كانت هناك شروط معينة يجب كتابتها).
4. من الممكن أن نرغب في إستخدام المعلومات في منشورات أكاديمية. هل هذا مسموح بالنسبة للتسجيلات الصوتية____للفيديو____الصور الثابتة____الكتابات والمذكرات المكتوبه منك او منا____؟ (اكتب نعم، نعم بشروط، او لا، ان كانت هناك شروط معينة يجب كتابتها).
إن أجبت بنعم للأسئلة 1 و2 و3 و4 فإنه من المعتاد حين يقدم اللغويون نتائج دراساتهم بأن يسمّوا ويشكروا الأشخاص الذي ساعدوهم في البحث. هل نستطيع ذكر اسمك في العلن من أجل هذا الغرض؟ (نعم ام لا)
أن كان جوابك بلا فلن نربط اسمك بمعلوماتك وكل الاستخدامات لمعلوماتك لن تحتوي على أي معلومات من الممكن ان تؤدي الى الكشف عن هويتك.
مع من تتواصل في حال وجود اسئلة متعلقة بالبحث؟
قبل أو أثناء أو بعد مشاركتك في البحث تستطيع الإتصال بالباحث همّل البلوشي على الرقم +968 97772141 أو عن طريق البريد الإلكتروني mlhsab@leeds.ac.uk في حال وجود اسئلة أو في حال شعورك بأنك قد تضررت. تم مراجعة هذه الدراسة والموافقة عليها عن طريق مجلس المراجعة الاخلاقية ورقم البحث هو ()

مع من تتواصل بخصوص اسئلة تتعلق بحقوقك كمشارك في البحث؟
للإستفسارات عن حقوقك أو عدم الرضا عن أي جزء من اجزاء الدراسة فيمكنك الإتصال بشكل مجهول ان رغبت في ذلك بمجلس المراجعة الأخلاقية على الرقم 0113 34 34873 أو عن طريق البريد الإلكتروني :
ResearchEthics@leeds.ac.uk

المشاركة
إن وافقت على المشاركة في هذا البحث فيرجى التسجيل صوتيا او فيديو مع الباحث.
سيتم توفير نسخة لك من اجل سجلاتك.
بيان الموافقة
تم تبليغي عن هدف وطريقة وفوائد ومخاطر هذا البحث وقد استلمت نسخة من هذا الملف. تم منحي فرصة السؤال وتم إخباري بأنني أستطيع أن أسأل أسئلة اخرى في أي وقت و أوافق تطوعيا بالمشاركة في هذا البحث.

PRAAT SCRIPTS

File Converting Script

```
form mono converter
	sentence InputDir  ./
endform

createDirectory ("original")
Create Strings as file list... list 'inputDir$'*.wav
numberOfFiles = Get number of strings

for ifile to numberOfFiles

	select Strings list
	fileName$ = Get string... ifile
	name$ = fileName$ - ".wav"
	Read from file... 'inputDir$''fileName$'
	sound_name$ = selected$ ("Sound")
	Write to WAV file... ./original/'fileName$'

#Pause script to make sure not to overwrite files.

	if fileReadable: "original"
	pauseScript: fileName$ + " exists! Overwrite?"
```

```
		endif

		select Sound 'sound_name$'
		Convert to mono
		Save as WAV file: "./'name$'" + "_mono" + ".wav"

		select all
		minus Strings list
		Remove

	endfor

	select all
	Remove

	# Tell the user the script ended without error
	pauseScript: "Done! The script ran with no errors."
```

Textgrid Creator Script

```
	form Tier information
		comment Tier names, separated by spaces
		sentence Tier_names
		comment Which of these are point tiers?
```

```
	sentence Point_tiers
endform

# The tier names can't be empty
if tier_names$ == ""
	exitScript: "We need at least one Tier name"
endif

# Just to keep my naming scheme
# consistent and not change my working script,
# I'm going to rename the variables
tierNames$ = tier_names$
pointTiers$ = point_tiers$

inDir$ = chooseDirectory$: "Select folder with your .wav files"

# make sure they made a choice
if inDir$ == ""
	exitScript: "No folder given. Exiting"
endif

inDir$ = inDir$ + "/"
inDirWild$ = inDir$ + "*.wav"

# Get list of files
```

```
wavList = Create Strings as file list: "wavList", inDirWild$

# See how many there are for the loop
numFiles = Get number of strings

#if there are no files, we have a problem
if numFiles == 0
	exitScript: "I didn't find any .wav files in that folder. Exiting"
endif
#  Note that the script exits without error
#  if the value is zero
#  If the loop began with:
#			for i from 1 to 0
#  It wouldn't throw an error, it would just
#  never run

for fileNum from 1 to numFiles

	# I always select objects explicitly
	# at the beginning of a loop, since
	# they may not be selected by the end
	selectObject: wavList
	wavFile$ = Get string: fileNum
	wav = Read from file: inDir$ + wavFile$
```

```
	textGrid = To TextGrid: tierNames$, pointTiers$

	# Get the name of the object, use it
	# to create a file name for the TextGrid
	objName$ = selected$: "TextGrid"
	outPath$ = inDir$ + objName$ + ".TextGrid"

	# Since this will be for the "public",
	# be strict about overwriting files
	if fileReadable: outPath$
		pauseScript: objName$ + ".TextGrid" + " exists! Overwrite?"
	endif

	Save as text file: outPath$

	# Remove newly opened objects for cleanup
	selectObject: wav
	plusObject: textGrid
	Remove
endfor

# Remove the wav list
selectObject: wavList
Remove
```

```
# Tell the user the script ended without error
pauseScript: "Done! The script ran with no errors."
```

Pauses Marking Script

```
form Give the parameters for pause analysis
  comment This script marks the pauses in the LongSound to the IntervalTier of the TextGrid.
  comment Give the time period you wish to include (The TextGrid will be overwritten!):
  real Starting_time_(seconds) 0
  real Finishing_time_(0=all) 0
  comment The following criteria define a pause:
  positive Minimum_duration_(seconds) 0.6
  positive Maximum_intensity_(dB) 59
  comment Give the intensity analysis parameters:
        positive Minimum_pitch_(Hz) 100
        integer Time_step_(0=auto) 0
  comment Give the window size for the intensity analyses (smaller window requires less memory):
        positive Window_size_(seconds) 20
        choice Boundary_placement 2
       button One boundary at the center of each pause
       button Two boundaries with a time margin of:
       positive Margin_(seconds) 0.1
       comment (The margin will not be used if the pause is shorter than 2 * margin.)
```

```
		boolean Mark_pause_intervals_with_xxx 0
	comment Save TextGrid file to folder:
		sentence output_dir .\
	comment The script will pause after calculating 4 windows, so you can interrupt the script and check if the pause detection works optimally.
endform



soundname$ = selected$ ("LongSound")

select TextGrid 'soundname$'
	endofsound = Get finishing time
select LongSound 'soundname$'
	pausenumber = 0
	duration = 0
	count = 0
	loops = 0
	pauses_found = 0
	windowstart = 0
	windowend = 0
	frame = 0
	frames = 0
	time = 0
	intensity = 0
	pausedetected = 0
```

```
pausestart = 0
pauseend = 0
pausenumber = 0
halfpause = 0
# This form prompts for parameters for the pause analysis:
if finishing_time < 0
exit Finishing time must be greater than or equal to zero! (If you give a zero, the whole LongSound will be analysed.)
endif
if finishing_time = 0
finishing_time = endofsound
endif
#***********************************************************************************************
# BEGIN
#***********************************************************************************************
# DIVIDE LONGSOUND INTO SHORTER PERIODS AND LOOP THROUGH EACH
duration = finishing_time - starting_time
#-------------------------------------------------------------------------------------------------
# Default number of loops is 1
loops = 1
# but if the period to be analysed is longer than 60 seconds, it will be divided into 60-second
# periods for which the analysis is made:
```

```
if duration > window_size
loops = ceiling ((duration/window_size))
endif
#-----------------------------------------------------------------------------------------------
# START LOOPING THROUGH SHORT WINDOWS HERE
count = 1
latest_endboundary = 0
while count <= loops
	if count = 5
		pause Continue?
	endif
	# Create a window of the LongSound and extract it for analysis
	windowstart = starting_time + ((count - 1) * window_size)
	windowend = starting_time + (count * window_size)
	if windowend > endofsound
	windowend = endofsound
	endif
	if windowend > finishing_time
	windowend = finishing_time
	endif
	select LongSound 'soundname$'
	Extract part... windowstart windowend yes
	windowname$ = "Window_" + "'count'" + "_of_" + "'loops'"
	echo Analysing Intensity window 'count' of 'loops'
	if count < 5
```

```
		printline The script will pause after calculating 4 windows, so you can check
the result...
	endif
	Rename... 'windowname$'
	#-----------------------------------------------------------------------------------------------
-
	# CALCULATE INTENSITY
	To Intensity... minimum_pitch time_step
	frames = Get number of frames
	#-----------------------------------------------------------------------------------------------
-
	# Check the pause criteria
	pauseend = 0
	frame = 1
		#-----------------------------------------------------------------------------------------
----------
		# Loop through all frames in the Intensity object:
		while frame <= frames
			select Intensity 'windowname$'
			intensity = Get value in frame... frame
			time = Get time from frame... frame
				if intensity > maximum_intensity
					# If the end of an earlier detected possible pause has
been reached:
					if pausedetected = 1
```

```
if frame - 1 < 1
pauseend = windowstart
else
pauseend = Get time from frame... (frame - 1)
endif
pausedetected = 0
endif
# If below intensity limit, a possible new pause is started
if one hasn't been detected yet:
elsif pausedetected = 0
pausestart = Get time from frame... frame
pauseend = 0
pausedetected = 1
pausenumber = pausenumber + 1
# If a detected pause just continues, do nothing special.
endif
#-----------------------------------------------------------------------------
-------------------
# IF PAUSE CRITERIA ARE FULFILLED, ADD A BOUNDARY
OR TWO TO TEXTGRID
if pauseend > 0
pauseduration = pauseend - pausestart
if pauseduration >= minimum_duration
select TextGrid 'soundname$'
halfpause = pauseduration / 2
```

```
if boundary_placement = 1
	boundary = pausestart + halfpause
	call BoundaryCheck
	if boundaryexists = 0
		Insert boundary... 1 boundary
		latest_endboundary =
boundary
		Insert boundary... 2 boundary
		latest_endboundary =
boundary
		Insert boundary... 3 boundary
		latest_endboundary =
boundary
		Insert boundary... 4 boundary
		latest_endboundary =
boundary
		Insert boundary... 5 boundary
		latest_endboundary =
boundary
	endif
else
	boundary = 0
	if pauseduration >= (2 * margin)
		if pausestart > margin
```

boundary = pausestart

+ margin

call BoundaryCheck

if boundaryexists = 0

and boundary > latest_endboundary

Insert

boundary... 1 boundary

Insert

boundary... 2 boundary

Insert

boundary... 3 boundary

Insert

boundary... 4 boundary

Insert

boundary... 5 boundary

endif

#If the pause overlaps

with the preceding pause, do a merge:

if boundary =

latest_endboundary

Remove

boundary at time... 1 boundary

Remove

boundary at time... 2 boundary

Remove

boundary at time... 3 boundary

Remove

boundary at time... 4 boundary

Remove

boundary at time... 5 boundary

endif

endif

if

mark_pause_intervals_with_xxx = 1

pauseinterval = Get

interval at time... 1 boundary

Set interval text... 1

pauseinterval xxx

mark_pause_intervals_with_xxx = 2

pauseinterval = Get

interval at time... 2 boundary

Set interval text... 2

pauseinterval xxx

mark_pause_intervals_with_xxx = 3

pauseinterval = Get

interval at time... 3 boundary

Set interval text... 3 pauseinterval xxx

mark_pause_intervals_with_xxx = 4

pauseinterval = Get interval at time... 4 boundary

Set interval text... 4 pauseinterval xxx

mark_pause_intervals_with_xxx = 5

pauseinterval = Get interval at time... 5 boundary

Set interval text... 5 pauseinterval xxx

endif

boundary = pauseend - margin

call BoundaryCheck

if boundaryexists = 0 and boundary > latest_endboundary

Insert boundary... 1 boundary

latest_endboundary = boundary

Insert boundary... 2 boundary

```
                                        latest_endboundary =
boundary
                                        Insert boundary... 3
boundary
                                        latest_endboundary =
boundary
                                        Insert boundary... 4
boundary
                                        latest_endboundary =
boundary
                                        Insert boundary... 5
boundary
                                        latest_endboundary =
boundary
                                   endif
                              else
                                   if pauseend < (endofsound -
margin)
                                        boundary = pausestart
+ halfpause
                                        call BoundaryCheck
                                        if boundaryexists = 0
and boundary > latest_endboundary
                                             Insert
boundary... 1 boundary
```

latest_endboundary = boundary

Insert

boundary... 2 boundary

latest_endboundary = boundary

Insert

boundary... 3 boundary

latest_endboundary = boundary

Insert

boundary... 4 boundary

latest_endboundary = boundary

Insert

boundary... 5 boundary

latest_endboundary = boundary

endif

endif

endif

endif

pauseend = 0

pauses_found = pauses_found + 1

```
                                        Write              to              text              file...
'output_dir$''soundname$'.TextGrid
                                endif
                        endif
                        frame = frame + 1
                        # When all frames in the intensity analysis have been looked at, end
the frame loop.
                endwhile
                #-------------------------------------------------------------------------------------
----------
        select Sound 'windowname$'
        Remove
        select Intensity 'windowname$'
        Remove
        # END LOOPING THROUGH WINDOWS HERE
        count = count + 1
    endwhile
    select TextGrid 'soundname$'
    Write to text file... 'output_dir$''soundname$'.TextGrid

    echo Ready! The TextGrid file was saved as 'output_dir$''soundname$'.TextGrid.

    #**********************************************************************
*****************************
```

```
procedure BoundaryCheck
# This procedure checks whether a boundary already exists at a given time (in tier 1).
# Added 23.1.2006
	tmpint = Get interval at time... 1 boundary
	tmpstart = Get starting point... 1 tmpint
	if tmpstart <> boundary
		boundaryexists = 0
	else
		boundaryexists = 1
	endif
endproc
```

Transcription and Translation Facilitating Script

```
sn$ = selected$ ("Sound")
select Sound 'sn$'
select TextGrid 'sn$'
numint = Get number of intervals... 1
Read Strings from raw text file... labelfile.txt
Rename... wordfile

	for i from 1 to numint
		select TextGrid 'sn$'
		Set interval text... 1 i
		if i mod 2 = 0
```

```
                wrdnum = i / 2
                select Strings wordfile
                wrd$ = Get string... wrdnum
                select TextGrid 'sn$'
                #Set interval text... 1 i 'wrd$'
                Set interval text... 1 i 'wrd$'

            endif
        endfor
    select Strings wordfile
    Remove
```

Stops Measurement Sript

```
    #Ask the user for the input and output directories
    form Input Enter directory and output folder name
        comment Enter directory where soundfiles are kept:
     sentence sound_dir .\
     comment Enter directory where TextGrid files are kept:
     sentence textgrid_dir .\
        comment Enter output directory:
        sentence output_dir .\
    endform

    writeInfoLine: "This script has started:"
```

```
#Reads in a list of all .wav files in the folder
list_id = Create Strings as file list: "list", sound_dir$ + "\*.wav"
number_of_files = Get number of strings

#Creates table for results
table_id = Create Table with column names: "results", 0, "file 'tab$' word_id 'tab$' word 'tab$' word_duration 'tab$' segment_id 'tab$' segment 'tab$' preceding_segment 'tab$' following_segment 'tab$' stress 'tab$' segment_duration 'tab$' vot_id 'tab$' vot_label 'tab$' vot_duration "
counter_table = 0

#Loops through all the files
for ifile to number_of_files
	selectObject: list_id
	filename$ = Get string: ifile
	name$ = filename$ - ".wav"

	# Reads in TextGrid (label) and sound (wav) files
	textgrid_id = Read from file: textgrid_dir$ + "\" + name$ + ".TextGrid"

	# Gets the number of intervals in the word tier
	selectObject: textgrid_id
	number_of_vot_intervals = Get number of intervals: 5
	number_of_phoneme_intervals = Get number of intervals: 2
```

```
number_of_word_intervals = Get number of intervals: 1

for vot_interval to number_of_vot_intervals
	selectObject: textgrid_id
	vot_label$ = Get label of interval: 5, vot_interval
	length_vot_label = length (vot_label$)

	if length_vot_label > 0
		counter_table += 1
		start = Get starting point: 5, vot_interval
		end = Get end point: 5, vot_interval

		#calculates beginning, end and duration
		vot_duration = end - start
		vot_dur_ms = vot_duration*1000

		# gets the segment
		int_corresponding_segment = Get interval at time: 2, start
		segment$ = Get label of interval: 2, int_corresponding_segment
		segment_start = Get starting point: 2, int_corresponding_segment
		segment_end = Get end point: 2, int_corresponding_segment

		#calculates beginning, end and duration
		segment_duration = segment_end - segment_start
		segment_dur_ms = segment_duration*1000
```

```
# gets the preceding and following segment
preceding_segment$ = Get label of interval: 2, int_corresponding_segment - 1
following_segment$ = Get label of interval: 2, int_corresponding_segment + 1

# gets the stress
int_corresponding_stress = Get interval at time: 4, start
stress$ = Get label of interval: 4, int_corresponding_stress


# get information on the 'interesting points tier'
## I am not having this tier!

# gets the word
int_corresponding_word = Get interval at time: 1, start
word$ = Get label of interval: 1, int_corresponding_word
word_start = Get starting point: 1, int_corresponding_word
word_end = Get end point: 1, int_corresponding_word

#calculates beginning, end and duration
word_duration = word_end - word_start
word_dur_ms = word_duration*1000
```

```
appendInfoLine: vot_interval, tab$, vot_label$, tab$, int_corresponding_segment,tab$, segment$, int_corresponding_word, tab$, word$

#adds values to the table by appending rows
selectObject: table_id
Append row
Set string value: counter_table, "file", name$
Set numeric value: counter_table, "word_id", int_corresponding_word
Set string value: counter_table, "word", word$
Set numeric value: counter_table, "word_duration", word_dur_ms
Set numeric value: counter_table, "segment_id", int_corresponding_segment
Set string value: counter_table, "segment", segment$
Set string value: counter_table, "preceding_segment", preceding_segment$
Set string value: counter_table, "following_segment", following_segment$
Set string value: counter_table, "stress", stress$

Set numeric value: counter_table, "segment_duration", segment_dur_ms
Set numeric value: counter_table, "vot_id", vot_interval
Set string value: counter_table, "vot_label", vot_label$
Set numeric value: counter_table, "vot_duration", vot_dur_ms
```

```
                endif
        endfor
endfor

#Saving the output into a txt file
selectObject: table_id
Save as tab-separated file: output_dir$ + "\consonants.txt"



pauseScript: "This script has finished"
select all
Remove
```

Fricatives Measurement Script

```
#Ask the user for the input and output directories
form Input Enter directory and output folder name
        comment Enter directory where soundfiles are kept:
   sentence sound_dir .\
   comment Enter directory where TextGrid files are kept:
   sentence textgrid_dir .\
        comment Enter output directory:
        sentence output_dir .\
endform

writeInfoLine: "This script has started amazingly!:"
```

```
#Reads in a list of all .wav files in the folder
list_id = Create Strings as file list: "list", sound_dir$ + "\*.wav"
number_of_files = Get number of strings

#Creates table for results
table_id = Create Table with column names: "results", 0, "file 'tab$' word_id 'tab$' word 'tab$' word_duration 'tab$' segment_id 'tab$' segment 'tab$' preceding_segment 'tab$' following_segment 'tab$' stress 'tab$' segment_duration 'tab$' vot_id 'tab$' vot_label 'tab$' vot_duration 'tab$' fric_intensity 'tab$' CoG "
counter_table = 0

#Loops through all the files
for ifile to number_of_files
	selectObject: list_id
	filename$ = Get string: ifile
	name$ = filename$ - ".wav"


	# Reads in TextGrid (label) and sound (wav) files
	textgrid_id = Read from file: textgrid_dir$ + "\" + name$ + ".TextGrid"
	wav = Read from file: sound_dir$ + "\" + name$ + ".wav"


	# Gets the number of intervals in the word tier
```

```
selectObject: textgrid_id

number_of_vot_intervals = Get number of intervals: 5
number_of_phoneme_intervals = Get number of intervals: 2
number_of_word_intervals = Get number of intervals: 1

for vot_interval to number_of_vot_intervals
	selectObject: textgrid_id
	vot_label$ = Get label of interval: 5, vot_interval
	length_vot_label = length (vot_label$)

	if length_vot_label > 0
		counter_table += 1
		start = Get starting point: 5, vot_interval
		end = Get end point: 5, vot_interval

		#calculates beginning, end and duration
		vot_duration = end - start
		vot_dur_ms = vot_duration*1000



		# gets the segment
		int_corresponding_segment = Get interval at time: 2, start
		segment$ = Get label of interval: 2, int_corresponding_segment
		segment_start = Get starting point: 2, int_corresponding_segment
```

```
segment_end = Get end point: 2, int_corresponding_segment

#calculates beginning, end and duration
segment_duration = segment_end - segment_start
segment_dur_ms = segment_duration*1000

# gets the preceding and following segment
preceding_segment$ = Get label of interval: 2,
int_corresponding_segment - 1
following_segment$ = Get label of interval: 2,
int_corresponding_segment + 1

# gets the stress
int_corresponding_stress = Get interval at time: 4, start
stress$ = Get label of interval: 4, int_corresponding_stress


# get information on the 'interesting points tier'
## I am not having this tier!

# gets the word
int_corresponding_word = Get interval at time: 1, start
word$ = Get label of interval: 1, int_corresponding_word
word_start = Get starting point: 1, int_corresponding_word
word_end = Get end point: 1, int_corresponding_word
```

```
#calculates beginning, end and duration
word_duration = word_end - word_start
word_dur_ms = word_duration*1000

# Gets intensity
selectObject: wav
To Intensity... 100 0 (dB)
intensity = Get mean... start end

# Gets CoG
	selectObject: wav
	Extract part... segment_start segment_end Rectangular 1 no
	intID = selected("Sound")
	select 'intID'
To Spectrum... Fast
	spectrum = selected("Spectrum")
	select 'spectrum'
	cog = Get centre of gravity... 2/3



appendInfoLine: vot_interval, tab$, vot_label$, tab$, int_corresponding_segment,tab$, segment$, int_corresponding_word, tab$, word$

#adds values to the table by appending rows
```

```
selectObject: table_id
Append row
Set string value: counter_table, "file", name$
Set numeric value: counter_table, "word_id", int_corresponding_word
Set string value: counter_table, "word", word$
Set numeric value: counter_table, "word_duration", word_dur_ms
Set numeric value: counter_table, "segment_id", int_corresponding_segment
Set string value: counter_table, "segment", segment$
Set string value: counter_table, "preceding_segment", preceding_segment$
Set string value: counter_table, "following_segment", following_segment$
Set string value: counter_table, "stress", stress$

Set numeric value: counter_table, "segment_duration", segment_dur_ms
Set numeric value: counter_table, "vot_id", vot_interval
Set string value: counter_table, "vot_label", vot_label$
Set numeric value: counter_table, "vot_duration", vot_dur_ms
Set numeric value: counter_table, "fric_intensity", intensity
Set numeric value: counter_table, "CoG", cog

select 'intID'
```

```
                select 'spectrum'
                Remove
            endif

        endfor
endfor

#Saving the output into a txt file
selectObject: table_id
Save as tab-separated file: output_dir$ + "\fricatives.txt"


pauseScript: "This script has finished"
select all
Remove
```

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