Investigating the Perception and Production of the Arabic Pharyngealised Sounds by L2 Learners of Arabic

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Abstract

Pronunciation has received relatively little attention within the field of Arabic second language teaching and learning, particularly with respect to the more prominent areas of morphology, syntax, psycholinguistics and sociolinguistics. In the field of phonetics and phonology, it has been argued that Arabic pharyngealised sounds are distinctive and unique to Arabic and they are considered the most difficult sounds to acquire by L2 learners of Arabic. This research included two experiments that focused on examining the ability of a group of Arabic L2 learners from different L1 backgrounds to perceive and produce the fricative sounds /z/, /θ/, /f/, /ʃ/, /ħ/, /h/, /χ/, /ɣ/, /ʕ/, /sˤ/, /ðˤ/, /s/, /ð/, and the emphatic sounds /sˤ/, /ðˤ/, /dˤ/, and /tˤ/ in contrast with non-pharyngealised variants /s/, /ð/, /d/ and /t/. The aims were to investigate which aspects of acquisition were difficult and to examine the effects of technology-based instruction and traditional-based instruction to find an appropriate pronunciation teaching method to facilitate the perception and production of fricatives and emphatics.

The technology-based method used in this study was adapted from Olson (2014) and Offerman and Olson (2016) to investigate the extent to which using speech analysis technology (Praat) can help in visualising the difference between pharyngealised and non-pharyngealised sounds in order to aid production and perception learning. The traditional-based method used in this study included repetition, practicing minimal pairs, and reading aloud techniques. Data were collected from forced-choice identification tasks and recordings taken during pre- and post-test conditions.

The results revealed that the some of the fricatives and all the emphatic sounds posed perception and production difficulty to some L2 learners of Arabic, which is likely to be due to the absence of these sounds from the learners' L1s. The results also showed significant improvements among all participants after the traditional and technology training courses. However, no significant difference was observed between L2 learners who received the traditional-based method and those who received the technology-based method. Both methods have increased students' awareness and understanding of the features of the sounds under investigation.

The contribution of the current study is to show how Arabic fricative and emphatic sounds can be effectively taught using form-focused instruction involving different traditional and technological techniques. This research has implications for the implementation of both techniques for language teachers and researchers as it shows how both approaches can be used to enhance students' perceptive and productive skills.

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Declaration

I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

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Table of Contents

List of Abbreviations

CA	Contrastive Analysis
CAH	Contrastive Analysis Hypothesis
CALL	Computer Assisted Language Learning
F1	First Formant
F2	Second Formant
F3	Third Formant
IPA	International Phonetic Alphabet
L1	First Language
L2	Second Language
L3	Third Language
MDH	Markedness Differential Hypothesis
MRI	Magnetic Resonance Imaging
M	Mean
SD	Standard Deviation
PAM	Perceptual Assimilation Model
PAM-L2	Second Language Perceptual Assimilation Model
RTR	Retracted Tongue Root
SLA	Second Language Acquisition
SLM	Speech Learning Model
SPSS	Statistical Package for Social Sciences
VOT	Voice Onset Time

List of Tables

List of Figures

CHAPTER ONE

INTRODUCTION

1.1 Introduction

This study examines the ability of a group of Arabic second language (L2) learners from different first language (L1) backgrounds to produce the fricative sounds /z/, /θ/, /f/, /ʃ/, /ħ/, /h/, / χ /, /ɣ/, /ʕ/, found in Modern Standard Arabic (MSA), and to perceive and produce the Arabic emphatic sounds /sˤ/, /ðˤ/, /dˤ/, /tˤ/ in contrast with non-emphatic sounds /s/, /ð/, /d/, /t/. The investigation focuses on the fricative and emphatic sounds because they are considered unique characteristics of Arabic (Embarki, Yeou, Guilleminot, & Al Maqtari, 2007; Jongman, Herd, & Al-Masri, 2007; Newman, 2002). The absence of emphatics in most languages of the world may pose a difficulty in pronunciation for L2 learners of Arabic.

Over the past 50 years, technology, and, specifically, computers have come a long way to be part of everyday tasks and at the forefront of human education. Exponential growth in educational technology has been seen in recent years (Butler-Pascoe, 2011). Some tools have been created specifically for the purpose of language teaching and learning, such as Compleat Lexical Tutor (Dodigovic, 2005; Godwin-Jones, 2010); some tools were invented to serve other purposes, but have been adopted or adapted for supporting language learning, such as social media, audio books and speech analysis and recognition programs.

The aims of this study are to investigate which aspects of the acquisition of the Arabic sounds listed are difficult for L2 learners, and also to examine the effects of technology-based instruction in comparison with traditional instruction to find a suitable pronunciation teaching method to enhance the perception and production of fricatives and emphatics.

This study contains theoretical and pedagogical discussions of two aspects. First, the theory of language transfer suggests a role for L1 in identifying and discriminating novel phonetic segments of a foreign language by L2 learners. Therefore, theoretical concepts of Language transfer including L2 speech perception and production theories are briefly discussed in this study in identifying errors produced by L2 learners of Arabic based on their similarities with Learners' L1s.

Second, the development of pronunciation teaching and availability of computer technology in Arabic language institutes in Saudi Arabia has created many opportunities for applying various pedagogical tools and applications. There are different computer programs that show potential and value for enhancing the learning of particular languages such as English and Spanish, which also could generate a number of possibilities for teaching Arabic. The main part of this thesis is an attempt to facilitate the perception and production of fricatives and emphatics by investigating the efficacy of specific pronunciation instruction, which involves noticing and understanding specific linguistic features in the pronunciation of Arabic sounds by two kinds of approaches: technology and traditional.

The technology teaching approach in this study is adapted from Olson (2014) and Offerman and Olson (2016), which includes using speech analysis technology (Praat; Boersma, 2002) to visualise specific linguistic forms and detect the difference between pharyngealised and non-pharyngealised sounds. The traditional teaching approach includes repetition, practicing minimal pairs, and reading aloud techniques, which are commonly used in pronunciation teaching and learning (Hismanoglu & Hismanoglu, 2010).

1.2 Arabic L2 Teaching and Learning in Saudi Arabia

Shehata (2015) noted that "with the growing importance of the Middle East in international affairs, Arabic is presently seen as a strategic language that has recently witnessed a rapid increase in the number of colleges and universities offering Arabic language courses and the number of students in these programmes in the United States" (p. 25). Ryding (2006) noted that, since 1960, there had been a 92.3% increase in the number of Arabic learners in the United States. This is supported by another study, which shows an increase in comparison with 1960 from 92.3% between 1998-2002 to 126.5% between 2002-2006 (Furman, Goldberg, & Lusin, 2010); it is possible that the figure has risen again at the time of writing this thesis. Although the popularity of Arabic has risen throughout the world and Arabic has become one of the most interesting languages to study (Ryding, 2006), there is still a lack of research in teaching Arabic as L2, especially as regards pronunciation (Shehata, 2015).

In Saudi Arabia, there is a noticeable increasing interest in the field of teaching and learning Arabic as L2. Al-Agla (2001) in his thesis listed only four Saudi Arabian institutions that offered teaching Arabic courses as L2 at that time. In 2017, there are six non-profitable Arabic linguistic institutions sponsored by six major universities in Saudi Arabia, which provide free Arabic courses to male and female students from different countries. Those universities are: King Saud University, Imam Mohammed Bin Saud University and Princess Nourah Bint Abdulrahman University, all in Riyadh; King Abdul-Aziz University in Jeddah; Umm Al-Qura University in Makkah; and the Islamic University in Madinah. Those institutions do not only offer Arabic courses but also offer courses to Arabic language teachers and provide master degrees in the field of Arabic as L2 and applied linguistics. Furthermore, many for-profit institutions have been established recently that offer Arabic language courses to non-Arabic residents in Saudi Arabia, including foreign workers in companies and hospitals. The Al-baian Institute in Jeddah is an example of one of these for-profit concerns.

Recently, two major contributions were made to the field of Arabic L2 teaching in Saudi Arabia. The first one is the establishment of the King Abdullah bin Abdulaziz Centre for Arabic Language, which was established at the request of King Abdullah bin Abdulaziz in 2008, and is under the supervision of the Ministry of Education. The major goal for this centre is to support and fund any project that helps in enhancing the status of the Arabic language around the world, including books, conferences, institutions, research and technology. This centre supports, funds and supervises many Arabic institutions in the world, such as in Russia, Turkey, Indonesia, China, India, Uganda, Chad, Senegal, Malaysia, Spain, France, Singapore and North Korea. Information about the King Abdullah bin Abdulaziz Centre for Arabic Language can be found at this link: https://www.kaica.org.sa/.

The second contribution is the establishment in 2014 of an online programme for teaching the Arabic language internationally by the Saudi Electronic University in Saudi Arabia. This programme contains a large database of teaching materials, including audio and video clips, reading passages and quizzes. It is based on 75% self-learning and 25% virtual classes where the learners can interact online with their instructors. Information about the Arabic language programme at Saudi Electronic University can be found at this link:

https://www.seu.edu.sa/sites/ar/colleges/CSTS/Arabic_nn%20Department/Pages/About.aspx.

With this growing interest in the field of teaching Arabic as L2 in Saudi Arabia and the rest of the world, there is a need for more research to promote linguistic and pedagogical research into the teaching of Arabic as L2 and the development and selection of innovative teaching materials. Furthermore, there is a need for more research that helps in providing advanced training to Arabic language teachers who work in the field of teaching Arabic as L2.

1.3 Rationale of Study

Emphatics are considered to be a distinctive characteristic of Arabic, and the absence of these sounds in most languages of the world often results in pronunciation difficulties among L2 learners of Arabic (Embarki et al., 2007; Jongman et al., 2007; Newman, 2002). The primary reason for these challenges in pronunciation is likely to be because of the acoustic and auditory similarities of emphatic sounds to their plain counterparts /s/, /ð/, /d/, and /t/, which exist in most languages (Abu-Rabia & Sammour, 2013; Taha, 2013). What distinguishes the emphatics from the non-emphatics is the coarticulatory process of pharyngealisation – i.e., the simultaneous movement of the back of the tongue towards the rear pharyngeal wall – which additionally results in an effect on the following and preceding vowels, causing an ‘emphasis or pharyngealisation spread’ and altering these vowels to allophones (Shar & Ingram, 2010; Watson, 1999).

Studies in the field of Arabic phonetics and pronunciation have focused only on studying the sound properties of emphatics in relation to their production by native speakers of Arabic (e.g. Amayreh & Dyson, 1998; Jongman, Herd, Al-Masri, Sereno, & Combest, 2011; Khattab, Al-Tamimi, & Heselwood, 2006). However, very little is known about the production of these sounds by non-native speakers of Arabic. Specifically, no previous studies have, to our knowledge, focused on both the perception and production of emphatic and fricative sounds amongst L2 learners of Arabic.

The primary motivation to conduct this study is to facilitate learning the Arabic emphatic and fricative sounds among L2 learners of Arabic. Different studies have agreed on the influence of L1 on the acquisition of L2. Hence, the first step in overcoming difficulties is by predicting errors that can help L2 teachers save time and effort and focus on certain sounds extensively rather than explaining and repeating sounds that are more likely to be acquired successfully owing to their similarity with L1 sounds.

The second step for facilitating learning these target sounds is by looking at different kinds of instruction that have proven their efficacy in the field of pronunciation teaching. Form-focused instruction was chosen, according to different studies that agreed on its usefulness in teaching pronunciation (Saito, 2013b). To ensure a better learning of the target sounds, specific form-focused teaching methods are conducted for two different groups of participants.

1.4 Objectives of Study

Overall, the objectives of the study are:

1- To identify the difficult areas of acquisition in the Arabic fricative and emphatic sounds and whether L2 learners of Arabic in different language backgrounds and proficiency levels find these sounds difficult to perceive and produce accurately.

2- To investigate the difference between traditional and technology (i.e., speech analysis) pronunciation form-focused instruction to find an appropriate method to moderate the difficulty of learning Arabic fricatives and emphatics and to develop L2 learners' perceptive and productive skills.

1.5 Scope of Study

The scope of this study is to obtain perception and production data from Mandarin, Urdu, Tagalog and English native speakers who are all L2 learners of Arabic. The focus will be on these languages because speakers of Mandarin, Urdu, Tagalog and English are the majority L2 learners of Arabic in the Arabic language institutes in Saudi Arabia, and most importantly, these four languages lack emphatics and some fricatives in their phonemic systems. The learners are all female students who came to Saudi Arabia to study Arabic at the Princess Nourah University in three proficiency levels (i.e., beginner, intermediate and advanced). The data are identification test results and recordings of Arabic words and phrases spoken by these learners containing the target fricative and emphatic sounds. The performance data are rated by Arabic native speakers and, then, statistically by quantitative analysis.

1.6 Outline of Thesis

This chapter has introduced the study by providing an overview of the research, followed by a brief introduction of Arabic L2 teaching and learning, and the rationale and the objective of the study. The scope of the study has also been discussed.

The second chapter will present the background of the research. Definitions and important terminology will be presented and defined at the beginning of this chapter. The first major section will present the features of pharyngealisation in Arabic. The second section will discuss the teaching of pronunciation and will describe different pronunciation teaching approaches. The third section will define computer-assisted language learning (CALL) and will offer speech analysis technology as a tool in teaching pronunciation. The fourth section will review L2 acquisition theories including Language Transfer and Contrastive Analysis hypothesis along with a brief discussion about L2 speech perception and production models. The last section will present the summary of chapter and the research questions of Study 1 and Study 2.

The third chapter is contrastive analyses, which will present phonetic comparisons between Arabic and the learners' L1s, Mandarin, Urdu, Tagalog and English to identify the areas of difficulties in each language group. The language learning context of the participants in the present study is discussed at the end of this chapter.

The fourth chapter will present the quasi-experimental design of Study 1 regarding the production of Arabic fricative sounds. It will provide information on the ethical considerations, participants, materials, and procedure. It will also explain how the data is collected and analysed. Details on the pilot study will be shown to assure the validity and reliability of the materials.

The fifth chapter will present the results of Study 1. The first part will present the purpose of the study and the research questions. The second part will show the difficulty levels in the pronunciation of fricatives. The third part will provide the results of using traditional-based and technology-based instruction in enhancing learners' pronunciation of fricatives.

The sixth chapter will discuss the findings of Study 1. First, learners' errors and their relationship to learners' native languages will be discussed. Second, the difficulty levels in the pronunciation of fricatives will be explained based on learners' number of errors with each fricative. The difference in the outcomes between traditional-based and technology-based instruction in enhancing learners' pronunciation of fricatives will be discussed. The limitation of Study 1 will be presented next, followed by the conclusion, which will summarise the main findings of this initial study. At the end, preface and rationale for conducting Study 2 will be presented.

The seventh chapter will provide a description of the methodology of Study 2 regarding the perception and production of Arabic emphatic sounds. The ethical considerations, participants, materials and procedure will be presented to illustrate the way the study is constructed. Furthermore, details related to piloting the study and collecting the data will be discussed. Towards the end of chapter seven, the inter-rater reliability of the raters and the validity of the study will be provided, along with descriptions about analysing the data.

The eighth chapter will present the results of Study 2. The beginning of this chapter will offer a brief summary of the purpose of the study and will present the research questions. Next, the statistical results of the perception and production frequency and types of errors will be provided to address the first research question. Then, the statistical results of technology-based instruction and traditional-based instruction in teaching pronunciation will be provided to answer the second and third research questions. At the end, a summary of the findings and a summary of the results chapter will be presented.

The ninth chapter will discuss the findings of Study 2. In the first part, the focus will be on learners' perception and production of emphatics and the influence of the three vowel contexts on the realisation of these sounds. The second part will present a discussion about the technology and the traditional methods and their contribution to enhancing learners' perception and production of emphatics. It will also include a discussion about the effect of these teaching methods on learners in different proficiency levels and from different language backgrounds. At the end of this chapter, some limitations in this research will be presented.

Finally, the tenth chapter will involve a summary and a conclusion of the major findings. Pedagogical implications will be discussed and a summary of the limitations, followed by recommendations for future research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The purpose of this chapter is to present and discuss the theories and approaches that are associated with the pronunciation skills of L2 learners of Arabic. The literature review is organised into four main sections. The beginning of this chapter provides definitions of the main key terms that are used in this study. The first section discusses the pharyngealisation phenomenon in Arabic and explains its articulatory and acoustical characteristics. The second section investigates the teaching and learning of L2 pronunciation and offers several pronunciation teaching approaches. The third section introduces CALL and provides details of the use of speech analysis technology in pronunciation teaching and learning. The fourth section briefly reviews the theoretical concepts of language transfer, L2 speech perception and production and the role of L1 in the process of L2 acquisition. It also presents and discusses previous studies that investigated the perception and production of Arabic consonants among L2 learners of Arabic. In addition, it provides several factors – other than the influence of L1 – that could affect perception and production accuracy. The information in the four sections is used to formulate the research questions for Study 1 and 2, which are presented at the end of this chapter.

2.2 Definition of Key Terms

This section defines the key terms that are used throughout this thesis.

2.2.1 Fricatives

Fricative sounds are characterised by friction resulting from a continual airflow through a narrow channel in the oral cavity. The air flows rapidly through specific positions of constriction to form turbulence in the flow and creates a fricative sound (Jongman, Wayland, & Wong, 2000; Ladefoged & Johnson, 2014). Examples are the initial sounds in ‘fly’, ‘shy’, and ‘sun’. MSA has 13 fricative phonemes, which are: /z/, /s/, /sˤ/, /θ/, /f/, /ʃ/, /ħ/, /h/, /χ/, /ɣ/, /ʕ/, /ð/, /ðˤ/ (Al-Ani, 1970).

2.2.2 Pharyngealisation

The term ‘pharyngealisation’ is a description of a speech sound that has a primary articulation in the anterior vocal tract and a secondary articulation in which the back of the tongue moves towards the rear wall of the pharynx (Card, 1983). The secondary articulation often influences the surrounding vowels. This is usually realised by the movement of the vowels towards the rear of the vowel space, which varies, based on the speaker’s country or city of origin (Al Khatib, 2008; Watson, 1999). Examples of pharyngealised consonants are the Arabic /sˤ/ in /sˤabi/ ‘boy’ and /tˤ/ in /tˤalib/ ‘student’.

2.2.3 Emphatics and Non-emphatics

In MSA, the pharyngealised consonants are traditionally called emphatics (Watson, 2002). They are four consonants: two stops /tˤ/ and /dˤ/; and two fricatives /ðˤ/ and /sˤ/. There are four plain equivalent phonemes of Arabic emphatic phonemes, which are /t/, /d/, /s/ and /ð/, and which are called non-emphatics and are articulated only by coronal approximation, i.e., the movement of the front of the tongue towards the dental and alveolar ridge area of the oral cavity which, in this case, results in a complete closure (/t/, /d/) or a narrow approximation (/s/, /ð/) between the articulators. Examples of a minimal pair containing emphatic and non-emphatic sounds are /sˤar/ 'became' and /sar/ 'walked'. The primary phonetic place of articulation of both the emphatic and non-emphatic sound is the same; however, they vary by the position of the back of the tongue, as the tongue when pronouncing the emphatics is raised further back than the non-emphatics. In all cases, the velum is raised.

2.2.4 L2 Speech Perception

Speech perception is the process and mechanism by which human speech is heard, understood and processed in the brain (Fitch, Miller, & Tallal, 1997). L2 speech perception research aims at understanding how non-native listeners recognise speech sounds and use acoustic cues to understand the spoken form of the target language. The pedagogical aims through investigating L2 speech perception are achieved by understanding the relationship between learners' L1s and the target language, which helps in enhancing L2 pronunciation teaching and in building applications that aid L2 learners to differentiate speech sounds belonging to different phonetic categories (Derwing & Munro, 2015).

2.2.5 L2 Speech Production

L2 speech production is defined as the process by which L2 learners translate their thoughts through speaking the target language, which includes words, organisation of grammatical forms, and sounds. This process is divided into two forms: speaking and pronunciation. The difference between pronunciation and speaking is confusing. Sometimes these two terms are, as Gilakjani and Ahmadi (2011) have stated, “wrongly applied interchangeably” (p. 74).

Pronunciation is a part of speaking, and they are both productive skills, which are always combined. Speaking involves producing, receiving and processing information, which requires constructing meaning in an interactive process (Brown, 1994). For example, speaking involves a level of ideas, words and sentences. It also involves fluency, which Baker and Westrup (2003) defined as ‘speaking with ease and without thinking of possible errors’ (p. 90). Pronunciation, on the other hand, is related to sounds and the way of producing them to construct meaning. Yates and Zielinski (2009) clarified that pronunciation includes consonants, vowels, and aspects of speech such as stress, timing, rhythm, intonation and phrasing. These two forms of speech production cannot be used separately. As Macdonald (2015) pointed out, “[p]ronunciation is part of speaking, and together they are central to the dynamic processes of the creation of identities that individuals engage in on a daily basis” (p. A-34). This study investigates the accuracy in the pronunciation of certain L2 sounds, which may affect L2 learners’ speaking abilities in general.

2.2.6 Features of Pronunciation

It is important to define ‘pronunciation’ and understand its features. Schmitt (2013) defined pronunciation as “a term used to capture all aspects of how we employ speech sounds for communication” (p. 203). There are two key features of pronunciation, and each feature is comprised of many attributes. Figure 2.1 clearly shows the features of pronunciation.

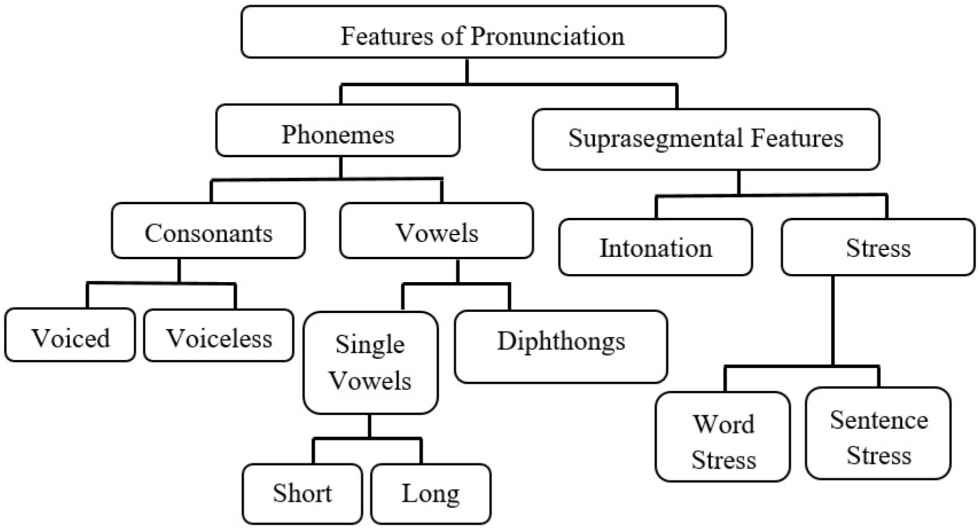


Figure 2.1: Pronunciation features (Murcia-Celce, Brinton, & Goodwin, 1996)

All these features have undergone a variety of studies (e.g. Behzadi & Fahimniya, 2014; Derwing, 2010; Gilakjani & Sabouri, 2016; Gooch, Saito, & Lyster, 2016; Hellmuth, 2014; Osmany & Azad, 2016; Rallo Fabra & Jacob, 2015). However, and with all these studies, linguists still consider pronunciation a neglected area, and the attention given in research to other language skills such as reading and writing is not given to pronunciation (Gilakjani & Sabouri, 2016; Hashemian & Fadaei, 2011; Osmany & Azad, 2016).

2.2.7 Analysis of Speech

Speech analysis is the study of speech sounds for particular purposes. It represents the acoustic properties of speech such as formants and amplitude, by transforming the acoustic data into spectral and temporal forms. In the past, spectral analysis could be obtained only in laboratory settings. Nowadays, spectrograms and waveforms can be easily generated through any type of computer platform (Derwing & Munro, 2015), often using free programs, such as Praat (Boersma, 2002) and Speech Analyser (Williamson, 1979).

2.3 Pharyngealisation in Arabic

This section presents an analysis of the feature of pharyngealisation in Arabic, in both consonants and vowels. It starts by exploring MSA and presenting its consonant and vowel inventories. Then, it provides acoustic and articulatory analysis of emphatics, along with a description of their distinctive features. Finally, it discusses the functional load of emphatics, their orthographical representations and the variation in their pronunciation across different Arabic dialects.

2.3.1 Modern Standard Arabic

Arabic is a Semitic language and is one of the most ancient languages, having existed for more than 16 centuries (Alghamdi, 2001). It is the national language in the Middle East, and the North African states of Algeria, Tunisia, Morocco, Libya, Egypt, and Sudan, and it is the language of all Muslim countries, which have more than 400 million people (Chejne, 1969). Modern Standard Arabic (MSA) is the official and written form of Arabic used in all Arabic countries. It is the language of media and literature and the closest form to Classical Arabic, which is described now as an ancient form and called 'Qur'anic Arabic' (Al-Ani, 1970). MSA is considered the less regular version of Classical Arabic and has some Classical Arabic features (Amayreh, 2003). It is now the only formal written form, and people use it in literature, drama and for religious purposes, but they do not use it in regular conversations (Amayreh, 2003; Haddad, 2006), in which dialect forms are more common.

Al-Ani (1970) demonstrated that MSA is not the everyday speech of the people, and many Arabic people find it easier to communicate using their dialects. There are many local dialects, which may vary in their vocabulary and pronunciation. The feature that distinguishes MSA among all Arabic dialects is that it is understood by all speakers of Arabic (Shaalan, Bakr, & Ziedan, 2007). L2 learners whose purpose for learning Arabic is to learn about Islam and read the Quran in a correct and understandable way must learn it in MSA form. This study focuses on MSA, which is the official version and is the only form used in all Arabic language learning institutions in Saudi Arabia. Saudis speak Gulf Arabic dialect but, as all Arabic speakers, they use MSA in media and education, especially when talking about the Quran and Hadith (i.e., the prophet Mohammed's speech).

2.3.1.1 The Structure of MSA

MSA has 28 consonantal phonemes and three vowels, which can each have long and short variants. Table 2.1 illustrates the consonant and vowel phonemic inventory in MSA.

	Bilabial	**Labiodental**	**Dental**	**Alveolar**	**Palatal**	**Velar**	**Uvular**	**Pharyngeal**	**Glottal**
Stop	b			d t dˤ tˤ		k	q		ʔ
Fricative		f	ð θ ðˤ	z s sˤ	ʃ		ɣ χ	ʕ ħ	h
Affricate					ʤ				
Nasal	m			n					
Liquid				l					
Tap/Trill				r					
Glides	w				j				

Notes: Voiced consonants are presented on the left and voiceless consonants on the right.

Table 2.1: Inventory of MSA consonant phonemes (Amayreh, 2003)

MSA has a triangular vowel system. It consists of three short and three long vowels, as in Figure 2.1.

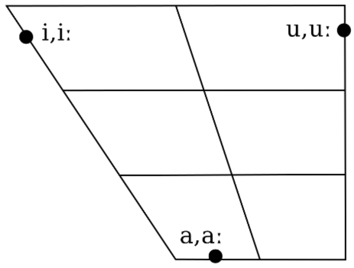


Figure 2.1: Inventory of MSA vowels (Salameh & Abu-Melhim, 2014)

MSA and most Arabic dialects are distinguished by the existence of nine consonants with a pharyngeal constriction in their articulation. These sounds are known as the pharyngeal fricatives / ħ / and /ʕ/, the velar fricatives /x/ and /ɣ/, the uvular plosive /q/ and the emphatics /ðˤ/, /sˤ/, /tˤ/ and /dˤ/, which are phonetically described as pharyngealised sounds (Shar & Ingram, 2010). As mentioned above, the back of the tongue approaches the pharyngeal wall when pronouncing these nine sounds, and this feature is called 'Retracted Tongue Root' (RTR) (Al Khatib, 2008).

Delattre (1971) found that the sounds /ħ/ and /ʕ/ are primarily and only articulated by the tongue and the pharynx, in which the back of the tongue is moved towards the back wall of the pharynx to form a stricture. The emphatics, on the other hand, have two articulations, in which the secondary articulation is the tongue moving towards the pharynx and the primary articulation is in the anterior vocal tract. Jongman et al. (2007) defined emphasis as "consonants produced with a secondary constriction in the posterior vocal tract and a primary constriction typically in the dental/alveolar region" (p. 913).

What distinguishes the emphatics among other pharyngeal sounds is the effect of these sounds on the following and preceding vowels, causing an ‘emphasis or pharyngealisation spread’ and altering these vowels to allophones (Al-Ani, 1970; Shar & Ingram, 2010; Watson, 1999). This phenomenon is described in the next sections, along with how it was described historically.

2.3.2 The History of Research in Arabic Pharyngealisation

The study of Arabic pharyngealisation was established by Sibawayh – the Arabic grammarian – in his famous Arabic book ‘Alkitab’ (the book) in the 8th century when he suggested the terms ‘itbaq’ (closing) and ‘infitah’ (opening), and proposed the term ‘al-huroof al-almutbaqa’ (closing letters) for the Arabic pharyngealised sounds (Embarki et al., 2007). The reason for calling the emphatic sounds closing letters is the movements of the tongue. When pronouncing the emphatics, the front of the tongue rises to the hard palate, which results in closing the mouth. More recently, Arab linguists call these sounds ‘al-huroof al mufaxamah’ (thick or heavy letters) (Boxberger, 1981), and the phenomenon of pharyngealisation is called in Arabic ‘tafxeem’ (Lehn, 1963).

Pharyngealisation is an interesting topic of Arabic linguistic research. Almost all of the studies on Arabic pharyngealisation have focused on the properties and differences of pharyngealised sounds among Arabic dialects, such as the study of Embarki et al. (2007), who distinguished MSA pharyngealisation from the pharyngealisation of Yemeni, Kuwaiti, Jordanian and Moroccan dialects and compared pharyngealised and non-pharyngealised sounds in these dialects. Also, a study was done by Barkat-Defradas, Al-Tamimi, and Benkirane (2003) in investigating the acoustic vocalic space in different phonological systems in Arabic, which discussed the issue of pharyngealisation in Jordanian Arabic and Moroccan Arabic.

Besides the comparisons of pharyngealisation in Arabic dialects, Abudalbuh (2011) and Khattab et al. (2006) conducted studies on distinguishing between males and females in the production of pharyngealised consonants in Jordanian Arabic, and found that emphasis was more acoustically evident in the speech of males than in the speech of females.

Some studies discussed the significant similarities between pharyngealised sounds and their counterparts and how these sounds share similar acoustic features (e.g. Aldahri, Almanjoomi, Seddiq, Al-Otaibi, & Alotaibi, 2010; Embarki et al., 2007). These studies provided details about the way native Arabic speakers articulate the pharyngealised and non-pharyngealised sounds. Up to now, very few studies have discussed the pronunciation of Arabic sounds by L2 learners of Arabic from a pedagogical perspective or singled out the subject of pharyngealisation as a particular issue in teaching L2 pronunciation.

2.3.3 Arabic Pharyngealised Consonants

As mentioned earlier in this chapter, Arabic pharyngealised consonants have a coronal constriction as a first articulation and a secondary constriction at the pharynx. The coronal constriction, which involves the tip or blade of the tongue, occurs at the alveolar ridge in the case of /$t^ʕ$, $d^ʕ$, $s^ʕ$/, or at the teeth for /$ð^ʕ$/. There are four plain equivalent phonemes of Arabic pharyngealised phonemes, which are /t/, /d/, /s/ and /ð/. These plain counterparts are articulated only by coronal approximation. Figure 2.2 shows tracings of X-ray data taken from Ouni and Ouni (2007), indicating the difference in pronouncing the emphatic /$t^ʕ$/ and the non-emphatic /t/.

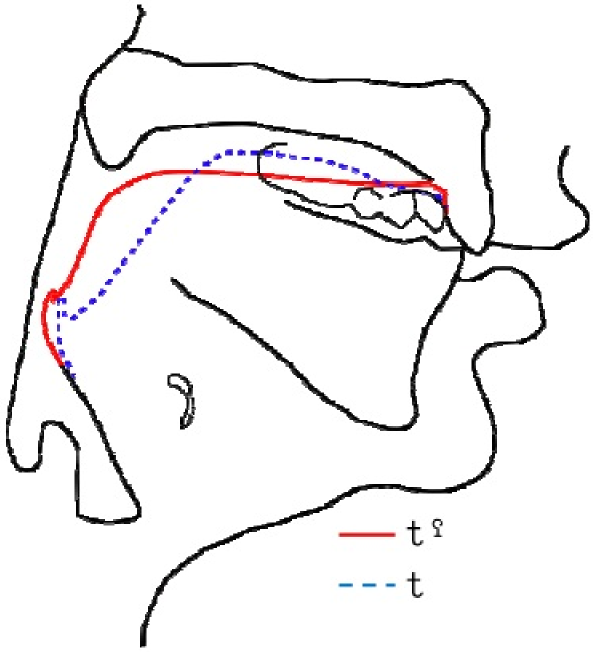


Figure 2.2: Tracings of X-ray data: pharyngealised /tˤ/ vs. non-pharyngealised /t/ (Ouni & Ouni, 2007)

As seen in Figure 2.2, the primary place of articulation of both the emphatic /tˤ/ and non-emphatic /t/ is the same, and shows that the constriction of both sounds occurs at the alveolar ridge; however, they vary in their secondary articulation by the position of the back of the tongue, as the tongue when pronouncing the emphatic /tˤ/ is pulled further back than the non-emphatic /t/. This case applies to all Arabic emphatic and non-emphatic sounds.

In exploring the differences visually through speech analysis technology, it can be seen that there are differences in shape between emphatic and non-emphatic consonants, which result in differences in the quality of the vowels surrounding these sounds. These differences in certain contexts may not be accurately perceived by some non-native speakers in the natural speech of native speakers (Al Mahmoud, 2013; Hayes-Harb & Durham, 2016; Hong & Sarmah, 2009; Zaba, 2007). Figures 2.3 and 2.4

show the differences between minimal pairs with pharyngealised versus non-pharyngealised sounds.

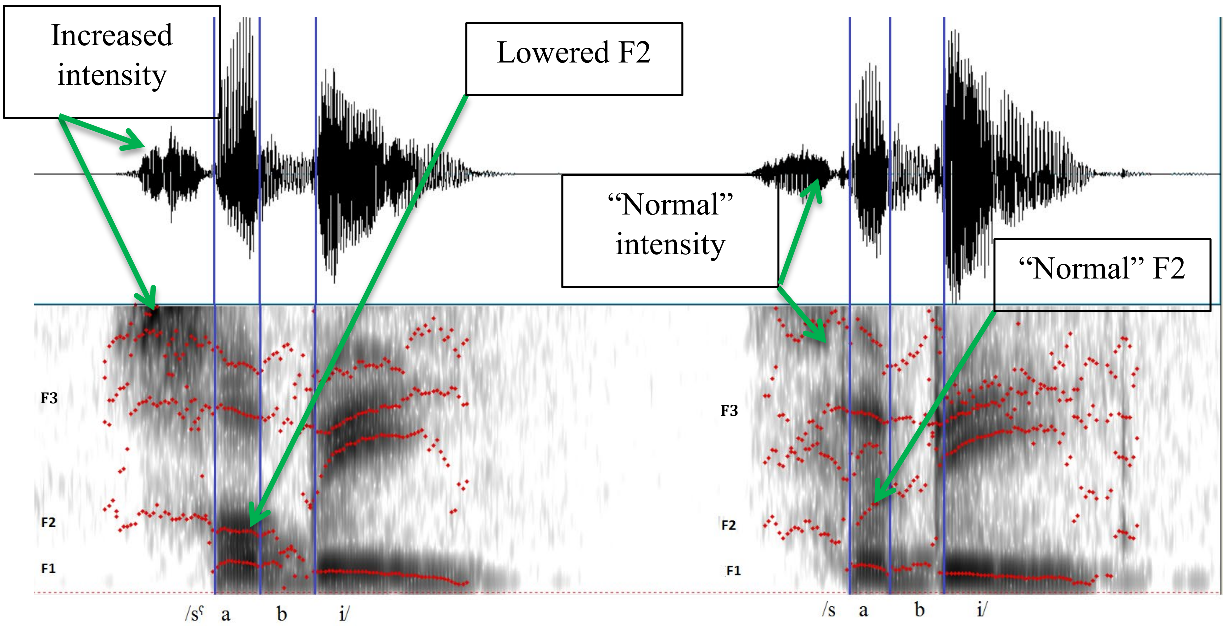


Figure 2.3: The acoustic shape of the words [sˤɑbi] 'boy' and /sabi/ 'steal'

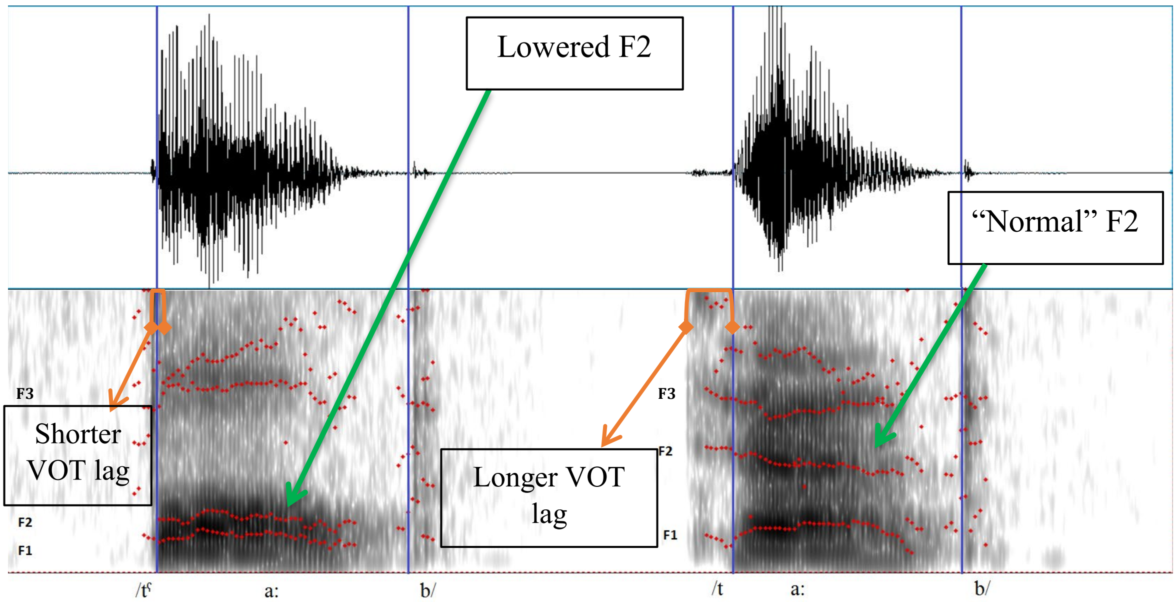


Figure 2.4: The acoustic shape of the words [tˤɑ:b] 'recovered' and /ta:b/ 'repented'

Figures 2.3 and 2.4 are spectrogram screenshots of two minimal pairs. They show acoustic differences between the pharyngealised and non-pharyngealised consonants and vowels. Regarding intensity, the pharyngealised consonants, especially fricatives, appear to be more intense at higher frequencies than the non-pharyngealised sounds, because they require more pressure to produce them. This is clearly observable in Figure 2.3 above. Regarding the frequencies of the first formant (F1) and the second formant (F2), the pharyngealisation spread influences the formants of the vowels followed the pharyngealised sounds, which causes raising F1 and lowering F2. Furthermore, it can be seen that the third formant (F3) is also affected by the existence of the emphatics, although the degree of influence is not similar to the second formant (F2). This current study focuses only on the F2 lowering because it appears to be a robust indicator of emphasis more than the F3 (Hayes-Harb & Durham, 2016).

Besides the difference between the emphatic /tˤ/ and the non-emphatic /t/ in the degree of F1 and F2 lowering in Figure 2.4, the amount of the Voice Onset Time (VOT) (i.e., the voiceless gap between release and voicing) is also observable. The VOT of the emphatic stop /tˤ/ is shorter than that of the plain counterpart. Khattab et al. (2006) mentioned that there is a clear difference in the VOT between /tˤ/ and /t/ and this can be seen in the amount of delay between the burst and the voicing in the transition from the target sound into the vowel. They also explained that the amount of VOT results in a clear aspiration in the non-emphatic /t/, while the emphatic /tˤ/ is not -or slightly- aspirated. However, this observation of the VOT length in the emphatic and non-emphatic stops is not found in all Arabic dialects (Khattab et al., 2006; Rifaat, 2003; Yeni-Komshian, Caramazza, & Preston, 1977).

It can be said that the great degree of similarity in pronunciation between emphatics and non-emphatics makes it difficult for L2 learners of Arabic to distinguish between them (Al Mahmoud, 2013). The similarities between the acoustic cues of emphatics and non-emphatics may confuse L2 learners of Arabic and cause perception and production problems. There are a significant number of minimal or near minimal pairs in Arabic of contrasting emphatic and non-emphatic sounds as shown in the following examples:

/sˤ/ & /s/ [sˤɑr] ‘became’ vs. /sar/ ‘walk’

/tˤ/ & /t/ [tˤɨːn] ‘clay’ vs. /tiːn/ ‘fig’

/ðˤ/ & /ð/ [ħaðˤɑr] ‘forbid’ vs. /ħaðar/ ‘cautions’

/dˤ/ & /d/ [wadˤɨːʕ] ‘humble’ vs. /wadiːʕ/ ‘meek’

2.3.4 Arabic Pharyngealised Vowels

Al-Ani (1970) mentioned six pharyngealised vowel allophones that follow or precede a pharyngealised consonant. These vowels are:

the short high front unrounded vowel /i/ = [ɨ]

the long high front unrounded vowel /iː/ = [ɨː]

the short high back rounded vowel /u/ = [ʊ]

the long high back rounded vowel /uː/ = [ʊː]

the low short central unrounded vowel /a/ = [ɑ]

the low long central unrounded vowel /aː/ = [ɑː].

It should be noted that the Arabic high back pharyngealised vowel [ʊ] is different from the English high back vowel /ʊ/. The Arabic pharyngealised vowel [ʊ] is an allophonic version of the vowel /u/, which is longer and more rounded and back than the English vowel /ʊ/ (Roach, 2010). Al-Ani (1970) in his book used the symbol [ʋ] to refer to the Arabic pharyngealised high back rounded vowel. According to the International Phonetic Alphabet (IPA) chart, the symbol /ʋ/ refers to the labiodental approximant consonant. Therefore, it was decided to choose the vowel [ʊ] in this current study to represent the pharyngealised high back rounded vowel.

As shown earlier in Figures 2.3 and 2.4, the F2 of the pharyngealised vowels, which follow the pharyngealised consonants, show a degree of lowering more than the non-pharyngealised vowels. This phenomenon is called ‘emphasis spread’ or ‘pharyngealisation spread’; many researchers have discussed it, and have also provided evidence that the spread does not stop with the vowels that come after the emphatics but continues to affect the neighbouring sounds (Al-Ani, 1970; Anyanwu, 2008; Shar & Ingram, 2010). The amount of spread is varied according to dialects and speakers (Davis, 1993; Huneety & Mashaqba, 2016; Israel, Proctor, Goldstein, Iskarous, & Narayanan, 2012; Watson, 1999; Youssef, 2016).

The lowering of F2 varies, based on the quality of the vowel (Card, 1983; Zawaydeh, 1999). That is, the impact of the emphatic sounds on the adjacent vowels differs in the vowels [ɨ], [ʊ], and [ɑ] (Card, 1983; Yeou, 1997). The greatest effect is on the low front vowel [ɑ], while the vowel [ʊ] has the least amount of lowering (Al-Ani, 1970; Jongman et al., 2007). Figures 2.5, 2.6 and 2.7 are evidence taken from a native speaker of Arabic, which show the effect of the four emphatic sounds on the three adjacent vowels /a/, /u/ and /i/, which precede and follow the pharyngealised consonant in each case. The resulting effect on F2 of the allophone following the consonant is clearly observable.

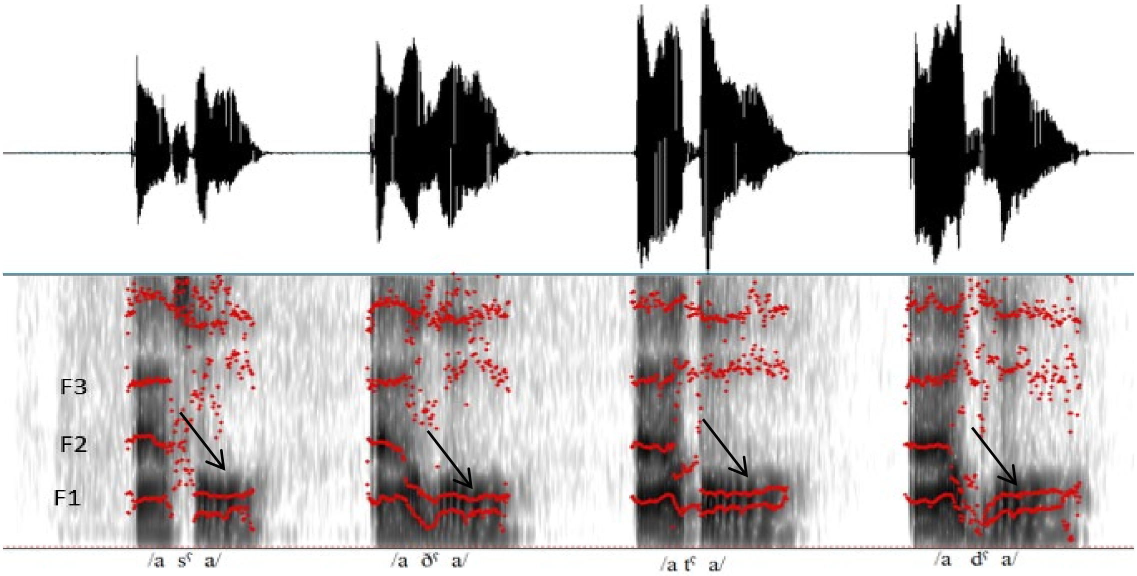


Figure 2.5: Spectrogram of the pharyngealised vowel /a/

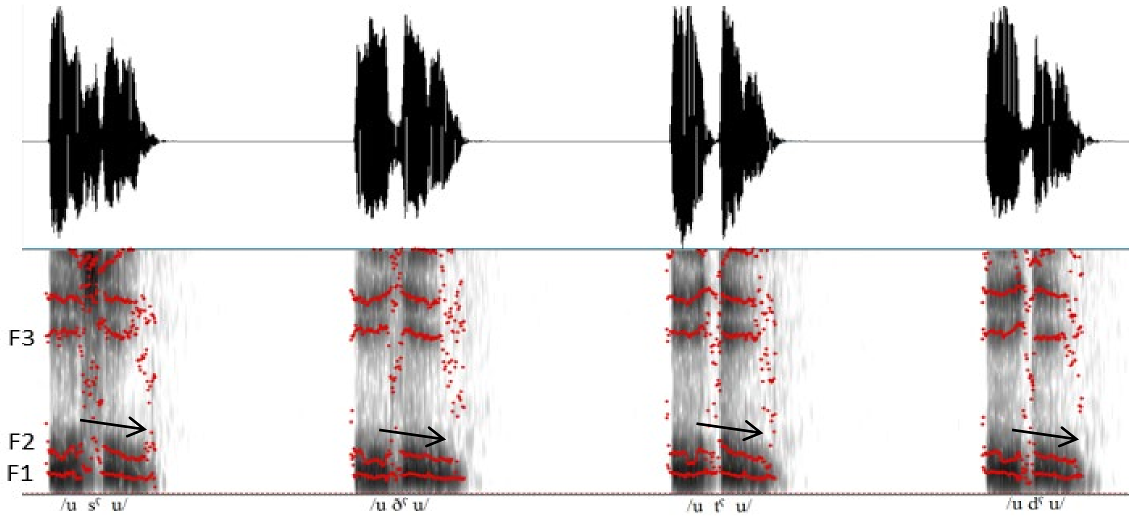


Figure 2.6: Spectrogram of the pharyngealised vowel /u/

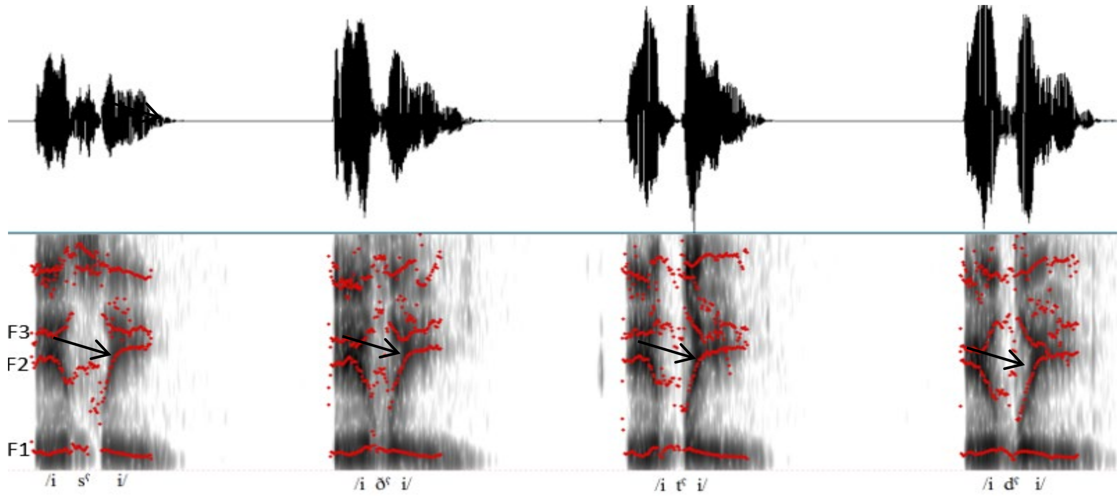


Figure 2.7: Spectrogram of the pharyngealised vowel /i/

In Figures 2.5, 2.6 and 2.7, the pharyngealised vowels [ɑ], [ʊ] and [ɨ], preceded by the four emphatic sounds /sˤ, ðˤ, tˤ, dˤ/, show varying degrees of F2 lowering**.** As is shown in the figures above, the vowel [ɑ] has a noticeable degree of lowering, more than the vowels [ʊ] and [ɨ]. The F2 lowering of the vowel [ɨ], on the other hand, was the least of all, which shows that the pharyngealisation spread from emphatics towards the vowel [ɨ] is weaker than the vowels [ʊ] and [ɑ]. This conclusion leads to the assumption that the pronunciation of the allophone [ɨ], when neighbouring emphatics in MSA might be very similar to the phoneme /i/, could pose discrimination difficulties between emphatics and non-emphatics in this vowel context. Therefore, it is possible that L2 learners of Arabic are more likely to correctly perceive, identify and pronounce an Arabic word that has a pharyngealised consonant followed by the vowels [ɑ] and [ʊ] than a pharyngealised consonant followed by the vowel [ɨ].

A study that tested this assumption on L2 learners of Jordanian Arabic was done by Hayes-Harb and Durham (2016). The idea was based on the findings of Walley and Carrell (1983), who found that adult and child native English listeners may rely on the acoustic information of adjacent vowels to identify stop consonants. Furthermore, Jongman et al. (2011) found that Jordanian Arabic listeners recognised emphasis based on information in the rest of the word, including vowel and non-target consonants, and not only the emphatics.

Based on these findings from Walley and Carrell (1983) and Jongman et al. (2011), Hayes-Harb and Durham (2016) sought to test these hypotheses on English native speakers to examine whether English native speakers also recognise the acoustic information of the Arabic pharyngealised vowels and rely on adjacent vowels in perceiving the emphatic sounds from a pedagogical perspective. They are empirically testing whether non-native speakers of Arabic focus on adjacent vowels for cues to the emphatic and non-emphatic contrasts.

Hayes-Harb and Durham mentioned that, since there is a potential acoustical overlap of the allophonic variation of the Arabic /a/ with English /æ/ and /ɑ/, it is expected for English speakers to experience cross-linguistic influence of the English vowels /æ/ and /ɑ/ on the perception of the allophonic variation of the Arabic /a/. This cross-linguistic influence could result in facilitating Arabic emphatic consonant perception by some English speakers. The relationship between the Arabic and English vowel inventories could result in the improvement of native English speakers' ability to discriminate Arabic emphatic and non-emphatic contrasts in different vowel contexts.

They conducted discrimination and cross-language vowel identification tasks on forty native English speakers to reveal whether native English speakers were able to discriminate Arabic emphatic and non-emphatic onset consonant contrasts when they are in a certain vowel context similar to English vowel phonemes. They used cross-spliced stimuli of three pairs of Arabic non-words with a CVC syllable structure pronounced by a male native speaker of Jordanian Arabic and placed in a carrier phrase. The sound contrasts used in these stimuli were the pharyngealised /dˤ/ and the plain /d/, which were placed at the onset of the six stimuli followed by one of the three Arabic vowels /a/, /u/ and /i/, whereas the final consonant was /k/ in all the stimuli. The stimuli pairs were /dˤæk/-/dæk/, /dˤuk/-/duk/, and /dˤik/-/dik/. The three pairs were used in both tasks.

In the cross-language vowel identification task, participants were asked to listen to each token of the six Arabic non-words and choose which English vowel sound each word contained by using DMDX experiment presentation software (Forster & Forster, 2003). The preparation and execution of perception identification tasks using DMDX is explained in detail in section 2.6.4.3.2.

In the discrimination task, the tokens were cross and same-spliced. The onset consonants were extracted and recombined respectively with rimes from other tokens to form four different splice types (i.e. onset from plain token with rime from pharyngealised token “cross-spliced”, onset from pharyngealised token with rime from plain token “cross-spliced”, onset and rime from two different pharyngealised tokens “same-spliced”, onset and rimes from two different plain tokens “same-spliced”). An AXB discrimination task was conducted by using the same DMDX software. In this task, listeners were asked to compare which stimulus from the same-spliced items sounded most similar to one of the four splice types, (see section 2.6.4.3.1 for more description of the preparation and execution of AXB discrimination tasks).

The results of the cross-language vowel identification task revealed that there was a high sensitivity in the identification of the emphatics with the vowel [ɑ] more than with the vowels [ɨ] and [ʊ], because of the overlap between the Arabic variations of the vowel /a/ with the English vowels /æ/ and /ɑ/. The percentage of identification overlap for [ɑ] was only 3.7% in emphatic and non-emphatic contexts, i.e., the listeners were mostly able to hear the difference between emphatic and non-emphatic sounds in contexts where the /a/ phoneme was present. On the other hand, the percentage of identification overlap for the vowel [ɨ] was 71.3%, and for the vowel [ʊ] was 69.2%, and they were significantly higher than the vowel [ɑ] (both $p<0.001$).

The results of the discrimination task showed a significant vowel effect. Participants recorded higher rates of emphatic response when the rimes were originated from emphatic productions than plain productions. Furthermore, the emphatic response was higher for /æ/ (79%) than for /u/ (60%) and /i/ (34%) in the rimes that were originated from emphatic productions. On the other hand, the emphatic response was lower for /æ/ (2%) than for /u/ (10%) and /i/ (9%) in the rimes that were originated from plain productions.

To confirm whether participants' responses were influenced by their native language, the researchers conducted a small follow-up study. Four native Arabic speakers took part in the study and completed the same AXB discrimination task. The response pattern of the Arabic speakers was found similar to the English speakers in the reliance of rime over the onset. However, differential pattern of perceptual sensitivity by vowel was found between Arabic speakers and English speakers. In the stimuli with emphatic rimes, Arabic speakers recorded highest emphatic response in the context of /u/, while English speakers recorded highest emphatic response in the context of /æ/. This result indicated that participants' responses were influenced by their language-specific perceptual systems and not only by the acoustic properties of the emphatic and plain contrast.

Another study was conducted by Zaba (2007), which investigated the relationship between Arabic and English vowel inventories and suggested a role for the adjacent vowels as cues for accurately perceiving emphatics. The researcher sought to find which vowels native English listeners perceive following pharyngealised and non-pharyngealised consonants. To this end, 13 native English speakers underwent both identification and AXB discrimination tests. The identification test included 24 Arabic stimuli, and participants were asked to listen to each stimulus and chose which English vowel each stimulus contained /ɑ/, /æ/, /i/, /ɪ/, /e/, /u/, /ʊ/ or /o/. The Arabic stimuli were in a CVC structure, in which the first consonant was either /t/, /tˤ/, /d/ or /dˤ/, the vowel was either /a/, /u/ or /i/ and the second consonant was /k/. The results for the identification task showed that participants did not accurately discriminate emphatics that came after the high front vowel /i/, but they had the ability to accurately identify the emphatics that came after the high back vowel /a/, which agreed with the findings of Hayes-Harb and Durham (2016).

The studies of Hayes-Harb and Durham (2016) and Zaba (2007) were the first to provide significant and valuable results, which shed light on understanding the role of the surrounding vowels of the emphatics in accurately perceiving and producing the Arabic emphatics for L2 learners. This hypothesis opened a new approach to create a training method and materials that are concerned with not only teaching the emphatic sound itself but also raising learners' awareness about the role of the surrounding vowels.

The results from Hayes-Harb and Durham (2016) and Zaba (2007) were primarily taken into account in this current study and were considered from two different perspectives: first, from a theoretical perspective, to test the role of emphasis spread in the identification of emphatics by L2 learners with different language backgrounds, and second, from a pedagogical perspective, to examine the outcomes from integrating teaching pronunciation instruction that focuses on emphatics and the adjacent vowels in enhancing learners' perception and production of emphatics.

2.3.5 Articulatory and Acoustic Analysis of Arabic Pharyngealisation

Different techniques have been used by researchers in identifying whether the emphatic is realised as pharyngealisation or velarisation and where exactly these sounds occur. Many studies agreed that the emphatic is pharyngealised rather than what Sibawayh (1970) in the past believed to be velarised. Sibawayh (1970) found that when pronouncing emphatics, the back of the tongue is constricted against the velum, which made him assume that these sounds are velarised. This also seems to be what other linguists who followed Sibawayh's approach believed (Rabin, 1972). Because of the techniques developed for investigating emphatics, many studies discovered more movements in pronouncing emphatics, which led many researchers to agree that the emphatic is realised as pharyngealisation (Laufer & Baer, 1988). These techniques are described next.

Articulatory cinefluorography was used in investigating the articulation of the pharyngealised sounds in Iraqi Arabic by Ali and Daniloff (1972) and Tunisian Arabic by Ghazeli (1977). Cineradiography images of Arabic pharyngealisation were taken and studied by Giannini and Pettorino (1982) and Al-Ani (1970). Magnetic Resonance Imaging (MRI) was used by Israel et al. (2012) in examining the production of emphatic consonants by a speaker of Lebanese Arabic, and by Shar and Ingram (2010) in studying pharyngealisation in Assiri Arabic. These studies concluded that there were specific mechanisms for the production of emphatic consonants involving the tongue shape and epiglottis, in which the tongue root retracts backward, and the epiglottis makes a constriction against the pharyngeal wall. Producing emphatics involves consistent acoustic strategy across speakers of Arabic including the upper-pharyngeal constriction.

Use of a fiberscope was significant in studying pharyngealisation in Hebrew and Arabic by Laufer and Baer (1988) and Iraqi Arabic by Hassan and Esling (2007), and they concluded that the emphatics are pharyngealised, having a secondary articulation in the lower part of the pharynx. Their claims are supported by providing laryngoscope images of the pharyngeal gesture.

Al-Halees (2005) used three different articulatory techniques, which are Xeroradiography, ultrasound, and laryngoscopy, in investigating the articulation of emphatics in Jordanian Arabic. He concluded that there are a number of mechanisms involved in pronouncing the emphatics, where the back of the tongue and the attached upper edge of the epiglottis are lowered in most cases, and retracted towards the back wall of the pharynx, which causes narrowing in the pharyngeal cavity. Lowering the mid body of the tongue occurs spontaneously after the lowering and retraction of the back of the tongue and dropping of the lower jaw, which results in widening in the oral cavity. The soft palate is stretched down, the tip of the uvula is curved forward, and the lips are slightly rounded and protruded (Al-Halees, 2005).

Hassan and Esling (2007) demonstrated that detecting and understanding pharyngealisation in articulation is complicated, especially in secondary articulation, because speakers have different articulatory strategies with degrees of constrictions and larynx height. Furthermore, the way speakers pronounce the emphatics varies according to their native dialect, gender, phonological context, and social background.

Acoustically, studies on pharyngealisation have used many strategies to measure and understand the way emphatics are pronounced, such as the shape of the spectrogram, formants values, and spectra. Shoul (2008) conducted an acoustic analysis of the emphatic voiceless stop /tˤ/ in Moroccan Arabic and concluded that, from the shape of spectrogram, the F1 value is increased and the F2 value is lowered for vowels neighbouring the emphatic /tˤ/.

Through spectral realisation, Shoul (2008) noticed that the last half of the spectra reflects a raising of amplitude in high frequencies for the non-emphatic /t/ compared to the emphatic /tˤ/, which results in less anterior articulation for the emphatic /tˤ/. Other studies confirmed that the most consistent acoustic feature that distinguishes emphatic from non-emphatic sounds is lowering F2 and raising F1 in the emphatics' neighbouring vowels (Al-Halees, 2005; Hassan & Esling, 2007; Shar & Ingram, 2010).

It should be noted that these studies mentioned above examined different Arabic dialects and revealed different results about the acoustic features of Arabic pharyngealisation such as in the frequency, the intensity and the degree of F2 lowering (e.g. Hassan, 2012; Shar & Ingram, 2010). However, they all agreed that F2 lowering is a robust evidence for Arabic pharyngealisation.

2.3.6 Distinctive Features of Arabic Pharyngealisation

Jakobson and Halle (1956) suggested that the phoneme can be further analysed into distinctive features – which are considered the most basic units of phonological structure – and they described a phoneme as a bundle of features. Distinctive features characterise speech sounds to be distinguished according to their manner and place of articulation and their acoustic characteristics.

The theory of distinctive features was then elaborated by Chomsky and Halle (1968) when they redefined the distinctive features of phonemes using mainly articulatory classifications and assigned plus and minus values (e.g., [+high], [+back] [–continuant]) to formulate phonological rules. These distinctive features are used as a classification system for categorising and describing phonemes for several aims: to show how segments contrast with each other and what groups of segments have in common, specify a phoneme or a set of phonemes used in a particular language, and to write phonological rules that describe changes and speech disorder (Chapman & Routledge, 2009).

A variety of proposals were discussed regarding the classification of the distinctive features that characterise Arabic pharyngealised consonants. Acoustically, the feature [+flat] was used by Jakobson (1957), and the feature [+F2 drop] was used by Card (1983) to describe pharyngealisation, and both elements represent lowering in the F2. In terms of articulation, the feature [+low, +back] was used by Chomsky and Halle (1968), and the feature [+constricted pharynx] was used by Hoberman (1989). Other researchers have used different terms in describing the feature of pharyngealisation, such as [+emphasis] (Van der Hulst & Smith, 1982) and [+pharyngealisation] (Heath, 1987).

There were studies that discussed the distinctive feature of Arabic pharyngealisation and concluded, due to the articulatory nature of those phonemes, that the unique feature that accurately describes Arabic pharyngealisation is called Retracted Tongue Root [+RTR] (Al-Ani & El-Dalee, 1983; Broselow, 1979; Davis, 1993). Davis (1993) believed that the term [RTR] might not be used to describe pharyngealised sounds in all Arabic dialects. He focused on describing the articulatory features of Palestinian Arabic and concluded that the crucial feature that characterises emphatics in the Palestinian dialect is the tongue height feature [RTR]. He noted that his findings were solely limited to the Palestinian dialect, as he was unable to demonstrate this feature in pharyngealisation in all Arabic dialects.

Figure 2.8 shows some of the distinctive features of Arabic pharyngealised consonants and their counterparts. It can be noticed from these characteristics that the pharyngealised and non-pharyngealised consonants are similar in all their features but one, which is [+pharyngealisation].

$$/s/= \begin{pmatrix} -\text{voice} \\ +\text{consonantal} \\ +\text{coronal} \\ +\text{anterior} \\ +\text{continuant} \\ -\text{pharyngealisation} \end{pmatrix} \quad \text{VS.} \quad /s^{\text{ʕ}}/= \begin{pmatrix} -\text{voice} \\ +\text{consonantal} \\ +\text{coronal} \\ +\text{anterior} \\ +\text{continuant} \\ +\text{pharyngealisation} \end{pmatrix}$$

$$/\text{ð}/ = \begin{pmatrix} +\text{voice} \\ +\text{consonantal} \\ +\text{coronal} \\ +\text{anterior} \\ +\text{continuant} \\ -\text{pharyngealisation} \end{pmatrix} \quad \text{VS.} \quad /\text{ð}^{\text{ʕ}}/= \begin{pmatrix} +\text{voice} \\ +\text{consonantal} \\ +\text{coronal} \\ +\text{anterior} \\ +\text{continuant} \\ +\text{pharyngealisation} \end{pmatrix}$$

$$/d/= \begin{pmatrix} +\text{voice} \\ +\text{consonantal} \\ +\text{coronal} \\ +\text{anterior} \\ -\text{continuant} \\ -\text{pharyngealisation} \end{pmatrix} \quad \text{VS.} \quad /d^{\text{ʕ}}/= \begin{pmatrix} +\text{voice} \\ +\text{consonantal} \\ +\text{coronal} \\ +\text{anterior} \\ -\text{continuant} \\ +\text{pharyngealisation} \end{pmatrix}$$

$$/t/ = \begin{pmatrix} -\text{voice} \\ +\text{consonantal} \\ +\text{coronal} \\ +\text{anterior} \\ -\text{continuant} \\ -\text{pharyngealisation} \end{pmatrix} \quad \text{VS.} \quad /t^{\text{ʕ}}/= \begin{pmatrix} -\text{voice} \\ +\text{consonantal} \\ +\text{coronal} \\ +\text{anterior} \\ -\text{continuant} \\ +\text{pharyngealisation} \end{pmatrix}$$

Figure 2.8: Distinctive feature matrices for Arabic emphatics and non-emphatics

These distinctive features of pharyngealised and non-pharyngealised consonants have been described to give an insight into the significant similarities between emphatics and their counterparts.

2.3.7 The Functional Load of Emphatics

The term 'functional load' in pronunciation refers to the rank of segmental contrasts according to their importance and frequency in a language (Munro & Derwing, 2006). Functional loads of phonemic contrasts can be specified by the frequency of minimally paired words containing the two phonemes and the frequency of each phoneme in a language (Brown, 1988; Munro & Derwing, 2006). For example, the /l/ - /n/ contrast distinguishes many English word pairs and it is seen as a high functional load contrast in English (Munro & Derwing, 2006). On the contrary, the /θ/ - /ð/ contrast has a low functional load in English (Brown, 1988). Generally, contrasts with greater occurrence in minimal pairs in a language are expected to be learned or acquired earlier than other contrasts and vice versa (Amayreh & Dyson, 2000; Moskowitz, 1975). Examining this pedagogically important topic is expected to benefit L2 teachers and learners in prioritising issues in pronunciation teaching and learning.

The only studies that have mentioned the term 'functional load' of Arabic phonemes have focused on exploring the acquisition of Arabic sounds by child native speakers of Arabic in different developmental stages (< 2 to > 6 years old) (Al Amayreh, 1994; Amayreh, 2003; Amayreh & Dyson, 1998, 2000; Dyson & Amayreh, 2000). The order of acquisition found in these studies served as indirect evidence and corresponds to functional load (Hellmuth, 2014). These studies showed acquisition of the sounds /b/, /t/, /d/, /k/, /f/, /ħ/, /m/, /n/, /l/, and /w/ by children in the early period (<2 years to 3:10). They also showed that the sounds /s/, /ʃ/, /x/, /ɣ/, /h/, /j/ and /r/ were acquired in the intermediate period (4 years to 6:10). Finally, the sounds that were acquired in the late period (> 6:4 years) were /tˤ/, /dˤ/, /q/, /ʔ/, /θ/, /ð/, /ðˤ/, /z/, /sˤ/, /ʕ/. While previous studies discussed the term ‘functional load’ as a means to justify the early pronunciation of some Arabic phonemes by Arabic children, it is possible that this term can be applied to adult L2 learners of Arabic too.

These studies on the production of Jordanian Arabic consonants by child native speakers of Arabic formulated general trends in the order of acquiring Arabic consonants (Amayreh & Dyson, 1998, 2000; Dyson & Amayreh, 2000) (see Figure 2.9).

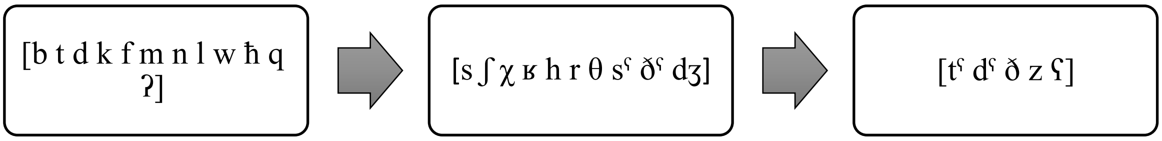


Figure 2.9: General trends in the order of acquiring Arabic consonants by child native speakers of Arabic (Amayreh & Dyson, 1998, 2000; Dyson & Amayreh, 2000)

Hellmuth (2014) inferred from the results of Amayreh and Dyson (1998) and Amayreh (2003) that it might be more important for L2 learners of Arabic to master the accurate pronunciation of sounds such as [ħ q ʔ] and [x ɣ sˤ ðˤ] than [tˤ dˤ ʕ]. Hellmuth (2014) indicated that phonemes with high functional load are likely to be more important to acquire by L2 learners of Arabic than phonemes with mid or low functional loads.

The mechanism used by Amayreh and Dyson that led to determine the order of functional loads of Arabic sounds drew the attention of Hellmuth and she concluded the possibility to apply the same order of functional load to adult learners of Arabic

(Hellmuth, 2014). However, Hellmuth (2014) stated that the order of functional load of Arabic sounds is subject to revision in view of future research because the order was supported only indirectly, based on studies of L1 order of acquisition of consonants.

2.3.8 The Orthographic Representations of Emphatics and Non-emphatics

This section shows the orthographic representation of each emphatic and non-emphatic sound. The current study does not focus on the orthographic representation of these sounds, but the intention is to demonstrate the differences orthographically between emphatics and their counterparts. The reason for making a comparison in the Arabic graphemes between emphatics and non-emphatics is to eliminate the effect of orthographic representation on learners’ perception and production errors. The orthographic representations for the emphatic and non-emphatic sounds are presented in Table 2.2.

The sound	initially	medially	finally
The voiceless emphatic fricative /sˤ/	صـ	ـصـ	ـص
The voiceless non-emphatic fricative /s/	سـ	ـسـ	ـس
The voiced emphatic stop /dˤ/	ضـ	ـضـ	ـض
The voiced non-emphatic stop /d/	د	ـد	ـد
The voiceless emphatic stop /tˤ/	طـ	ـطـ	ـط
The voiceless non-emphatic stop /t/	تـ	ـتـ	ـت
The voiced emphatic fricative /ðˤ/	ظـ	ـظـ	ـظ
The voiced non-emphatic fricative /ð/	ذ	ـذ	ـذ

Table 2.2: The orthographic representations of the emphatic and non-emphatic sounds

From the orthographic representation of each phoneme above, it can be seen that each emphatic representation is different from the non-emphatic counterpart. ‘Spurious homophony’ is a term that is used to describe the confusion that occurs for L2 learners when facing novel L2 phonological contrasts (Ota, Hartsuiker, & Haywood, 2009; Showalter & Hayes-Harb, 2015). This confusion leads L2 learners to mispronounce contrastive lexical items. Several studies have discussed the role of orthographic representations and the contribution of L2 orthographic input to L2 learners' lexical and phonological development (Cutler, Treiman, & Van Ooijen, 2010; Escudero, Hayes-Harb, & Mitterer, 2008; Hayes-Harb, Nicol, & Barker, 2010). Since the orthographic representations of phonemes could affect learners' pronunciation of sounds, the comparison in this section shows that there is no resemblance between emphatics and non-emphatics in their orthographic forms. However, it can be seen that emphatics resemble each other orthographically in which, /sˤ/ (ص) resembles /dˤ/ (ض) and /tˤ/ (ط) resembles /ðˤ/ (ظ). Therefore, it is expected to find errors of emphatics resulting from a confusion between the emphatics graphemes.

2.3.9 Arabic Dialectal Variations in the Pronunciation of Emphatics

Arabic has been divided into five big dialectal zones: Arabian, Mesopotamian, Levantine, Egyptian and Maghrebi (Embarki et al., 2007). These dialects differ in the pronunciation of emphatic and non-emphatic sounds, but not in the graphical representations of these sounds. Speakers of an Arabic dialect have a set of underlying forms that are different from MSA (Haddad, 2006).

Many studies have shown that MSA, Egyptian, Iraqi, Tunisian, Palestinian, Yemeni, Gulf, Jordanian and Moroccan speakers pronounce the pharyngealised sounds differently (Al-Raba'a, 2015; Al-Tamimi & Heselwood, 2011; Aldahri et al., 2010; Ali & Daniloff, 1972; Embarki et al., 2007; Hassan, 2012; Hassan & Esling, 2007; Israel et al., 2012; Shar & Ingram, 2010; Sussman, Hoemeke, & Ahmed, 1993). These studies demonstrated that pronunciation of emphatics is different between Arabic dialects, either in the amount of emphasis spread, the place of articulation (i.e., velarisation, uvularisation or pharyngealisation), tongue shape between emphatics and their plain counterparts, or the amount of VOT and F1 raising and F2 lowering.

The differences in spoken dialects could result in difficulties in learning a particular language. For example, evidence can be seen in a study by Broselow (1984), who found that Iraqi and Egyptian native speakers differed in producing the English syllable structure with initial consonant clusters, based on the differences in the constraints of their native dialects.

Haddad (2006) argued that L2 learners of Arabic would find it difficult to move from learning one of the Arabic dialects to MSA and vice versa. The difficulty lies in learning the phonological features that differ between the formal standard and colloquial Arabic. All native speakers of Arabic, regardless of their variation in spoken dialects, use the same graphical representations of phonemes, although these phonemes are different in pronunciation. A simple example can be seen in the word (نظير) /naðˤi:r/ ‘equivalent’, which Egyptian and some Levantine speakers pronounce as /nazi:r/, and Gulf speakers pronounce as /naðˤi:r/. The written form of this word for Egyptian, Levantine and Gulf speakers is the same (نظير), although they pronounce it differently. Hence, the orthographic representation of the same lexical item does not guide Arabic learners to understand that they are dealing with two different phonological variations of the same word. The dialectal variations are discussed here to imply that L2 learners of MSA who have already started with an Arabic dialect acquire a set of underlying forms that are different from MSA. Therefore, some perception and production errors could be a result of these dialectal variations.

This section presented details about pharyngealisation in MSA, the history of Arabic pharyngealisation research and the features that distinguish pharyngealised sounds among Arabic phonemes. The next section discusses the importance of pronunciation teaching and presents several approaches to facilitate learning novel L2 sounds.

2.4 Teaching Pronunciation

Only in the last few decades, efforts have been made to study the role of pronunciation teaching in eliminating the effect of L2 foreign accent on communication (Derwing & Munro, 2005). As Derwing and Munro (2005) stated, “[t]he study of pronunciation has been marginalised within the field of applied linguistics” (p. 379). Because of the lack of research on teaching pronunciation, teachers have had to rely on their intuition in deciding which materials or features are learnable in a classroom setting (Levis, 2005). However, not all pronunciation teachers are able to achieve their objectives in this manner because some critical questions cannot be answered by using intuition (Derwing & Munro, 2005).

2.4.1 Objectives in Teaching Pronunciation

The aims of L2 teachers in teaching pronunciation are a significant concern. What do teachers want to see in their students and how can they assess them? The teachers’ primary goal is to make students’ pronunciation intelligible and comprehensible (Morley, 1991). Intelligible pronunciation means that the learner pronounces recognisable sounds, whereas comprehensible pronunciation implies that the listener can understand the learner’s speech (Burns & Claire, 2003). Sajavaara and Dufva (2001) argued that it is hard to assess L2 learners’ pronunciation, and it should be considered wrong only if it is unintelligible. There is a difference between intelligibility and perfection. Perfect pronunciation is no longer considered a realistic objective in teaching and learning (Gilakjani, 2012).

Forcing students to speak like natives places a burden on L2 teachers. Before the 1960s, pronunciation teaching was influenced by the principle of nativeness, which held that it was both possible and necessary to achieve native-like pronunciation (Levis, 2005). This principle lost favour after the appearance of the critical period hypothesis, which stated that after puberty, it was almost impossible for L2 learners to pronounce the target language as a native speaker would (Lenneberg, Chomsky, & Marx, 1967). However, the nativeness principle still influences some teachers' views and practices (Levis, 2005). Other teachers have recently focused on intelligible speech rather than native-like speech (Saito, 2012).

2.4.2 The Importance of Teaching Pronunciation

Pronunciation teaching opponents argued that pronunciation is an acquired skill and learners will not develop pronunciation skills by focused practice (Krashen, 1982). Few studies that discussed the importance and effectiveness of pronunciation teaching mentioned that pronunciation instruction did not help to prompt communication in the target language and that most people could acquire this skill without formal training (MacDonald, Yule, & Powers, 1994). In addition, teaching skills such as vocabulary and writing is more important than training students to pronounce the L2 with a near-native accent (Leather, 1983).

From a positive view, Setter (2008) pointed out that it is pointless to study a language if the intention is not to communicate. Therefore, she asserted that learning pronunciation is necessary for listeners to be able to understand the learner's speech. Supporting Setter's view, Behzadi and Fahimniya (2014) insisted that every language programme should include pronunciation instruction, and this instruction should contribute in developing the learner's abilities to comprehend spoken language and to communicate successfully. From the point of view of teachers and learners, teachers feel that pronunciation teaching is essential (Fraser & Perth, 1999), and students consider pronunciation a priority in learning a language (Willing, 1988).

Couper (2003) suggested that, if the right and suitable approaches are used in teaching pronunciation, teachers can succeed in helping students improve. Furthermore, Fraser's (2000) view is that research in L2 teaching should not focus on the importance of teaching pronunciation but on the methodology used to teach pronunciation. Pronunciation teachers should use different strategies in language classrooms to help in developing pronunciation knowledge, such as focusing on individual syllables, single words, sentences or minimal pairs (Murcia-Celce et al., 1996).

2.4.3 General Approaches to Teaching Pronunciation

Generally, three approaches are used in pronunciation instruction: the intuitive-imitative approach, which was the only method used before the late 19th century; the analytic-linguistic approach; and the integrative approach (Murcia-Celce et al., 1996). These approaches combine traditional methods and modern techniques. The intuitive-imitative approach is based on listening and imitating the sounds of the target language without explicit instruction and intervention from the instructor. The modern techniques used in this approach are videos, audiotapes, computer programs and websites.

The analytic-linguistic approach is based on explicit instruction using tools, such as the phonetic alphabet, charts of the vocal tract and articulatory descriptions (Hashemian & Fadaei, 2011). Interactive speech software and websites could also be used in this approach. The integrative approach does not focus on pronunciation as an isolated skill. The main feature of practice in this method is the use of pronunciation-focused listening activities. Furthermore, the integrative approach focuses on the suprasegmentals of rhythm, intonation and stress, which goes beyond the level of the phoneme and the word (Hismanoglu & Hismanoglu, 2010).

Many studies examined one or two of these approaches and investigated their efficacy in developing accurate pronunciation. A recent study conducted by Ghorbani, Neissari, and Kargozari (2016) investigated the effect of explicit instruction in teaching English as L2 to Persian native speakers. This study aimed at comparing the outcomes of the intuitive-imitative and the analytic-linguistic approaches in enhancing learners' perception of English vowels. The study included 38 female undergraduate university students who underwent a compulsory training course of one and a half hours of instruction per week for eight weeks. The participants were divided into two groups, with 19 learners in each: the experimental group and the control group.

The experimental group was taught by using the analytic-linguistic approach, in which the instructor played audio CDs and provided specific information regarding the articulatory descriptions of vowels and phonetic alphabet training. Participants were also trained to discriminate between English and Persian vowels. Furthermore, feedback from the instructor was received when necessary.

The control group, on the other hand, were taught through an intuitive-imitative approach, where the instructor played the same CDs as with the experimental group, but this group used only their books, without any intervention from the instructor. This group did not receive explicit information regarding articulatory descriptions, training, or feedback.

The pre-and post-identification tests included 40 English words, each word had one vowel. The post-test was similar to the pre-test, but the words were in a different order. The participants listened to each word three times, and they were asked to choose the correct answer from an answer sheet.

The results of Ghorbani et al. (2016) showed a significant difference between the two groups. The experimental group who received the analytic-linguistic teaching approach performed significantly better in perceiving English vowels than the control group who received the intuitive-imitative teaching approach. The researchers suggested that raising learners' awareness and understanding of English vowel features explicitly is more effective than the implicit teaching method. This study strongly emphasised the importance and the role of explicit instruction and showed that exposure alone to natural speech is not enough to improve L2 pronunciation.

Following a similar objective, Jam and Adibpour (2014) conducted a study that aimed at comparing the outcomes of the intuitive-imitative and the analytic-linguistic approaches in enhancing learners' production of the English /w/, /ð/ and /θ/ that are absent in Persian. To this end, two groups of 12 high school students who were native speakers of Persian were recruited to participate in the study.

The first group received explicit training which contained articulatory descriptions of sounds, information about the phonetic alphabet, presentation of vocal charts and corrective feedback from the instructor. The second group, on the other hand, listened to the instructor's utterances, repeated them after him and received corrective feedback. The results showed that there was no significant difference between the two groups in the pronunciation of the English consonants /w/, /ð/ and /θ/ after experiencing the intuitive-imitative and the analytic-linguistic teaching approaches.

Jam and Adibpour (2014) had several limitations that affected the validity and reliability of their claim. First, and most importantly, there was no pre-test. The researchers tested learners' pronunciation only after they had received the pronunciation training. Their pronunciation competence before the training was not known. Therefore, it was impossible to measure whether the groups improved significantly after the training and whether there was a significant difference between them before the training.

Second, information that is important to researchers and language teachers was missing from this study, such as the duration of the training courses, whether the same instructor gave the two training courses to both groups and how the recordings from the post-tests were rated.

Third, corrective feedback was integrated into both teaching approaches, which made the intuitive-imitative approach become more like the analytic-linguistic approach. The intuitive-imitative approach requires no intervention of any sort from the instructor. Therefore, the results of Jam and Adibpour (2014) cannot be used to prove the insignificant outcomes of the analytic-linguistic approach.

Most of the previous studies that dealt with and investigated the analytic-linguistic approach have used different materials and techniques, and most of these techniques proved its efficacy, such as reading aloud (Al-Ahdal, Al-Hattami, Al-Awaid, & Al-Mashaqba, 2015), minimal pair drills (Haghighi & Rahimy, 2017), thin strips of paper to practise the puff of air when pronouncing aspirated sounds (Linebaugh & Roche, 2013), using ultrasound to understand articulation (Wilson, 2014) and using computer assisted pronunciation instruction (Liu & Hung, 2016). It can be noted from these examples above that the tools that successfully proved their efficacy in teaching the analytic-linguistic approach ranged from very simple to very sophisticated. However, different variables may impede the applicability of these teaching methods, which may lead to different results in different classroom environments, such as the type of targeted features (i.e., consonants, vowels or suprasegmental features), the instructors' experiences and goals, and the learnability and motivation of the learners.

The main aim of this current research is to find an appropriate pronunciation teaching method to facilitate the perception and production of emphatics. The analytic-linguistic approach was chosen to be the teaching method to adult L2 learners of Arabic in the current study, since many recent studies have suggested the high efficiency of this approach to gain learners' engagement and attention (Baran-Łucarz, 2012; Behzadi & Fahimniya, 2014; Demirezen, 2010; Ghorbani et al., 2016; Hashemian & Fadaei, 2011; Jahangiri & Sardareh, 2016; Liu & Hung, 2016; Roohani, 2013). Learners' attention to and awareness of specific linguistic rules and phonetic features help in developing accurate perception and production.

2.4.4 Form-Focused Instruction

Some researchers believe that some rules or certain features can be learned basically through exposure to the L2, while other complex or novel rules and features need to be directly explained through instruction to develop higher levels of knowledge and performance (Foote, Trofimovich, Collins, & Urzúa, 2016; Spada, 1997). Effective instruction involves certain techniques that help L2 learners to notice novel features and receive constructive feedback. This section covers three aspects that are related to the concept of form-focused instruction, which are the role of focusing on form, theories of L2 input and corrective feedback in developing learners' pronunciation of L2 sounds.

Long (1991) was one of the first scholars who distinguished different types of instruction. Three types of L2 instruction forms were proposed: a focus on forms (i.e., instruction that is based on teaching parts of a grammar as discrete units, in which each unit is treated as an activity to be practised systematically); a focus on meaning (i.e., instruction that lacks explicit focus and intends to lead to incidental L2 acquisition through exposure to rich input of the target language); and a focus on form or form-focused (i.e., any pedagogical effort involving planned or incidental activities that lead learners to notice linguistic forms) (Long & Robinson, 1998; Long, 1991; Lyster, 2004a; Oosthuizen, 2005; Saito, 2015; Spada, 1997).

Form-focused instruction involves any sort of direct teaching that focuses on specific rules or features and involves interactions with learners' errors. Ellis (2001) distinguished between two kinds of form-focused instruction: incidental (i.e., spontaneous) and planned (i.e., pre-designed activities). The current study employs planned form-focused instruction because the instructional activities in Study 1 and 2 involve a pre-planned teaching design that seeks to draw learners' attention to specific features of Arabic fricatives and pharyngealisation.

It is known to the field of Second Language Acquisition (SLA) that input plays a central role in developing learners' L2 acquisition (Izumi, 2002). Therefore, researchers and language teachers have tested various techniques that incorporated form-focused instruction through L2 input and feedback, such as written input enhancement (Amrhein & Nassaji, 2010; Doughty & Williams, 1998), verbal input enhancement (Su & Tian, 2016), visual input enhancement (Doughty, 1988; Offerman & Olson, 2016; Olson, 2014) and meaning-oriented treatment (Gass & Varonis, 1994; Salimi & Shams, 2016). The concept of form focused and these types of L2 input were designed based on four hypotheses: the Comprehensible Input Hypothesis (Krashen, 1985), the Noticing Hypothesis (Schmidt, 1990), the Interaction Hypothesis (Long, 1990), and the Output Hypothesis (Swain, 1985).

Krashen's (1985) Comprehensible Input Hypothesis is one of the best known SLA hypotheses, which indicates that an L2 learner has to be exposed to a rich L2 input which must be comprehensible but challenging. Krashen argued that the most beneficial input for L2 learners has to be challenging and slightly beyond the learners' current level of L2 competence.

Schmidt's (1990) Noticing Hypothesis indicates that learners must notice specific L2 linguistic features in order to produce those features accurately. The process of noticing linguistic forms through L2 speech starts from constructing effective instruction that aids in enhancing learners' ability to notice features that cannot be recognised in natural speech. As Derwing and Munro (2015) noted, teachers can help learners with "noticing what they are doing" (p. 387). Noticing is an important element for L2 learners to start recognising their errors and correct them accordingly (Schmidt, 1990).

Long's (1990) Interaction Hypothesis indicates that the interaction and communication between a non-native speaker and a native speaker (or an advanced non-native speaker) by using the target language very often draws learners' attention to specific language forms, which will promote the conversion of L2 input. This hypothesis links learners' L2 skills through input, learners' capacity, selective attention and output (Long, 1990). This hypothesis is clearly presented through communicative learning activities that help in facilitating L2 learning which includes negotiation of meanings and an opportunity to receive corrective and constructive feedback.

Swain's (1985) Output Hypothesis indicates that L2 learners must engage in L2 production activities in order to focus on specific language forms and boost their L2 competence. Creating a pedagogical form-focused syllabus must include activities that lead learners to notice the gap in their knowledge in specific linguistic contexts and provide input to enhance production.

These four hypotheses – explained above – were incorporated in many pedagogical studies to design successful form-focused syllabi (e.g. Ellis, 2001; Lyster, 2004a; Saito, 2007; Sheen, 2007). Choosing a form-focused instruction method to push learners to notice the gap or rise to the level of understanding in particular L2 contexts depends on the nature of the teaching purpose. Therefore, Spada and Lightbown (2008) used the terms 'isolated' and 'integrated' to define two approaches that lead to drawing learners' attention to L2 form through instruction.

Integrated form-focused instruction includes using communicative or content-based instruction to draw learners' attention to language form. This can be either incidental or planned. Isolated form-focused instruction includes focusing on teaching a particular language feature that L2 instructors believe that learners are unlikely to acquire during communicative activities. L2 instructors believe that isolated form-focused instruction always implies intentional learning and explicit instruction (Spada & Lightbown, 2008).

To some extent, the definitions of Long's (1991) planned and incidental focus on form fall in with Spada and Lightbown's (2008) definitions of isolated and integrated form-focused instruction. Focus on form's main emphasis is on communicative tasks and the feedback from the instructor is provided when required to help students to accurately communicate. So, the feedback given by the instructor is provided when he or she thinks it is needed as students engaged in communicative activities. In focus on form instruction, specific language features that are difficult to acquire are either incidentally learned or learned through pre-planned activities, that were designed based on the instructor's anticipations of difficult features. However, the main purpose of these activities is focusing on meaning (Doughty & Williams, 1998; Long & Robinson, 1998; Spada & Lightbown, 2008).

Form-focused instruction, on the other hand, can include communicative activities but the main purpose of this type of instruction is to draw learners' attention to specific linguistic feature, whether by focusing mainly on this feature explicitly in isolation or integrating the form-focused instruction with communicative tasks. Ellis (2002b) and Doughty and Williams (1998) provided definition of integrated form-focused instruction, which corresponds to the definition of focus on form and they both include communicative activities. The experiments in this study do not include communicative activities and the main purpose is to teach fricatives and pharyngealisation by using explicit planned teaching design.

Therefore, this current study employs an isolated form-focused teaching approach that includes directing L2 learners to accurately perceive and produce certain sound features through using explicit instruction and explicit corrective feedback without integrating it with communicative activities. Furthermore, the current study followed three stages of interlanguage development, which were identified based on a pedagogical sequence of form-focused instruction (Lyster, 2004a, 2004b, 2007; Ranta & Lyster, 2007). These three stages are the noticing stage (i.e., initial stage of interlanguage development that includes designed activities to promote learners' noticing of L2 linguistic features); the awareness stage (i.e., engaging learners to further elaborate and analyse those L2 linguistic features); and the practice stage (i.e., final stage of interlanguage development that includes repetitive practice of the target linguistic feature in production under authentic contexts). The main objective of using the stages of interlanguage development in the current study was to build learners' declarative knowledge of the distinctive features of emphatics.

2.4.5 Previous Studies on Explicit Form-Focused Instruction

Different explicit pronunciation techniques were examined to enhance L2 learners' production skill, such as repetition practice, phonetic or orthographic transcriptions, and types of corrective feedback, including verbal, written and computer-mediated feedback (e.g. Kartushina, Hervais-Adelman, Frauenfelder, & Golestani, 2015; Levis & Pickering, 2004; Peltola, Tamminen, Alku, & Peltola, 2015; Sisinni, d'Apolito, Fivela, & Grimaldi, 2016; Tateishi, 2013). Other techniques were used to examine the effects of perceptual training on L2 speech perception and the extent of its influence on L2 speech production (e.g. Bradlow, Akahane-Yamada, Pisoni, & Tohkura, 1999; Hardison, 2003; Iverson, Hazan, & Bannister, 2005; Krzonowski, Ferragne, & Pellegrino, 2015; Lambacher, Martens, Kakehi, Marasinghe, & Molholt, 2005; Lengeris & Nicolaidis, 2014; Wong, 2013). Although these studies yielded noteworthy results in favour of explicit perception and production phonetic training, they focused on learning difficult sound features under strict laboratory settings. Many of these techniques have been quite inaccessible, and, as a result, might have been of little practical value to pronunciation teaching and in particular to the classroom activities of language teachers.

Research in teaching pronunciation in actual classrooms is gaining little attention. Such lack of attention to L2 perception and production teaching has resulted in an inadequate understanding of the application of pronunciation training in L2 classrooms. Specifically, there is a need for more pedagogical studies in L2 speech perception and production teaching and learning, along with techniques for incorporating different modern methods into practical classroom instruction (Lambacher, 1999; Lee & Lyster, 2016b; Saito & Lyster, 2012a).

Among effective form-focused activities identified and discussed in previous research, particular techniques that are directly relevant to the current study are discussed in this section, including explicit isolated form-focused instruction and corrective feedback (i.e., “responses to learner utterances containing an error” (Ellis, 2006, p. 28)). The very few quasi-experimental studies that focused particularly on teaching segmentals and conducted in a range of classroom settings emphasised the effectiveness of these two techniques on learners’ development of speech perception and production in L2.

The most frequently cited study on form-focused segmental and suprasegmental English pronunciation instruction was conducted by Derwing, Munro, and Wiebe (1998). In their study, speech samples were collected before and after specific treatments from 48 English learners, who were divided into three groups. The aim of their study was to compare the outcomes of three different scopes of content in pronunciation classes. The first group received segmental form-focused instruction focusing on individual sounds and syllables, the second group received suprasegmental form-focused instruction focusing on stress, intonation, and rhythm and the third group received no specific pronunciation instruction and attended regular skills-based English classes. In the three groups, the focus was on both perceptive and productive skills. The training was for 11 weeks, 20 minutes per week. The rating of learners' speech was based on comprehensibility, accentedness, and fluency. The results showed that the segmental group improved significantly more than the other two groups in the level of accentedness, while both the segmental and suprasegmental groups improved significantly in the level of comprehensibility.

Although the results of this study can be used to the benefit of form-focused segmental and suprasegmental instruction, it was impractical to compare two methods that have two different objectives in pronunciation teaching. Teachers use a specific teaching approach based on learners' needs. Using form-focused instruction in teaching segmental and suprasegmental features is helpful in improving learners' accents and comprehensibility. However, it is difficult to choose and focus on one scope of content in pronunciation because its effectiveness was confirmed, while learners have weaknesses in other aspects of pronunciation. Another issue is the rating scale, which was based on accentedness, fluency and comprehensibility. Rating learners based on these three aspects, especially accentedness, is difficult and is subject to individual opinions, because a group cannot agree on a decision about what an accurate English accent from L2 learners looks like (Derwing & Munro, 1997).

Saito and Lyster (2012a) were the first to investigate the role of form-focused instruction with corrective feedback in classroom pronunciation learning. Their study aimed at examining the development of the English /ɹ/ by 65 Japanese learners of

English after receiving form-focused instruction with and without corrective feedback. To this end, participants were divided into three groups and received four hours of pronunciation training, one hour per day. The control group (n=11) received pronunciation instruction but without the form-focused method. The second group (experimental 1, n=29) received form-focused instruction with corrective feedback. The third group (experimental 2, n=25) received form-focused instruction without corrective feedback. The form-focused instruction for the experimental 1 and 2 groups included 38 minimally paired words, in which English /ɹ/ appeared in various positions, italicised and highlighted in red to help learners notice the target feature. The instructor in experimental group 1 was asked to recast learners' mispronunciation or unclear pronunciation of /ɹ/, while experimental group 2 did not receive recasts on their mispronunciation.

Three pre-and post-tests were administered, each requiring an audio recording of participants pronouncing the sound /ɹ/. The tests were word-reading, sentence-reading and picture-description. After analysing learners' pronunciation, the results showed that experimental groups 1 and 2 outperformed the control group significantly. Furthermore, experimental group 1, who received corrective feedback, improved significantly more than experimental group 2, who did not receive any feedback.

This study of Saito and Lyster (2012a) took a first step in investigating form-focused instruction in classroom settings and provided noteworthy results, indicating that form-focused instruction with corrective feedback can make a positive difference and help L2 learners improve their intelligibility. Saito and Lyster have continued investigating this subject, and their studies have confirmed the impact of form-focused instruction and corrective feedback on developing L2 perceptive and production skills

(Gooch et al., 2016; Lee & Lyster, 2016a, 2016b, 2017; Lyster, 2004a, 2004b, 2007; Saito, 2007, 2011a, 2012, 2013a, 2013b, 2015; Yang & Lyster, 2010).

Researchers believed that corrective feedback is a crucial element in production training (Gordon, Darcy, & Ewert, 2012; Kartushina et al., 2015; Lyster, 2004a; Su & Tian, 2016). The ongoing interest in the role of corrective feedback in developing learners' understanding of L2 features has led to the investigation of different types of feedback. Sheen and Ellis (2011) noted different types of oral feedback, including on-line feedback (i.e., the feedback is provided immediately following the learner's error) and off-line feedback (i.e., the feedback is withheld until the learners' communicative event has finished). They also mentioned that feedback can be input-providing (i.e., give a correction to the learner) or output-prompting (i.e., help the learner to elicit a correction). Furthermore, oral feedback also can be explicit (i.e., when the teacher corrects the learner's error) or implicit (i.e., when the teacher requests clarification for the learner's error). Each type has specific strategies, and the definitions of these different types are provided next, based on Sheen and Ellis (2011), Ranta and Lyster (2007) and Lyster, Saito, and Sato (2013).

Input-providing feedback has two strategies: implicit and explicit. The implicit input-providing feedback includes conversation recasts (i.e., reformulating the learner's response in order to resolve a communication problem). The explicit input-providing feedback includes didactic recasts (i.e., reformulating and correcting the learner's response, even if there is no communication problem), explicit correction only (i.e., correcting the learner's errors directly) and explicit correction with metalinguistic explanation (i.e., correcting the learner's errors directly and providing a metalinguistic explanation).

Output-prompting feedback also has two strategies: implicit and explicit. The implicit output-prompting feedback includes repetition (i.e., repeating the learner's utterance without mentioning the error) and clarification requests (i.e., drawing the learner's attention to an error by asking for clarification). The explicit output-prompting feedback includes a metalinguistic clue (i.e., eliciting a correction from the learner by providing a brief metalinguistic explanation), elicitation (i.e., eliciting a correction verbally from the learner by, for instance, a prompting question) and paralinguistic signal (i.e., eliciting a correction from the learner non-verbally).

The current study employs form-focused instruction and corrective feedback, following studies that showed positive outcomes in aiding L2 learners to develop perceptive and productive skills. Previous studies that showed that corrective feedback was beneficial in teaching pronunciation used different strategies, such as recasts (Gooch et al., 2016; Lyster, 2004a; Saito, 2013a; Saito & Lyster, 2012b), repetition (Bradlow, Pisoni, Akahane-Yamada, & Tohkura, 1997; Dlaska & Krekeler, 2013) and multiple types of feedback (Chu, 2011; Suzuki, 2005). The process of receiving and producing feedback in those studies involves a direct interaction between L2 learners and their teachers. Another type of corrective feedback can be found in computer-assisted programs. The next section focuses on using computers in L2 teaching and discusses previous studies that tested the efficacy of exploiting speech analysis tools in receiving immediate feedback in the field of teaching pronunciation.

2.5 Computer Assisted Language Learning

The use of technology in language classrooms dates back to the 1950s and 1960s (Brown, 1994). With the development of the mainframe computer and programs in the 1960s, Computer Assisted Language Learning (CALL) started to appear gradually

(Butler-Pascoe, 2012; Heift, 2017; Kasemsap, 2017). In that period, mainframe computers were located in universities and students could get access to limited terminals. The programs that were created at that time were simple, and focused on grammar, translation and vocabulary (Butler-Pascoe, 2012; Chapelle, 2001).

In the early 1980s, language teachers had the ability to own their personal computers, which made integrating that technology in L2 classrooms obtainable and manageable, and that was an active time in the evolution of CALL (Chapelle, 2001). During that period, researchers called for developing programs that have the ability to communicate with learners (Underwood, 1984). The research and development of CALL continued and now has become more intelligent and sophisticated than before. New technological didactic tools have increased educational capabilities (Heift, 2017).

Recently, the integration of technology into L2 classroom and out-of-classroom settings has been widely employed (Amaral & Meurers, 2011; Lai, Hu, & Lyu, 2018; Neri, Cucchiarini, & Strik, 2008; Parmaxi & Zaphiris, 2017; Scholfield & Ypsilandis, 2018) and different technologies, such as cell phones and computer programs, have been used in L2 teaching and learning. As educational technology evolved, creating software that serves the purpose of teaching and learning a language has become increasingly widespread.

Egbert and Petrie (2006) defined the term CALL as “learners learning a language in any context with, through, and around computer technologies” (p. 4). A great number of studies investigated and proved the efficacy of the use of CALL in and outside of classrooms, particularly for English language learners (Al-Qudah, 2012; Anderson-Hsieh, 1994; Chen & Li, 2012; Godwin-Jones, 2009; Hsu, 2016; Maftoon, Hamidi, & Sarem, 2015; Matthews, O'Toole, & Chen, 2017; Neri, Cucchiarini, & Strik, 2002; Neri, Cucchiarini, Strik, & Boves, 2002; Nunan & Richards, 2015; Prashanti, 2014). The L2 and L1 in many CALL studies varied; however, overall, English was the L2 in most of these studies. There have been far fewer studies on learners of Arabic as L2.

These studies on CALL in learning Arabic as L2 focused only on designing and developing CALL systems. These systems have not been tested on actual learners of Arabic, but the researchers provided a number of suggestions for future work or implication. For example, Shaalan (2003) described a CALL system which used Natural Language Processing that could aid learners to practice grammar. Natural Language Processing is concerned with the way computers are used to recognise, understand and manipulate natural language speech and text (Chowdhury, 2003). Learners produce sentences in various contexts and situations and this system detects the errors and the misused expressions. Shaalan (2005) also described an intelligent system that was based on Natural Language Processing and serves both language learners and students at primary schools. This system gives its users feedback on their production, which uses morphological and syntax analysers. Moreover, Magdy, Shaalan, and Fahmy (2007) presented the development of an automated lexical error diagnosis system that helps learners of Arabic to learn Arabic verbs.

Zainuddin and Sahrir (2016), on the other hand, evaluated the design and development of a multimedia program for learning Arabic vocabulary among beginner learners of Arabic. To the knowledge of the researcher, no experimental study was conducted in or outside of classrooms, and none has concerned developing learners' pronunciation of Arabic as L2 by using CALL.

2.5.1 The Advantages and Disadvantages of CALL

Several advantages and features distinguish CALL over the traditional tools. One of the main advantages to language teachers is that computers have the ability over instructors to serve individuals' needs. Teachers are required to monitor students' progress in a very short class time, which prevents them from giving adequate feedback or tracking the progress and performance of every learner. CALL can solve this issue and provide the feedback needed and record learning progress for every learner.

There are many advantages to language learners of using CALL, such as the immediate access to feedback (Echávez-Solano, 2003), the accessibility of materials inside and outside the classroom and for as long as students wish (Maftoon et al., 2015; Neri, Cucchiarini, & Strik, 2002), enhancing students' achievement and motivation (Lee, 2000) and reducing learners' stress and anxieties (Lai & Kritsonis, 2006; Luo, 2016).

On the other hand, one of the disadvantages or difficulties of using CALL in language teaching is the high cost, which makes it difficult for low-income learners or some low-budget language institutions to offer an adequate number of computers. Another difficulty is the importance of basic to advanced experience and knowledge of technology in language teachers and learners for them to deal appropriately with computers. Due to the limitations of technology intelligence, the shortcomings and imperfection of many applications require the existence of an instructor (Lai & Kritsonis, 2006).

2.5.2 Speech Analysis in Pronunciation Teaching

Speech analysis programs are used to create graphic representations of speech, which are based on the visual display of the articulation. Different kinds of information can be elicited from speech analysis technology, such as intensity, formant, and pitch, in which each object represents a function, for example, “the pitch contour is associated with the vibration of the vocal folds and the formant contours are related to resonances in the vocal tract” (Boersma & van Heuven, 2001, p. 341). Several programs are designed to show the visual movements of speech, such as WASP (Varden, 2006), Wave-Surfer (Sjölander & Beskow, 2000) and Praat (Boersma & van Heuven, 2001).

The current study focuses on the efficacy of using visualisation of speech through speech analysis technology in acquiring and understanding the phonetic and acoustic features of some Arabic sounds among L2 learners of Arabic. There are three reasons behind choosing this type of technology in this study. First, this technology has the ability to visually present specific acoustic features that cannot be caught by listening. Therefore, it is used in explaining the difference between pharyngealised sounds and their counterparts. As mentioned previously, because of the similarities between pharyngealised and non-pharyngealised sounds, it is difficult for L2 learners of Arabic to discriminate between them in the speech of native Arabic speakers. Speech analysis technology allows Arabic learners to see the acoustic cues of these sounds, and, with the help of the instructor, understand their features, which may help them to accurately perceive and produce these sounds.

Second, many studies have confirmed that the multi-modal presentation of information is beneficial. That is, information that is presented through visual and auditory channels at the same time facilitates retention and understanding (Chapple &

Curtis, 2000; Plass, Chun, Mayer, & Leutner, 1998; Yoshii, 2006). Findings of many studies supported a hypothesis called the dual-coding hypothesis (Paivio, 1991), which stated that information that is received by more than one cognitive channel is likely to be retained more than when it is received by only one channel (Danan, 1992; Sadoski, 2005; Sadoski & Paivio, 2013). This hypothesis was frequently applied to L2 vocabulary, reading and writing, and the idea could be applicable to that of visual speech and pronunciation too. In the current study and based on the dual-coding hypothesis, the audio explicit information provided from the instructor about the pharyngealisation feature, accompanied by the visual representation of this feature through the speech analysis tool, will be processed by both the verbal and the non-verbal cognitive channels, and, accordingly, will be retrieved and understood more successfully than information presented verbally and in only one modality.

Third, speech analysis technology has increasingly become one of the tools that is used in teaching pronunciation (Shimizu & Taniguchi, 2005). However, to the knowledge of the researcher, no study has tested this technology in teaching any feature of pronunciation to L2 learners of Arabic. Since many studies on speech analysis in teaching English provided significant and positive results, this tool has to be investigated regarding the teaching of Arabic pronunciation.

2.5.3 Research on Speech Analysis Technology in Pronunciation Teaching

Generally, this open-source tool is developed with manifold functions to help researchers analysing, measuring and understanding acoustic features of sounds (Durand & Pukli, 2004). Facilitating L2 learners’ pronunciation and understanding of sounds is not even addressed as one of the purposes of this tool.

A major focus in pedagogical research in using a visual representation of speech was on teaching suprasegmental features. Researchers believed that analysing intonation and stress is easier than analysing segmentals. Chun, Hardison, and Pennington (2008) commented that pitch is not complicated and easy for learners to understand and interpret. Derwing and Munro (2015) explained the process of learning through understanding pitch movements and patterns "by associating the rises and falls in visual patterns with pitch changes in another speaker's (or the learner's own) voice" (p. 127). They added that working in visual speech analysis with consonants and vowels is challenging and arduous, due to the nonexistence of simple acoustic representations of each sound.

The work on speech analysis technology in teaching pronunciation started in the late 1970s with a software called Visi-Pitch (Elemetrics, 1986). The creation of this software allowed researchers to investigate the potential benefits of teaching pronunciation through visual analysis of native speakers' speech (Abberton & Fourcin, 1975; Chun, 1998; De Bot, 1983; Weltens & De Bot, 1984). After that, other programs that serve similar purposes in teaching prosody appeared, such as VICK (Nouza, 1998) and WinPitch LTL (Germain-Rutherford & Martin, 2002). Anderson-Hsieh (1992) discussed in detail electronic visual feedback and how it can be successfully incorporated in teaching suprasegmentals.

One of the first informative studies that was conducted regarding speech analysis in teaching consonants was done by Lambacher (1999). He investigated the use of speech analysis in teaching English consonants to Japanese learners of English. The researcher believed that differentiating between L2 sound contrasts is challenging for non-native speakers, which makes speech analysis tools useful in teaching pronunciation. Lambacher (1999) mentioned that segmental and suprasegmental features can be improved by using electronic visual feedback, which allows learners to see the exact sound features of their pronunciation and change it.

What distinguishes Lambacher's (1999) study among many other studies that targeted teaching pronunciation through speech analysis spectrograms is that he focused on consonants, while many studies investigated pitch and intonation. Another matter is that he provided pictures of spectrograms showing patterns of each sound pronounced by native speakers of English and explained their frequency and duration. Unfortunately, his study did not include an experiment to demonstrate the extent to which these descriptions of spectrograms achieve accurate L2 pronunciation, yet, it gave an opportunity for researchers and teachers to easily follow this approach.

More recently, studies continued to investigate this teaching tool but mainly on suprasegmentals. One of the suprasegmental studies was done by Le and Brook (2011), which sought to show language students the differences between their pronunciation and that of native speakers in a visual form. They questioned the usefulness of Praat software in teaching intonation, and they sought to determine whether language students could improve by practicing yes/no and '*wh*' questions using this technology. Five Korean L2 learners of English and one Japanese L2 learner of English were taught English intonation by using Praat in 10 sessions of 45 minutes each.

The results indicated that the pronunciation of most students had improved significantly. Using this technology not only improved learners' pronunciation in English intonation but also gave students instant feedback, even outside the classroom, because they were able to use it on their computers at home. Although this empirical study examined the use of Praat software in teaching intonation and in making appropriate use of before and after measures, it did not include the types of exercises used or the techniques used to prepare the students to observe English intonation on the spectrograms. Importantly, teachers need to have sufficient knowledge of the content of the training sessions to be able to apply such programs in the classroom or for further research.

An additional limitation in Le and Brook's (2011) study is that the study involved only six students at one level of English proficiency; therefore, the results cannot be generalised, and they must be tested using a larger number of students with different proficiency levels. Also, because only one group of participants was used in the study, it cannot be confirmed whether they improved because they used Praat or because they received training in intonation.

Positive results were achieved in many studies following the same approach in teaching English stress and intonation (Gorjian, Hayati, & Pourkhoni, 2013; Levis & Pickering, 2004; Shimizu & Taniguchi, 2005). However, these studies lacked details about clear steps for the way they taught when using visual representations of speech.

A limited number of studies examined the use of speech analysis technology in teaching segmentals. The idea of using speech analysis for teaching segmentals began to be investigated in depth by Brett (2004), who examined a system for presenting instant feedback on learners' vowel production, based on the analysis of formants. He proposed the possibility of teaching segmentals through Praat, but he also integrated another technique to form a pronunciation teaching application.

The idea of Brett's application is based on comparing the scripts in the application with the learners' articulations of vowels. The learner chooses from the application the vowel that he wants to practice. Then, he listens to a recording of a native speaker pronouncing a word that contains the selected vowel. After one second, the learner has to repeat after the recording, and his voice is recorded in the application. The vowel is isolated from the utterance based on its intensity and then analysed based on its formants, to give proper feedback to the learner.

The purpose of using Praat in Brett's (2004) study was to create visual feedback for the learners and compare their utterances with native speakers' utterances, but at the same time, it does not make learners interact directly with Praat. Unfortunately, this idea of Brett has not been investigated empirically. However, it developed a concept for other researchers that Praat has potential in teaching segmentals.

An empirical study was carried out by Lord (2005) in investigating the benefit of spectrograms pictures taken from Praat in teaching Spanish phonemes to native speakers of English. Seventeen undergraduate students enrolled in a Spanish phonetic class participated in this study. The training course included clear explanations of English and Spanish sounds, oral and transcription practice, and voice analysis training.

The voice analysis training involved showing spectrograms of sounds and explaining their features. It also gave the students the opportunity to record their voices and compare them to native speakers' voices. The instructor allowed students to practise through this software several times throughout the semester.

The researcher measured students' performances before and after the training course and he found significant gains in their production after the treatment. Students were able to make significant improvements in pronouncing Spanish phonemes. The author called for integrating these explicit teaching techniques into the L2 pronunciation curriculum. He also pointed out the limitations that can be further investigated, which were the limited number of participants, and, more importantly, the absence of a control group.

In the same manner, Saito (2007) tested the production of the English low front vowels /æ/ learned by six Japanese learners of English after taking training in pronunciation with Praat. This pilot study included four students who were given explicit instructions and training through Praat, and two students who were given no instructions at all. The instructions for the experimental group involved explaining the differences between the Japanese and English vowel systems, and analysing students' pronunciation through Praat and comparing it with native speakers' pronunciation.

The participants took a pre-test and then they were given the training for only one hour, then they took an immediate post-test. After one week, they were given a delayed post-test. In the tests, students were recorded pronouncing a number of words that contained the English vowel /æ/. The results of this study showed that all subjects in the experimental group made significant improvements after the training. This study carried the same limitation as the previous study, which is the low number of participants, which made it difficult to generalise the results.

A study was conducted by Olson (2014) in demonstrating the use and usefulness of speech analysis technology, specifically Praat, in phonetic segmental instruction and the effectiveness of a visual feedback paradigm in second language segmental production in a classroom setting. In Olson's study, the main purpose was to explain certain activities that involved using Praat and to explore learners' attitude after performing these activities in the classroom. Twenty-five learners of Spanish (intermediate to low levels of proficiency) participated in this study, all of whom were native English speakers. The focus of the training was on the accurate production of the Spanish intervocalic stops [p, t, k].

Learners were given three sessions of visual feedback training, 30 minutes each. The training sessions included three steps, which were initial self-recording, guided visual analysis, and practice, then re-recording. The researcher did not test the learners after or before the training. However, he collected their feedback after receiving the training on Praat to respond to other researchers' claims, which indicated that Praat is only for researchers and beyond the grasp of students. The survey results showed that students were fully capable of downloading Praat, recording their voices and analysing them. Furthermore, students judged Praat as a useful and a unique tool for analysing their own pronunciation.

Although it cannot be confirmed whether the learners in the study of Olson (2014) improved or not, it is considered one of the most informative and significant studies regarding using speech analysis in teaching segmentals. The author successfully addressed the technique he used in teaching sound through Praat, which make his research easily applicable. This current study follows Olson's methodology and technique in teaching pharyngealisation to L2 learners of Arabic.

A more recent experimental study was done by Offerman and Olson (2016), and followed the same method as Olson (2014). The primary purpose of the study was to empirically test the method of Olson (2014) to improve students' acquisition of the Spanish segmental feature voice onset time (VOT) for /p, t, k/ through using Praat. A total of 24 participants were assigned to two groups, 17 in the experimental group and seven in the control group. The researchers followed the exact teaching method of

Olson (2014), which included the three steps for the experimental group: initial self-recording, guided visual analysis and practice and re-recording.

The researchers concluded that the experimental group improved significantly after the visual feedback training. Furthermore, they demonstrated the viability of visual representations of speech in teaching segmentals, which supported the few previous studies on segmental features. The authors called for more research regarding this visual feedback paradigm for new sounds, and compare it to other teaching approaches.

Although some researchers, such as Setter and Jenkins (2005), suggested that Praat and other speech analysis tools can be difficult to manage and they demand a high level of understanding, Olson (2014) demonstrated the opposite. He mentioned that learners did not report any problems or issues in using Praat. The L2 learners in Olson (2014) described Praat as a useful method for conceptualising and analysing their pronunciation. These two studies (i.e., Olson (2014) and Offerman and Olson (2016)) were the only recent studies found that evaluated and demonstrated teaching segmentals through Praat. Although this approach seems promising, it has a number of limitations that may hinder its successful application, which are presented in the next section.

2.5.4 Praat

Praat is a free speech analysis software created by Paul Boersma and David Weenink at the Institute of Phonetic Sciences of the University of Amsterdam. It is available at http://www.praat.org. It is a speech analysis program which analyses acoustics and shows visual waveforms and spectrograms of particular sounds (see Figure 2.17).

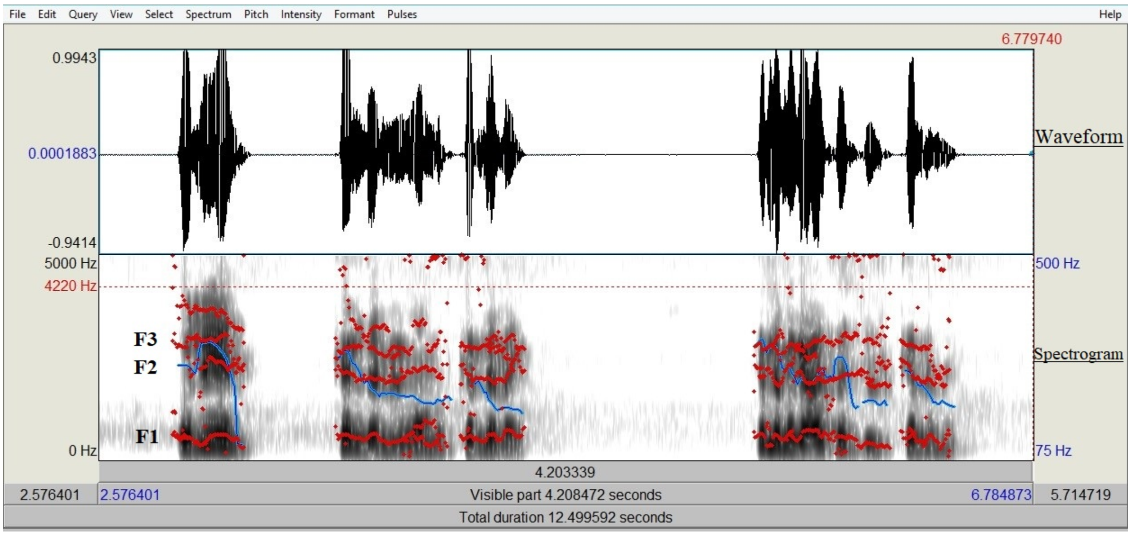


Figure 2.10: A screenshot of Praat software

In Figure 2.10, the upper rectangle shows a graphical representation of a sound in a shape called a waveform. The spectrogram in the lower rectangle shows a detailed representation of the components of a sound, such as intensity, pitch, duration and aspiration. The blue lines indicate the pitch, and the red dots indicate the formants. The F1, F2 and F3 in Figure 2.10 mean the first, second and third formants, and they are going to be used specifically in this study.

2.5.5 Limitations of Using Speech Analysis in Teaching Pronunciation

Despite the usefulness of technology in teaching pronunciation, there are several difficulties in integrating technology into the classroom, including cost, availability of computers and programs, technical support and knowledge, and users' attitudes and computer skills (Nadeem, Mohsin, Mohsin, & Hussain, 2012).

Moreover, there are criticisms of the usability of speech analysis software in classroom settings, which are based on practicality rather than theory (Olson, 2014). Using speech analysis software in pronunciation teaching has some limitations. Boersma and van Heuven (2001) described Praat as a tool having several features and possibilities for researchers but with very limited options for language learners. Praat was created and developed as a research tool – not a pedagogical tool. Hence, the potential for providing visual feedback is limited to graphs that can be read only by an individual with at least a simple understanding of articulatory phonetics (Brett, 2004). Setter and Jenkins (2005) also supported this opinion by saying that interpreting formants on spectrograms cannot be done without "a sophisticated level of understanding" (p. 10).

Chung (1994) noted that L2 learners should be trained in interpreting visual information correctly to gain positive outcomes by using this tool. The program does not tell the learner if the articulation is correct or wrong. The learner must compare the shape of the graph of his articulation to that of a native speaker. Suvorov (2008) observed that the lack of proper feedback in speech analysis programs is considered a disadvantage of using them in education.

Another limitation is that the program does not give learners a native speaker model of his or her articulation. Hence, a native speaker model must be provided for students to compare their articulation with that of a native speaker. Furthermore, the accent of a native speaker model that differs from that of the learners could appear in spectrogram differently, which learners may see as incorrect pronunciation (Brett, 2004).

Besides, the program does not detect or identify sounds. It shows only pauses and movements, and the learners have to decide or detect the position of the sound and its duration in the waveform and the spectrogram. Moreover, the previous studies on this program were conducted with L2 learners in intermediate and advanced levels of proficiency (Gorjian et al., 2013; Shimizu & Taniguchi, 2005). This tool has not been tested on learners at introductory levels (Olson, 2014).

This section discussed the importance of pronunciation teaching and presented several approaches to facilitate learning novel L2 sounds including using technology. The next section sets forth the theories and basis of the impact of language background and other factors that have a hand in increasing or decreasing the competency of L2 pronunciation.

2.6 Theoretical Concepts of L2 Speech Perception and Production

This study focuses mainly on moderating the difficulty of Arabic emphatic and fricative sounds through pronunciation instruction. This section gives brief information about and explanation of the theoretical views regarding some of the pronunciation errors that students make when they perceive and pronounce difficult or uncommon phonemes.

Many studies concluded that L1 might have an effect on the acquisition of L2, whether positive or negative (e.g. Cook, 2003; Derwing & Munro, 2013; Guion, Flege, & Loftin, 2000; Ortega, 2013). L1 could be a drawback that hinders the successful acquisition of L2 and could also be a facilitator to enhance L2 acquisition. The role of the L1 in SLA is central in the phonological theories discussed here.

2.6.1 Language Transfer

Studies on the role of L1 have an extended history in SLA research, especially those on the differences between children's and adults' acquisition of a second language, which supports the influence of the L1 background on L2 acquisition (Douglas, 2000). The role of L1 in SLA has been described variously as language interference (Krashen, Dulay, & Burt, 1982), language mixing (Kellerman, 1983; Selinker, 1972), cross-linguistic influence (Kellerman & Sharwood Smith, 1986) and language transfer (Gass & Selinker, 1993).

The definition of these terms began with Lado (1964), who initially proposed the idea of language transfer and suggested that "[i]ndividuals tend to transfer the forms and meanings, and the distribution of forms and meanings of their native language and culture" (p. 2). Since then, researchers have tried to define transfer, cross-linguistic influence or interference in various ways; however, they have expressed the same general idea. In attempting to predict errors produced by L2 learners with different language backgrounds, Corder (1971) explained the concept of transfer and reported that the habits of the learners' mother tongue could influence some L2 errors. Dulay, Burt, and Krashen (1982) defined interference as a spontaneous transfer that occurs because structural habits of the L1 are imposed on the structures of the target language. Similar to previous definitions, Lott (1983) specified that interference is "errors in the learner's use of the foreign language that can be traced back to the mother tongue" (p. 256).

Kellerman and Sharwood Smith (1986) preferred to use the term 'cross-linguistic influence' to refer to a broader definition, which included L1 to L2 or L2 to L1 transfer, and language loss or avoidance. They defined 'language transfer' as "those processes that lead to the incorporation of elements from one language to another" (p. 1).

The most widely held definition of transfer was proposed by Odlin (1989), who summarised language transfer as "the influence resulting from similarities and differences between the target language and any other language that has been previously (and perhaps imperfectly) acquired" (p. 27). Contrary to most researchers' definitions of 'transfer', which included or implied the word 'error', Odin's definition, particularly the inclusion of similarities and differences, implied different kinds of transfer, which is explained in the next section.

2.6.1.1 Classification of Language Transfer

Stockwell and Bowen (1983) specified three classifications of transfer (see Table 2.2).

Positive transfer	There is concordance between L1 and L2, and the learner responds similarly for both languages.
Negative transfer	A learner produces responses that are similar to the native language and different from the target language.
Zero transfer	There is no relationship between the learner's responses and his or her target language or native language.

Table 2.3: Language transfer classifications (Stockwell & Bowen 1983, p. 9)

Negative transfer occurs frequently in the speech of L2 learners, which leads to pronunciation problems affecting intelligibility and comprehensibility (Cortes, 2006). Liu (2011) described the results of negative transfer as a 'bad effect' and 'stumbling stocks' that could negatively affect the process of L2 learning. Odlin (1989) elucidated four consequences of negative transfer, which are presented in Figure 2.10.

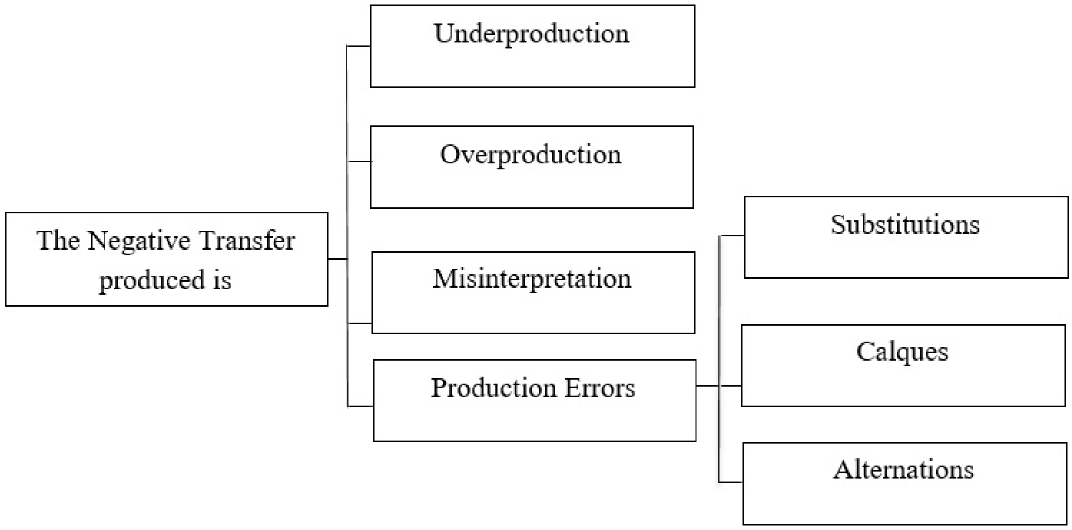


Figure 2.11: Classification of negative transfer (Odlin, 1989)

Each consequence is explained as follows:

- **Underproduction**: If the learner produces only a few examples of L2 or even avoids using certain L2 structures because of the differences between L1 and L2, then underproduction has occurred. This situation called 'avoidance'. Wang and Liu (2013) found that Chinese learners of English avoided using complex sentences because of the divergence between English structure and the structure of their native language, which has no complex sentence patterns that resemble those in English.
- **Overproduction**: When the learner avoids some L2 structures, he or she overproduces other structures that are similar to those in L1. For example, Japanese learners of English use too many simple sentences in their English writing instead of using relative clauses because the latter do not exist in their language (Schachter, 1974).
- **Misinterpretation**: If the learner's L1 influences the L2 structure and leads the student to infer a meaning that differs from what the speaker intended to express, then the negative transfer is a misinterpretation. For instance, word

order in English is different from that in Chinese, which affects Chinese learners' interpretation. One example mentioned by Gao (2013) is the phrase 'attend the game', which Chinese learners of English interpreted using Chinese word order to mean 'to take part in the game'.

- **Production**: There are three types of production errors: substitutions (i.e., the learner uses L1 forms instead of L2 forms), for example, Korean learners of English pronounced the sounds /s/ and /d/ in substitution for the interdental sounds in English /θ/ and /ð/ (Ioup, 2008); calques (i.e., the learner produces errors that very carefully reflect L1), for example, Hungarian L2 learners of Serbo-Croat were observed pronouncing Serbo-Croat sentences that were influenced by Hungarian stress patterns (Keys, 2002); as well as alternations (i.e., the learner produces errors that do not resemble the L1 structure and do not reflect any direct language influence). In the previous example, Hungarian L2 learners of Serbo-Croat were also observed pronouncing some sentences with stress patterns that resembled neither Hungarian nor Serbo-Croat (Keys, 2002).

Overproduction and underproduction are connected. L2 learners overproduce a structure in a language and therefore underproduce another structure (Wang & Liu, 2013). These two types of errors are common in grammatical structures but not in phonological output (Keys, 2002). Keys (2002) explained that L2 learners dislike difficult sounds, such as the English /ð/ and /θ/, but it is unlikely that they avoid using these sounds (underproduction) or prefer to use words that have simpler sounds (overproduction).

Since this current study focuses on the production and perception of Arabic phonemes, L2 Arabic learners' pronunciation errors are considered to occur in either production or misinterpretation. Unlike overproduction and underproduction, production and misinterpretation errors can be applied to the phonological input (Keys, 2002; Odlin, 1989). Odlin (1989) commented that production errors are likely to arise in spoken and written forms more than the other error types. Misinterpretation can be explained as the misperception of the target language's structure or sounds (Odlin, 1989). Therefore, in this study, problems in perception refer to misinterpretation, while problems in production refer to one of the three production types: substitutions, calques, and alternations, and they were defined and explained with examples earlier in this section.

Although most researchers agree that some L1 and L2 similarities facilitate L2 learning, which results in positive transfer (Benson, 2002; Brogan & Son, 2015; Carlisle, 2001; Cortes, 2006), finding similarities sometimes can be confusing or misleading (Cortes, 2006); for example, some cognates that carry a similar meaning in two or more languages are used in different contexts (Cortes, 2006), such as the word 'facteur' in French, which has two meanings, 'factor' and 'mailman' (Inkpen, Frunza, & Kondrak, 2005). In pronunciation, similarities between L1 and L2 sounds could negatively affect learners' perception and production more than L1-L2 differences, which are explained in the next sections.

2.6.1.2 Transfer in L2 Pronunciation

Berthold, Mangubhai, and Batorowicz (1997) described phonological interference as a foreign accent, which included features such as stress, rhythm, and intonation as well as the speech sounds that are present in L1 and which influence perception and production in L2. In other words, the influence of L1 on L2 affects the accuracy of pronunciation in both segmental and suprasegmental features, which results in a foreign accent that is often difficult for native speakers to understand (Sinha, Banerjee, Sinha, & Shastri, 2009).

In this respect, Ehrlich and Avery (2013) claimed that learners’ pronunciation of the target language could be influenced by the sound system of the native language, which could occur in three ways. First, a sound that exists in the native language but is absent from the target language could lead to mispronunciation or even misunderstanding of the sound. Second, the combination of sounds into words occurs differently in the native language than in the target language, which leads to problems in pronunciation because of the variations from one language to another. Third, stress and intonation in some languages determine different speech patterns that are transferred from the native language, which leads to errors in pronunciation and comprehension.

This study deals with the first situation Ehrlich and Avery (2013) described, in which pronunciation errors arise from variations in sounds between L1 and L2. The primary effect of the L1 is on the acquisition of consonants. Previous studies considered that consonant variation was more problematic than vowels (Cruttenden, 2014; Razavi, Naghavi, & Hajizade, 2013).

A growing body of literature on this topic recognises that the L1 sounds influence the acquisition of L2 pronunciation. For example, Seddighi (2012) investigated the influence of L1 on L2 pronunciation to detect difficult sounds that were pronounced by Iranian learners of English with low, intermediate and advanced levels of proficiency. The Iranian students were given a test consisting of 40 words and eight sentences, which they were asked to read aloud. The results showed that the Iranian learners of English in all three levels of proficiency encountered difficulties in pronouncing some

English sounds, such as the vowel /ə/ and the consonants /θ/, /ð/ and /w/. The researcher concluded that the errors with these English sounds occurred because they do not exist in the Persian phonetic system. The results of Seddighi (2012) agreed with many researchers who found that learners' language backgrounds impede their complete acquisition of L2 (Bian, 2013; Börjesson, 2014; Brogan & Son, 2015; Flores & Rodríguez, 2015; Ma & Tan, 2013; Major, 2008; Trude & Tokowicz, 2011).

Many studies on language transfer have focused only on the influence of the native language – the L1 – on the acquisition of the target language (Alhawary, 2009; Börjesson, 2014; Brogan & Son, 2015; Letica & Mardešić, 2007). However, other studies demonstrated a tendency for learners of additional or third languages (L3) to transfer L2 features to L3, especially in the initial stages of L3 acquisition, and that this tendency decreases with growing L3 proficiency (Dewaele, 1998; Wrembel, 2010). Transfer was therefore defined as influence resulting from differences and similarities between the target language and any language the speaker has previously acquired (Letica & Mardešić, 2007; Lipińska, 2015; Wrembel, 2010). Similar to L1-L2 transfer, L2-L3 transfer could be positive or negative (Hammarberg & Hammarberg, 2005; Mehlhorn, 2007).

Studies showed that L3 learners were relatively successful at transferring the knowledge of L2 to L3, particularly where L2 and L3 are similar. For example, English native speakers who have previously learned Spanish as L2 successfully acquired Portuguese as L3 (Salaberry, 2005). Moreover, Mehlhorn (2007) described the possibility for German native speakers who have previously acquired Russian as L2 to successfully acquire Polish as L3, due to the similarities in the phonological features between Russian and Polish. The mention of L2-L3 transfer here is important, as it could account for the pronunciation of Arabic emphatics and fricatives among some learners in the present study due to their previous knowledge of languages other than their L1s, especially English.

Several studies investigated the influence of Arabic as L1 on the acquisition of English by Arabic learners of English (e.g. Ahmad, 2011; Al-Saidat, 2010; Altaha, 1995; Flege & Port, 1981; Quinn, 2010). However, to the best of the researcher's knowledge, little research has been performed to investigate the influence of any L1 on the perception and production of Arabic by L2 learners of Arabic.

2.6.2 The Contrastive Analysis Hypothesis

The definition of interference or transfer from L1 to L2 elicited the idea of the contrastive approach. Fries (1945) formulated contrastive analysis (CA) when he contended that materials used in learning L2 are efficient when there are scientific parallel descriptions of the native language and the target language. Lado (1964) developed the hypothesis as a result of his comparison of English and Spanish. He noted that by comparing the language to be learned with the student's mother language, researchers or teachers could describe and predict patterns that would or would not cause difficulties. CA is defined as a comparative linguistic approach that investigates the similarities and differences between two or more languages in order to facilitate L2 learning (James, 1980).

The CA Hypothesis (CAH) was used in the 1960s and the early 1970s as a method of identifying the difficulties that were found in L2 learning (Alatis, 1968). At that time, it was argued that the errors L2 learners committed were not random mistakes, and there was a reason for these mistakes. As evidence for this theory, researchers pointed to common behaviours in L2 learners (Adjemian, 1976; Selinker, 1972).

2.6.2.1 Purpose of CA

The primary purpose of CA is to search for appropriate L2 teaching methods and materials. To achieve this purpose, L1 and L2 have to be compared to identify their structural similarities and differences; hence, CA simplifies detecting the language problems faced by L2 learners. In this case, errors in the use of the L2 are predicted initially, which helps language teachers construct appropriate materials to eliminate such errors.

2.6.2.2 Criticisms of CA

Although several empirical studies concluded that CA has pedagogical implications for the field of L2 teaching and learning (Abushihab, 2010; Mirzaei, Gowhary, Azizifar, & Jamalinesari, 2015; Rahimpour & Dovaise, 2011), some researchers have either ignored or denied the positivity of this approach. Cai and Lee (2015) stated that “CA began to be attacked by criticism particularly from the perspectives of feasibility and usefulness” (p. 719). Some researchers argued that CA focuses only on the similarities and differences between L1 and L2. Hence, it ignores other factors that may affect the L2 learner’s performance, such as training procedures, overgeneralisation, attention, sociolinguistic factors, and so on (MacCarthy, 2001).

According to its critics, CA highlights some potential difficulties that do not actually occur in the learner’s L2 production (Khansir, 2012; Major, 1987), such as the English fricative sound /ʒ/, which does not exist in MSA; however, Arabic learners of English do not have difficulty pronouncing this sound (Hamad, 2014; Mohammed, 2014; Zoghbor, 2011). In addition, CA fails to predict some errors that are detected in the L2 learner’s production (Khansir, 2012; Major, 1987), such as errors made by English native listeners in identifying the English voiced stops produced by Arabic learners of English, although these sounds exist in Arabic and English (Flege, 1981).

Although linguists may criticise CA, they do not deny the effects of L1 on the acquisition of L2. For instance, Corder (1967) believed that teachers find errors that linguists could not predict, and educators could predict difficulties based on their experience rather than on the CA approach. Furthermore, according to Mackey (1968), the predictions of experienced language teachers were much more reliable than those verified through CA. Other researchers believed that CA was not worth much attention, and it did not play a significant role in L2 learning (Whitman & Jackson, 1972). The opponents of CA suggested that to overcome language interference, learners should receive more training in L2 instead of focusing on differences between the languages (Newmark & Reibel, 1968). These criticisms of CA weakened its position as an effective pedagogical tool.

Despite the criticism of CA, some linguists see that CA could work and succeed in the field of L2 teaching and learning. Brown (1994) commented that the work of CA cannot be ignored because “such interference does exist and can explain difficulties” (p. 200). Specifically, the phonological aspect of L2 could be facilitated by contrasting sounds in L1 with those in L2 (Bian, 2013).

2.6.2.3 Limitations of CA Studies

Although some researchers have conducted studies that favoured CA as a useful pedagogical tool in teaching L2, their findings do not necessarily contradict the criticism of the CA method. For example, Rahimpour and Dovaise (2011) conducted a phonological contrastive analysis of Kurdish and English. After collecting data from Kurdish learners of English, the CA revealed that learners made errors in pronunciation which originated from the L1.

For example, the voiceless stops /p, t, k/ are aspirated in all positions in a word in Kurdish language. Hence, the Kurdish learners of English aspirated all English voiceless stops, regardless of their positions in a word. As L1, the Kurdish language affected the learners' acquisition of English and caused them to substitute the phonetic features in English with Kurdish. However, the authors did not show how Kurdish teachers or learners of English could overcome these differences or how understanding these differences could help improve language acquisition. Valero-Garcés (1996) suggested that the field of CA needs more research that concentrates on how to incorporate the differences between L1 and L2 in language teaching materials.

In another study, Abushihab (2010) performed a phonological CA of Arabic, Turkish and English. The aim was to detect differences and then find solutions to remove the difficulties, which is the objective of all contrastive studies. The analysis showed that one of the differences between these languages was in the relationship between language orthography and pronunciation. Unlike Arabic and Turkish, English orthography does not reflect pronunciation. For example, there is a difference between the pronunciation of the vowel in the words 'foot' /fʊt/ and 'fool' /fu:l/, although the vowels are both represented orthographically as 'oo'. The author noted that the results of the CA were used to prepare materials for language learners; however, the study did not show how L2 learners could overcome difficulties caused by the orthographic differences between those languages.

At the end of the study, Abushihab (2010) claimed that teachers should be aware of the differences between L1 and L2. Although he pointed out broad pedagogical implications for CA, he did not make recommendations about how to facilitate or improve English language instruction in order to eradicate or minimise the influence of L1.

Behzadi and Fahimniya (2014) argued that it is important for researchers to be able to apply their findings to pedagogical practice; otherwise, their research would have little value. The purpose of CA, as mentioned previously, is to help teachers construct the appropriate materials to eliminate the influence of L1 on L2 acquisition. The pedagogical part of these studies, which should explain the incorporation of the contrastive results in the pronunciation curriculum, is missing or only mentioned briefly. Despite the significant body of research on error prediction, the importance of CA as a pedagogical tool has received little attention.

It is important to mention that contrastive studies that are based on comparing two languages sometimes yield results that differ from those that are based on real data gathered from people. The strong version of CA is used to compare languages to investigate differences and then predict errors, whereas the weak version of CA is used to gather data from language learners to collect errors and then examine the reason for those errors by comparing and contrasting the target language with the mother tongue (Wardhaugh, 1970).

To illustrate this point, Rahimpour and Dovaise (2011), as mentioned previously, used the weak version of CA to compare English and Kurdish. Their study revealed that both Kurdish and English have the sound /v/. In this case, it was predicted that Kurdish native speakers would not have problems with the sound /v/ in English because it exists in their native language. On the other hand, Mirzaei et al. (2015) followed the strong version of CA in their investigation of the production of English sounds by native speakers of Kurdish. Their findings showed that 28 out of 30 students pronounced the English sound /v/ as /w/. For example, the words *van* and *vet* were pronounced incorrectly as [wæn] and [wet].

After comparing the participants' mother tongue with English, it was found that the Kurdish language has different dialects, one of which is called Sorani Kurdish, which contains the sound /v/. However, not all Kurdish dialects have this sound, which explains the contradictory results of their study. König (2012) pointed out that the results of contrastive descriptions are not always explicit or accurate, and such descriptions have potential falsifications; therefore, CA needs constant revision and improvement.

Further explanations are needed besides language transfer when the transfer from native language to the target language is not directly presented. That is, there might be an approach that is taken by L2 learners to determine their choices in pronouncing certain sounds that are not coming from their native languages, which is explained in the next section.

2.6.3 The Markedness Differential Hypothesis

Major (2008) noted that "[t]ransfer should not be studied as an isolated phenomenon, but rather only in relationship to other factors, including Markedness, similarity/dissimilarity, and other universals" (p. 82). The comparison between native and target languages to detect the challenging aspects of acquisition is not sufficient. A hierarchy of difficulties must be universally set to understand some L2 learners' errors that do not directly come from learners' L1s (Eckman, 1977).

The concept of 'Markedness' was used by Eckman (1977) to explicate the areas of difficulties in SLA. The Markedness Differential Hypothesis (MDH) is based on frequency of existence among languages of the world. The unmarked features are easy to learn and do not pose a difficulty for L2 learners, whereas the marked features cause perception and production problems for some L2 learners.

Results from different studies revealed a hierarchy of sounds acquisition that L2 learners of any language tend to follow. Coronal sounds that are articulated with the front part of the tongue are considered unmarked (more common) with respect to other places of articulation (Paradis & Prunet, 1991). Labial sounds have also been found to be unmarked cross-linguistically, which explains the high ability to perceive and produce these sounds among different L2 learners (Hume, 2003). Furthermore, Rice and Avery (1991) considered nasals unmarked with respect to other sonorants.

Regarding voicing, Lombardi (1999) demonstrated that voiceless obstruents are unmarked, in comparison to voiced obstruents. Since emphatics exist in a limited number of languages in the world, including Semitic languages, they are considered marked (Zemánek, 1996). According to previous conclusions, the Arabic emphatics /sˤ/, /dˤ/, /tˤ/ and /ðˤ/ and their counterparts are considered unmarked because they are coronal sounds. However, L2 learners of Arabic find the emphatics difficult to acquire. The place and manner of articulation in both emphatics and non-emphatics are unmarked and commonly used in most languages of the world. The marked aspect of these sounds is the feature of pharyngealisation, which L2 learners of Arabic find challenging.

MDH is explained briefly in this study to clarify the possible reason for some errors made by L2 learners of Arabic that are not directly derived from their native languages. Based on this theory, it can be predicted that the acquisition of the marked Arabic emphatic sounds may present difficulty in different phonological environments for L2 learners of Arabic. Errors that are not exactly similar to the learners' L1 phonemic system could be explained with respect to the theory of Markedness.

2.6.4 Second Language Speech Perception

The learning of pronunciation is based on developing two speech abilities: perception and production. Flege (1995) commented that perception development precedes production and accurate perception results in accurate production. According to Brown (2000), the "successful acquisition of phonological representations requires the accurate perception of phonemic contrasts in the input" (p. 7).

The study of L2 speech perception features listeners who vary concerning their experience with the L2 speech. Phonemic inventories differ from one language to another, which creates difficulties in perception and production for L2 learners. Although it does not occur in all cases, L2 learners perceive the sounds of the target language differently than native speakers do (Guion, Flege, Akahane-Yamada, & Pruitt, 2000), and each L2 learner perceives the sounds of the target language differently than other L2 learners, based on learners' linguistic knowledge (Elman & McClelland, 1988) and other individual variations (Mayr & Escudero, 2010).

This current study investigates the ability of a group of L2 learners of Arabic to perceive and produce the Arabic pharyngealised and fricative sounds. The theories of L2 speech perception and production could give a better understanding to the processes and techniques that L2 learners use in perceiving non-native speech sounds that are similar to some extent to L1 sounds. However, the main purpose of the current study is to record learners' errors and improvements during a very short period of time, while theories of speech perception look at changes and developments across time (Flege, 1995). This thesis is fundamentally about instructed SLA and teaching pronunciation. The theories of L2 speech perception and production discussed here will be used to support or justify some L2 learners' errors in the discussion chapters, but it should be noted that they are not the main theoretical underpinning of this thesis.

CAH has contributed to the SLA field by developing methods for comparing L1 and L2 and by questioning the relationship between the two languages (Brown, 2000). The L2 speech perception models support CAH by substantiating the role of L1 in the acquisition of L2 and by helping predict difficulties that occur because of the influence of L1. The proponents of CAH have claimed that L2 learners' errors could be predicted, according to the presence and absence of sounds in the native language and the target language. The proponents of CAH may not have been able to explain exactly how L1 influences L2, yet they have opened up new approaches to developing research on L2 acquisition (Brown, 2000). Therefore, three models were developed to examine the perception learnability of L2 speech based on learners' L1s, which are the Speech Learning Model (SLM; Flege, 1995; Flege, Schirru, & MacKay, 2003), the Perceptual Assimilation Model (PAM; Best, 1995) and its extension to L2 learning (PAM-L2; Best & Tyler, 2007). Linguistic experience is therefore at the core of L2 speech perception models, which attempt to explain the way different non-native sounds are perceptually acquired with age and the L2 experience, and how that could be used to predict acquisition difficulties in learning non-native sounds.

2.6.4.1 The Speech Learning Model

Flege (1995, 2003) formulated SLM when he proposed the idea of a 'common phonological space' in L1 and L2 speech perception. The idea of SLM concerns the acquisition (including both perception and production) of L2 segments by experienced L2 learners (Saalfeld, 2009). The concept of SLM is based on several assumptions.

The first assumption is that the similarities between L1 and L2 individual sounds can help predict difficulties in the acquisition of non-native sounds. Flege (1995) proposed that it is expected that L2 learners will face no problems if the sounds in L1 and L2 are either identical or very different. However, difficulties will appear in cases when the sounds in L1 and L2 are similar in some features but not identical. The varying degrees of similarity could be either an assistive or a disruptive element of acquisition.

Guion, Flege, Akahane-Yamada, et al. (2000) stated that "[t]he greater the perceived phonetic distance between an L2 sound and the closest L1 sound is, the more likely it is that phonetic differences between the sounds will be detected and a phonetic category eventually established" (p. 2713). SLM interprets the process of perception in terms of phonetic properties (Burgos, Cucchiarini, van Hout, & Strik, 2014).

This assumption was discussed extensively in previous studies. Two previously discussed examples are Zaba (2007) and Hayes-Harb and Durham (2016) in the Literature Review Chapter in Section 2.3.4.

The second assumption is that a new phonetic category can be established to represent L2 sounds that differ from L1 sounds. Previous studies have found evidence supporting this claim. They argued that the perceptual space of L2 learners can be reshaped or modified in response to the novel L2 sounds. For example, Japanese speakers tend to judge the English /l/ as more similar to the Japanese tap /ɾ/ than to English /ɹ/, although the alveolar tap /ɾ/ is close in its acoustic features to the English /l/ (Flege, 1995; Guion, Flege, Akahane-Yamada, et al., 2000; Sekiyama & Tohkura, 1993).

The third assumption is that adults can develop accurate native-like perception over time. In the beginning, learners will tend to make L2 speech sounds that exist in the L1. As they develop their proficiency in L2, they will be able to distinguish the differences between the L1 and L2 segments more accurately and they may produce native-like pronunciation in their ultimate attainment (Flege, 1995).

The fourth assumption is related to the age of L2 learners, which correlates negatively with their ability to discern phonetic differences between the native language and the target language. An example can be seen in Baker and Trofimovich (2005), who showed that early bilinguals demonstrated a higher degree of the discriminability of vowels between the native and the target languages than late bilinguals.

The fifth assumption is that there is a relationship between speech perception and production. First, L2 phonemic categories have to be accurately perceived before they can be produced, which means that inaccurate perceptual categorisation of L2 phonemes could cause production problems. The assumption that perception precedes production was tested many times on different L2 learners and found contradicted results (Baker & Trofimovich, 2006; Flege, MacKay, & Meador, 1999; Sheldon & Strange, 1982). It was found that perception does not always precede production and that they are both controlled by different mechanisms (Flege, MacKay, & Meador, 1999; Sheldon & Strange, 1982).

Second, the degree of perception difficulty is concurrent with the degree of production difficulty (Flege et al., 1999), which means that there is a correlation between perception and production, and that the sounds that are difficult in perception pose a similar level of difficulty in production. This assumption is based on studies that examined the relationship between perception and production and found that the features that pose perception difficulty pose production difficulty too (Flege, 1988; Hwang, 2011; Newman, 1996).

The present research briefly discusses the SLM assumption that concerns L1-L2 similarities and differences (the first assumption) to explain some L2 learners' errors. In addition, the benefit of increasing language experience in enhancing learning novel L2 sounds is shortly mentioned in this study. The relationship between learners' age, correlation between speech perception and production and L2 acquisition ability have not been examined in the current study due to lack of longitudinal data, precise tests and intensive analysis.

2.6.4.2 The Perceptual Assimilation Model (PAM and PAM-L2)

PAM was developed by Best (1995), who proposed that L2 sounds are assimilated to the native language sounds with regard to their articulatory similarities. The model explains how 'naïve' listeners categorise segments in languages with which they are not familiar and have not been exposed to by formal instruction or experiences (Best & Tyler, 2007).

Best (1994) claimed that the perceptual similarities and differences between L1 and L2 sounds govern the ability to perceive L2 sounds. PAM shows that non-native listeners 'perceptually assimilate' new and unfamiliar sounds that exist in the target language according to their articulatory similarities to the native language (Best, 1995). PAM predicts pronunciation errors based on the comparison of L1 and L2 sound contrasts.

Best (1995) proposed three patterns of the perceptual assimilation of non-native sounds for naïve listeners. L2 learners can either (a) assimilate to a different native category (*two-category assimilation*), and their perception and discrimination of L2 contrasts are expected to be excellent; (b) assimilate non-native L2 sounds to a single native category (*single-category assimilation*), and their perception and discrimination of L2 contrasts is expected to be poor; (c) assimilate non-native L2 sounds to the same native category, but they differ both from native sounds (*category-goodness*), and their perception and discrimination of L2 contrasts is expected to range from moderate to very good. Interestingly, Best and Tyler (2007) revised PAM to include not only naïve listeners but also experienced L2 learners (PAM-L2).

Best and Tyler (2007) observed that SLM and PAM have been wrongly used interchangeably, and the aim for integrating and developing PAM-L2 is "to probe the commonalities and complementarities of the two models, and especially to explore whether and how SLM can be used as a starting point to extend PAM's non-native speech perception framework to L2 learners" (p. 22). The perspective of PAM-L2 is that L2 users never stop learning and there is a difference between L2 active learners and stable bilinguals. The focus of PAM-L2 is on L2 learners who are actively acquiring an L2 (Antoniou, Tyler, & Best, 2012).

In describing the notion of PAM-L2, Best and Tyler (2007) identified factors that affect the formation of L2 speech perception which are: the age of L2 learning, the length of residence in L2 settings, and the amount of L1: L2 usage. The more the age of L2 learning, the length of residence in L2 settings, and the amount of L2 usage, the more L2 learners can discriminate L2 contrast.

Measuring L2 learners' perceptual assimilation abilities and accuracy based on PAM needs a particular discrimination test, which includes a rating scale that allows researchers to analyse learners' responses and how likely L2 contrast resembles L1 phonological categories. The current study focuses on the perception of Arabic individual sounds and applies a simple identification test that shows the ability of L2 learners to identify the target sounds for a purpose of identifying learners' perceptual knowledge. This study does not apply a perceptual assimilation test in Study 1 and 2, as it mainly focuses on testing learner's knowledge of fricatives and emphatics and finding a suitable way to improve it. The mention of PAM here is to give a brief insight into other speech perception theories that discuss L1-L2 similarities and how the existence of similar L1-L2 sounds could influence learners' perceptual abilities and accuracy.

The learning context and other variables such as age and L1-L2 use was not accurately measured when assessing participants' perceptual competence in this study due to the lack of large enough equivalent groups of participants who share similar conditions, such as language backgrounds. Furthermore, the type of stimuli utilised are not sufficient to judge learners' perceptual assimilation choices and may not be accurate to be assessed by SLM and PAM.

SLM concerns experienced listeners and immersion learners learning individual sounds through lifespan, while PAM concerns the acquisition of sound contrasts by naïve listeners. Learners in formal instruction settings are in a state of constant development and it is difficult to capture significant gains over time for learners in the current study. However, some data are assessed based on the SLM because of the existence of a degree of perceived phonetic similarity between Arabic and learners' L1s whose experience of Arabic as L2 ranged from poor to advanced. Furthermore, the SLM takes into account the benefit of pronunciation instruction in enhancing learners' abilities to perceive and produce accurate L2 sounds.

More explanations of discrimination and identification tests and other methods that are used to measure speech perception are presented in the next section.

2.6.4.3 Measuring L2 Speech Perception

Studies on speech perception have used different methods in investigating certain L2 perception problems. Mainly, there are three standard methods to test speech perception, which are delivered either on paper or via a computer. These three methods are the AXB discrimination test (Antoniou et al., 2012; Lai, 2010), the identification test (Baker, 2005; Baker, Trofimovich, Mack, & Flege, 2002; Horslunda, Ellegaardb, & Bohnc, 2015) and the similarity rating test (goodness judgment) (Sun & van Heuven, 2007). Some studies combined two or more of these methods (Tyler, Best, Faber, & Levitt, 2014). Each kind of test serves specific purposes, and each has advantages and disadvantages, so no test is superior to the rest in testing speech perception.

2.6.4.3.1 The Discrimination Test

The discrimination test is based on measuring learners' abilities to differentiate between L2 sounds and how closely they resemble L1 sounds. It is a good method to accurately measure differences in perception between individuals and how their perception changes due to L2 learning or L2 exposure (McGuire, 2010). This test involves three choices, A, X and B, in which A and B are the contrasts. In this test, listeners are asked to compare which stimulus (A or B) is the same or closely similar to the stimulus X, such as the perception test in Al Mahmoud (2013), which is mentioned in Section 2.4.5.2.

The advantage of this kind of test is that listeners do not have to explain the differences or similarities between the sounds, but simply select the ones they perceive to be similar. Moreover, it is straightforward to set up this task as it is relatively simple and understandable for participants. On the other hand, the disadvantages of this method are that items near the end of a list are remembered best and listeners might remember recently presented information (Nairne, 1988). Therefore, listeners can develop a bias toward the B stimuli, due to recency effects (McGuire, 2010).

2.6.4.3.2 The Identification Test

The identification test has three types: yes-no, forced choice and oddity. The yes-no identification task takes different forms and can be administered visually through computer or with an answer sheet. It can take the form of asking the subject whether or not a stimulus that they heard is presented again by choosing yes or no. Another form is when there are two sounds, A and B, and listeners decide which one they heard and put yes or no beside each sound. McGuire (2010) commented that this type of test is not challenging, and the calculation of the effect size is straightforward. However, there is no direct comparison between contrasts and the listeners are not asked if the sounds they heard are identical or just similar.

The forced choice identification test is the most popular perception task, where listeners hear only one stimulus, and they have to decide which sound they heard by choosing from two or more sounds or by writing what they heard. The purpose of this task is to assess listeners' categorical knowledge (McGuire, 2010). This task is simple and straightforward, the explanation to the listeners is simple and clear, and it can be performed and analysed within a short period (McGuire, 2010). The only disadvantage for this task is forcing listeners to choose one choice that is presented, which means imposing a categorical decision (McGuire, 2010).

The oddity identification test allows listeners to distinguish one different stimulus from multiple similar stimuli. This test seems similar to the AXB discrimination test, but the design and requirement are actually different. In the AXB discrimination test the listeners decide which sound (A or B) is similar to X, while in the oddity identification test the listeners identify which sound (A, B, C, etc) is different from the whole group of sounds. The oddity identification task is easy to explain to subjects. However, subjects find it difficult to hear various stimuli and hold them in their memory. Moreover, the same as the discrimination test, recency effects are observable (McGuire, 2010).

2.6.4.3.3 The Goodness Judgment Test

Goodness judgments tests allow the researcher to establish the location of the best exemplar and the place of the contrasts' identification boundary. In goodness judgment tasks, listeners are asked to rate the sound they hear on a rating scale from bad exemplar to good exemplar. This type of test is usually combined with the identification test (Iverson & Kuhl, 2000; Iverson et al., 2003). The disadvantage of this method is that subjects may vary in the way they understand and use the scale (McGuire, 2010).

Other methods are used to measure speech perception, but those mentioned above are the most common ones. The next section presents studies that have contributed to the field of perception and production of Arabic as L2 and provides an idea about the way CA, SLM and PAM-L2 could be promoted in identifying and explaining perception and production difficulties.

2.6.5 Perception and Production Studies of Arabic as L2

This section presents previous literature that investigated the way non-native speakers of Arabic perceive and produce Arabic sounds. The purposes of these studies varied; however, they all identified challenges in terms of the difficulty for non-native speakers of Arabic in learning and acquiring difficult Arabic sounds (such as emphatics). Since the current study investigates L2 learners' perceptive and productive abilities of Arabic sounds, it was essential to mention these studies to detect similarities and differences in the results between this study and previous literature.

A considerable amount of linguistic research on L2 acquisition of the Arabic language has investigated some morphological, syntactic, psycholinguistics and sociolinguistic issues. For example, Elkhafaifi (2005) examined the role of anxiety in Arabic learners' classroom learning experiences, and how anxiety affects the performance of learners of Arabic in listening comprehension. Alhawary (2009) examined the performance of English and French students of Arabic in the processing of verbal and gender agreements. Alhashmi (2013) investigated the vocabulary learning strategies of Malaysian learners of Arabic as a foreign language. In a similar vein, Khaldieh (2000) studied learning strategies in writing tasks by American students of Arabic.

Some authors focused on developing speaking skills in general for L2 learners of Arabic, without looking at specific sound issues, such as Yaqub (2012), who discussed the matter of speaking course design and materials/task development for L2 learners of Arabic in Nigerian universities. Another study was conducted by Haron, Ahmad, Mamat, and Mohamed (2012), who examined the performance of Malay speakers of Arabic to investigate the strategies used by them to develop Arabic speaking skills in the classroom.

Regarding phonological research, very few studies have explored Arabic phonology with respect to L2 acquisition. Generally, studies of Arabic phonology can be categorised into two main sections.

The first section of studies on Arabic phonology has applied the theory of CAH and focused on comparing and contrasting the sounds and phonological structure of Arabic and English. The purpose was to demonstrate the similarities and differences between the two languages and, therefore, facilitate teaching English (Flege & Port, 1981; Lehn & Slager, 1959; Malick, 1956; Odisho, 1979; Quinn, 2010). To the researcher's knowledge, other than English, only Malay (Ali, 2013) and Turkish (Abushihab, 2010) have been phonetically compared with Arabic, and these studies also included contrastive analysis of English language. Most of these contrastive analysis studies provided important linguistic descriptions and valuable pedagogical implications solely for the purpose of teaching English effectively._The second section of studies on Arabic phonology has empirically examined the production and perception of Arabic phonology by two kinds of subjects: native speakers of Arabic and L2 learners of Arabic. These studies are presented next.

2.6.5.1 Studies on Production

Studies on native speakers of Arabic have explored the acquisition of Arabic sounds by children in different developmental stages, as discussed previously in Section 2.3.7 (Al Amayreh, 1994; Amayreh, 2003; Amayreh & Dyson, 1998, 2000; Dyson & Amayreh, 2000).

Additionally, Abdul-Kadir and Sudirman (2011) conducted a study on bilingual children L2 learners of Arabic. The authors investigated the difficulties of MSA phonemes spoken by Malaysian primary school children aged from seven to eleven years old. The researchers analysed recordings of 25 children, where each pronounced 25 Arabic consonants. The study concluded that the fricatives were the most difficult sounds to pronounce, especially the phonemes /ðˤ/, /ɣ/, /ħ/, /x/, /ʕ/, /h/.

The difference between L1 and L2 acquisition can be seen clearly in the conclusions of Abdul-Kadir and Sudirman (2011) and Amayreh and Dyson (1998), who showed the role of speakers' language backgrounds. For example, monolingual children acquired the sound /ħ/ in their early period (Amayreh & Dyson, 1998), while bilingual children found it difficult to pronounce the sound /ħ/ accurately (Abdul-Kadir & Sudirman, 2011). This also applies to the sounds /ɣ/, /x/, /h/, which monolingual children in the transitional period had the ability to acquire quickly, while bilingual children faced difficulties in pronouncing these sounds.

With regard to adult L2 learners of Arabic, very few cross-linguistic studies have discussed the accuracy of perceiving and producing accurate Arabic segments, including vowels and consonants, at different levels of proficiency (e.g. Al Mahmoud, 2013; Alosh, 1987; Alsulaiman et al., 2014; Alwabari, 2013; Kara, 1976). For instance, Shehata (2015) has questioned the claim about the difficulties of Arabic consonant phonemes in both perception and production by 107 adult native English speakers residing in the US. An online questionnaire was used, which consisted of questions about participants' backgrounds and self-rating of the level of difficulty or easiness of all Arabic consonants in both perception and production. The results revealed that 90 out of 107 participants (84%) indicated the importance of learning Arabic language. Moreover, 97 out of 107 participants (90.6%) agreed that there is a difficulty with Arabic consonant sounds for native English speakers, and they considered the sounds /ħ, dˤ, tˤ, sˤ, ðˤ/ the most difficult consonants to perceive and produce. Furthermore, the results showed that the sounds /ɣ, ʕ, q/ are semi challenging and the sounds /k, j, s, b, f/ are the easiest. Shehata (2015) mapped the easiness of some Arabic sounds to their existence in English and the difficulties of the pharyngeal and pharyngealisation sounds to their absence in the phonetic system of English.

Shehata (2015) gave an insight into the attitude of L2 learners of Arabic with respect to the position and importance of learning Arabic language and the difficulty of Arabic sounds. However, learners' self-evaluation of their performance did not capture the actual difficulties they are facing in perception and production. The author discussed results from a previous study, which she claimed to be contradictory to the findings of her study. This study was done by Asfoor (1982), who examined the most intricate Arabic sounds pronounced by native speakers of English. To this end, 34 students were recorded pronouncing 10 Arabic sounds, rated by 24 Arabic instructors as the most difficult Arabic consonants. The results concluded that English speakers found difficulties in pronouncing the Arabic stops in general.

To have a closer look at the methodology of Asfoor (1982), instructors assigned 10 out of 28 sounds to be the most difficult sounds, and only those sounds were examined, which included /x/, /ɣ/, /ʕ/, /dˤ/, /sˤ/, /q/, /ʔ/, /tˤ/, /dˤ/, and /ðˤ/. The stops that were chosen by the instructors did not include all stops but only emphatics. The stops /b/, /t/ and /k/ were not included in the study. The author generalised his conclusion to include all stops.

The validity and reliability of the methodology used in Asfoor (1982) are questionable for two reasons. First, as commented earlier, a limited number of sounds were examined, based on difficulties assigned by native speakers of Arabic and not by L2 Arabic learners. The author did not mention the issue of pharyngealisation but generalised learners' deficiencies in pronouncing the emphatic stops to all stops, which is considered a mistake. Second, the author tested students' pronunciation based on imitating native speakers. The trial included recordings of native Arabic speakers pronouncing words, and the author asked the participants to imitate the recordings, which ignored the implicit knowledge of the learners. The validity of this method is questioned because this kind of test leads participants to merely repeat the words verbatim without using their own knowledge of production (Ellis, 2009). Although Shehata (2015) pointed out in her study that the results of Asfoor (1982) were incompatible with what other researchers found, the results were actually similar because the stops that Asfoor found difficult were emphatic stops and not all stops.

One of the studies in the production of Arabic phonetics by adult L2 learners was conducted by Alsulaiman et al. (2014), who investigated the variation in the pronunciation of Arabic sounds amongst 33 non-native speakers of Arabic with different nationalities, Pakistani, Indonesian, Nibali and Indian. Their primary intention for conducting this study was to develop an automatic error detection system for L2 learners of Arabic. The instruments were both read text and casual conversation, and the scripts were isolated words, digits, sentences, and paragraphs.

A number of errors were found in the production of each emphatic sound (/sˤ/ =69, /ðˤ/=52, /dˤ/=48, /tˤ/=13). Interestingly, the authors noticed that there were many commonalities in the types of errors among L2 learners of Arabic, regardless of their language backgrounds. The errors in the production of emphatics were:

- /dˤ/ → /d/ = alveodental voiced emphatic stop substituted with alveodental voiced non-emphatic stop.
- /tˤ/ → /t/ = alveodental unvoiced emphatic stop substituted with alveodental unvoiced non-emphatic stop
- /sˤ/ → /s/ = alveodental unvoiced emphatic fricative substituted with alveodental unvoiced non-emphatic fricative.
- /ðˤ/ → /ð/ = interdental voiced emphatic fricative substituted with interdental voiced non-emphatic fricative.

Moreover, there were unexpected and uncommon errors found in the data for the emphatics /ðˤ/ and /sˤ/ which were:

- /ðˤ/ → /z/ = interdental voiced emphatic fricative substituted with alveodental voiced non-emphatic fricative.
- /sˤ/ → /θ/ = alveodental unvoiced emphatic fricative substituted with interdental unvoiced non-emphatic fricative.

Alsulaiman et al. (2014) accounted for the pronunciation errors by referring to language transfer. The uncommon errors, on the other hand, were explained by confusion in the way the letter was written in the test. In fact, the written form of the sounds /ðˤ/ (ظ) and /sˤ/ (ص) is entirely different from /z/ (ز) and /θ/ (ث), so there might be another explanation for those errors. These uncommon errors require further investigation to find a reasonable explanation for this substitution.

The speech recorded by participants was different from one speaker to another, which means that the frequency of emphatics in participants' speech varied. Unfortunately, the numbers of each emphatic pronounced by each participant or language group are unknown. In addition, the characteristics of participants and their backgrounds were also unknown.

Although Alsulaiman et al.'s (2014) study was conducted mainly for the purpose of developing an automatic error detection system, the results derived from it are useful for L2 Arabic phonology research and serve as a base for what to expect from different non-native speakers of Arabic in their pronunciation of Arabic sounds. This study is the only study found to test the production of adult L2 learners of Arabic from different language backgrounds.

2.6.5.2 Studies on Perception

A great amount of research has been done regarding L2 speech perception, and to a large extent, it focused on one aspect: the perception of L2 vowels (rather than consonants) in English among all languages of the world (e.g. Bundgaard-Nielsen, Best, & Tyler, 2011; Escudero, Simon, & Mitterer, 2012; Escudero & Williams, 2011; Kartushina & Frauenfelder, 2014; Simon, Debaene, & Van Herreweghe, 2015). This section discusses studies that were done regarding L2 speech perception of Arabic consonants, using the kind of tests mentioned in Section 2.4.4.4, to measure L2 learners' perception of sounds. Although the research on Arabic speech perception is quite limited, the results and conclusions of these studies were remarkable.

Zahid (1996) conducted a speech perception study by using both discrimination and identification tasks to detect the way native speakers of French perceive the emphatic sound /sˤ/. The participants were ten native speakers of Moroccan Arabic and ten native speakers of French who had no experience with the Arabic language. Both groups took a forced choice identification test, which consisted of 12 stimuli repeated five times, and they were asked to write whether the sound they heard was /sˤ/ or /s/. After the first test, they took an AXB discrimination test and were presented with ten pairings, which were also repeated five times, and participants were asked to choose whether the sound they heard resembled or was closely similar to which choice: A or B.

The results of the identification test showed that the Arabic group tended to be consistent and more accurate in their choice among the repetitions. The French group marked more stimuli as /s/ than /sˤ/. Thus, the discrimination test showed that the French group was less accurate than the Arabic group in identifying the pharyngealised sound /sˤ/. Both tests revealed a compatible result, which was that the non-native group found difficulties in identifying and discriminating the emphatic sound /sˤ/. Zahid (1996) concluded that the French participants perceived the sound /sˤ/ based on the phonetic similarity of their native language category.

The results of Zahid's (1996) study support the second case of PAM assimilation patterns, which indicates that two non-native sounds – in this study /sˤ/ and /s/ – are assimilated into the same L1 category, but one of the sounds – which is /s/ – is perceived as a better exemplar than the other. The author noted that the subjects did not have any experience in Arabic, so they were treated as naïve listeners, which made PAM applicable to this case, and the pattern of assimilation, according to Best (1995), is single-category assimilation.

Another study investigating the perception of Arabic consonants was done by Al Mahmoud (2013), who examined the perception of Arabic consonants by English L2 learners of Arabic. The researcher conducted a contrastive phonetic analysis between English and Arabic to investigate sound differences. He concluded from the comparison that there are sounds in English that exist as separate phonemes, which are /t/, /d/, /θ/, /ð/, /k/, and /h/. These sounds, along with other Arabic sounds, have contrasts in Arabic /t/-/d/, /θ/-/ð/, /x/-/ɣ/, /ðˤ/-/ð/, /tˤ/-/t/, /q/-/x/, /ħ/-/h/, /k/-/q/, and /x/-/ħ/.

Based on these contrasts, the author predicted L2 perception difficulties according to the similarities in the gestural features of sounds. Some of the predictions that concern the current study were that English L2 learners of Arabic would find no difficulties in discriminating between the contrasts /t/- /d/ and /θ/- /ð/, due to their existence in English, and that each phoneme is assimilated to a single English phoneme. Furthermore, L2 learners of Arabic would perceive the contrast /ðˤ/-/ð/ and /tˤ/-/t/ as one single non-emphatic phoneme, and the discrimination between the emphatic and non-emphatic contrasts would be from moderate to poor, due to the existence of only one phonological category, which is non-emphaticness.

To test these predictions, he conducted a study on 22 American learners of Arabic as L2. The participants did an AXB discrimination task consisting of four test items

(AAB, ABB, BAA, BBA) that were generated for each contrast. They were asked to listen to three words in each set and record on an answer sheet whether the first or third word was the same as the second. There were 96 randomly ordered sets pronounced by native speakers of Arabic.

The results showed that the contrasts /t/-/d/, /θ/-/ð/ were excellently perceived, while the contrasts /ħ/-/h/, /k/-g/, /ħ/-/x/ and /x/-/q/ were very well perceived by L2 learners of Arabic. The sound contrasts /tˤ/-/t/, and /ðˤ/-/ð/ were moderately perceived, while the sound /x/-/ɣ/ was poorly perceived. Furthermore, the results showed that L2 learners perceived L2 sounds according to their L1 phonemic system. In addition, it was concluded that sounds that are different in the place of articulation are perceived better than sounds that are similar in the place of articulation but different in manner or voicing.

Another finding that concerns our current study is that emphatics are difficult to perceive by L2 learners of Arabic who have no emphatics in their L1 phonetic systems. Al Mahmoud (2013) supported his findings in light of PAM, although the subjects in his study were experienced L2 learners and not naïve listeners. Furthermore, his objective in integrating PAM was based on the gestural similarities between English and Arabic, while phonetic similarities also can be found which allow SLM to be used to interpret his study. Notwithstanding that, the emphatics /sˤ/ and /dˤ/ and their contrasts /s/ and /d/ are considered obstacles for L2 learners of Arabic, but they were not included in his research.

Moreover, the studies of Hayes-Harb and Durham (2016) and Zaba (2007), which were explained in Section 2.3.4, also showed that there were difficulties in the perception of the emphatic sounds in certain contexts by some non-native speakers of

Arabic. The L2 speech perception and production studies discussed above produced compatible results, which showed that the L1s of the learners have major influence on the perception and production of L2 sounds. They also revealed that Arabic emphatics are challenging and are governed by different aspects, such as learners' individual variations, the quality of emphatics and their adjacent vowels, and the phonetic relationship between the native language and the target language.

There are other factors that could affect L2 learners' perception and production of sounds and could lead to individual differences among learners. The next section shows some aspects that L2 researchers and teachers should take into account when examining the perception and production of L2 sounds.

2.6.6 Factors Affecting Pronunciation Acquisition (Other Than L1)

There are many factors – other than L1 transfer and Markedness – that affect the accurate perception and production of sounds. Research on the acquisition of L2 speech has investigated and identified factors other than language background that may improve or hinder the ability to produce clear and accurate speech. These factors include, but are not limited to, the amount of L2 exposure, the amount of L1 use, learners' motivation, learners' attitude, the length of residence in an L2 setting, the age of the learner, learners' gender and learners' ability to mimic. These aspects are discussed in the following sections.

2.6.6.1 The Amount of L2 Exposure

Many studies have confirmed that the amount of L2 exposure plays a vital role when learning an L2 and they suggested that the quantity of L2 exposure improves the acquisition of L2 (Farukh & Vulchanova, 2016; Flege, Frieda, & Nozawa, 1997; Kolb, 2014; Leow, 1998; Saladrigues & Llanes, 2014). The amount of L2 exposure can be highly beneficial to late bilinguals, and the results of previous studies demonstrated less accented pronunciation among learners of English who intensively exposed to English (Flege et al., 1999; Piske, MacKay, & Flege, 2001; Şenel, 2006).

Tremblay (2006) examined 13 learners of German who were speakers of English as L1. They were divided into three groups (low L2 proficiency and low L2 exposure (n=6), high L2 proficiency and low L2 exposure (n=3) and high L2 proficiency and high L2 exposure (n=4)). The test was comprised of collecting oral samples in German from each participant. The results showed that the influence of English on German learners who had low exposure to German is highly evident. The results suggested that the influence of L1 tends to decrease as L2 proficiency and exposure increases.

2.6.6.2 The Amount of L1 Use

Bilinguals are unable to isolate L1 and L2 sound systems entirely (Piske et al., 2001). The L1 subsystem may influence L2 subsystem to varying degrees. The influence may vary according to many factors, such as the amount of L1 use. Some studies have assessed and confirmed the negative impact of the amount of L1 use on performance in an L2, such as Flege et al. (1997), which found that Italian learners of English who continued to speak Italian during their English learning period had significantly stronger foreign accents in English than did learners who rarely spoke Italian.

2.6.6.3 Learners' Motivation

Learner's motivation has a significant impact on the success of learning. The term 'motivation' concerns the extent to which individuals desire to learn a language

(Dörnyei, 1998). A large amount of research has dealt with L2 learners' motivation and its impact on the language learning process, with significant results (Piske et al., 2001; Smit & Dalton, 2000). Questionnaire results from Shehata (2015) showed that L2 learners of Arabic who considered Arabic sounds to be difficult found the motivation factor to be the most influential factor in learning Arabic. Furthermore, results from Bajuniemi (2013) showed that motivation has a positive effect on speakers of English who were first-year Spanish L2 learners' ability to produce the target-like Spanish intervocalic sound /d/.

2.6.6.4 Learners' Attitude

Many studies showed that L2 learners' attitudes positively or negatively affect their learning abilities (Moyer, 2007; Sardegna, Lee, & Kusey, 2014; Tokumoto & Shibata, 2011). Moyer (2007) endeavoured to examine the influence of attitude on the development of 42 English L2 learners' accent. The learners of English represented 15 native languages. After filling in a questionnaire, learners were tested through read-aloud and free speech tasks. The results showed that learners' attitudes had a role in learners' accent and proficiency and it affected learners' desires to improve and exhibit native-like pronunciation. Pan, Zang, and Wu (2010) commented that attitude and motivation are directly related to each other, in which motivation depends on attitude, to some extent, and attitude is considered a motivational support for language learning.

2.6.6.5 The Length of Residence in an L2 Setting

This factor is about the amount of time spent in a community where the L2 is the predominant language. Studies concluded that foreign accents tend to diminish when L2 learners stay in an L2 country. Several studies found that length of residence in an L2 community had a significant effect on learning and accuracy of production and perception (Baker & Trofimovich, 2006; Flege & Liu, 2001; Flege, Takagi, & Mann, 1995; Jia, Strange, Wu, Collado, & Guan, 2006; Trofimovich & Baker, 2006; Trofimovich, Baker, & Mack, 2001).

Notwithstanding the fact that these studies agreed on the positive relationship between the length of residence and accurate pronunciation, this correlation is not always consistent. Measuring the number of years spent in an L2 setting does not mean assuring correct and meaningful input (Moyer, 1999; Piske et al., 2001).In addition, this factor does not give us information about learners' style and engagement in the process of L2 acquisition. However, it still plays a role in developing learners' accuracy and intelligibility in L2 pronunciation (Piske et al., 2001).

2.6.6.6 The Age of the Learner

According to L1 acquisition studies, children require years to learn to produce L1 sounds. Some phonemes are more complex in an articulatory sense than others, and are acquired in a late period of acquisition by most children. Adult L2 learners, on the other hand, may have the same difficulty with complex sounds, and find it difficult to establish new patterns of articulation that do not exist in their L1 patterns of sounds.

A large amount of L2 acquisition studies have investigated the effect of age on perceiving and producing certain pronunciation features (Baker, 2010; Flege et al., 2003; Mackay, Flege, & Imai, 2006; Patkowski, 1990; Singleton & Ryan, 2004). The results of these studies concluded that learners gradually lose their ability to acquire and produce certain features as they become older. Age is a substantial factor in learning a language, and many studies compared young and old L2 learners in their different stages of acquisition and showed a negative relationship between age and the ability to learn a new language (Baker & Trofimovich, 2006).

2.6.6.7 Gender

Many researchers conducted gender-based differences studies to detect the characteristics of both genders in the acquisition of L2. There are differences in the ability to use accurate pronunciation between males and females. The majority of the studies that related to gender in L2 pronunciation acquisition found that females usually received higher scores than males (Major, 2004; Piske et al., 2001). Some studies reported a significant effect of gender (Thompson, 1991), whereas others did not (Purcell & Suter, 1980). Therefore, Piske et al. (2001) commented that, “the results obtained for gender do not lead to any strong conclusions” (p. 200). Edwards (2008) concluded that studies on gender L2 acquisition “did not show gender to be a strong predictor of pronunciation accuracy” (p. 252). He added that gender in L2 pronunciation accuracy does not seem to be a significant factor.

2.6.6.8 Ability to Mimic

An oral mimicry skill is the capacity to imitate new and unfamiliar sounds successfully. Ability to mimic sounds and phonetic features is a factor in predicting the foreign accent of L2 learners (Piske et al., 2001; Purcell & Suter, 1980; Suter, 1976). Julie is a British English native speaker who moved to Egypt at the age of 21 and acquired Arabic spontaneously after 45 days without any formal instruction (Ioup, Boustagui, El Tigi, & Moselle, 1994). She reported that Arabic phonology and pronunciation was not an obstacle for her because she had the ability to mimic accents perfectly. Hinton (2013) investigated the ability of Polish learners of English to accurately mimic English sounds to determine the overall quality of pronunciation of foreign language learners. Learners' mimicry ability was first assessed by asking them to listen to 10 French words and phrases, repeating them immediately after they heard them. Their responses were rated on a scale of four points: no attempt, very weak, something recognisable and good pronunciation.

After measuring their ability to mimic sounds, learners then underwent an English-pronunciation test to measure their English pronunciation, and the results of the English test were compared with their mimicry ability. The results of the study showed that learners who were able to accurately mimic French words had a high pronunciation proficiency skill in English. The researcher concluded that mimicry ability is a key predictor of pronunciation skill (Hinton, 2013). This is in contrast with questionnaire results from Shehata (2015), which showed that L2 learners of Arabic believed that the capacity to mimic is the least important factor in the pronunciation acquisition of Arabic consonant sounds.

Learners' individual differences, cultures, and L1s may affect their ability to produce accurate sounds (LeVelle & Levis, 2014). Working memory constraints can also be a potential factor that distinguishes individuals (Daneman & Carpenter, 1980). Daneman and Green (1986) indicated that the fluency of words produced by L2 learners is related to their ability to coordinate the processing and storage functions of working memory. They tested this by conducting an experiment on 34 university students. Participants were tested by reading silently a set of words displayed on a computer. At the end of the set, they were asked to generate aloud sentences containing these words. The results showed variations between students' abilities to recall the set of words. The capacity of working memory varies between subjects and depends on the function of how efficient the individual is at a specific task.

Among all these factors mentioned, L1 has a major influence on L2 pronunciation regarding its structure and phonological space, which may become a significant obstacle on students' ability to produce accurate L2 sounds (Chang & Heift, 2015). Loewen (2015) explained an aspect that related to L1 influence concerning L2 learners' articulatory muscles, which are trained on L1 patterns (i.e., muscle memory). This could also pose a problem in pronouncing L2 sounds. The inevitable role of L1 has led researchers to search for the differences between particular languages to detect their interference in L2 acquisition. Therefore, CA between the L1s of the learners in the current study and the target language may play a role in detecting interference between languages.

2.7 Chapter Summary and Research Questions

This chapter was divided into four major sections. Definitions and important terminologies were presented and defined at the beginning of this chapter. The first section presented the features of pharyngealisation in MSA. The second section discussed teaching pronunciation and provided different pronunciation teaching approaches. The third section defined CALL and offered speech analysis technology as a tool in teaching pronunciation. The fourth section reviewed L2 acquisition theories and L2 speech perception and production models.

This thesis presents two studies. The first one concerns the production of the Arabic fricative sounds from three groups of L2 learners of Arabic speaking either Mandarin, Urdu or Tagalog as their L1 (N= 46). The second one concerns the perception and production of the Arabic emphatic sounds from three groups of L2 learners of Arabic speaking either Mandarin, Urdu or English as their L1 (N= 38).

Both studies carry out an experiment that involves teaching different pronunciation instruction to two groups in a short period of time and testing learners' productive accuracy in Study 1 and perceptive and productive accuracy in Study 2 before and after the treatments.

Given the relevant research areas reviewed, the following research questions emerged for Study 1:

1- To what extent do L2 learners of Arabic face difficulties in pronouncing Arabic fricative sounds?
2- Do traditional form-focused instruction and technology form-focused instruction have different effects on L2 learners' learning of Arabic Fricatives?

The following research questions emerged for Study 2:

1- What are the frequency and type of errors perceived and produced by L2 learners of Arabic in pronouncing the Arabic pharyngealised sounds:
    a) in different phonological environments,
    b) in different proficiency levels, and
    c) from different L1 backgrounds?
2- Do traditional form-focused instruction and technology form-focused instruction have different effects on L2 learners' learning of Arabic emphatics across different vowel contexts?
3- To what extent do traditional form-focused instruction and technology form-focused instruction affect the perception and production of emphatics on L2 learners of Arabic in different language groups and proficiency levels?

The rationale for choosing these specific sounds – fricatives and pharyngealised consonants – is demonstrated in the next chapter. The next chapter is a contrastive analysis of Arabic with the first languages of the participants chosen in these two studies. The purposes of conducting a contrastive analysis is to identify the difficult sounds based on the existence of these sounds in learners' L1s, which supports the concept of language transfer and whether there are L1 sounds that share similar acoustic features with Arabic and could hinder or enhance successful acquisition of Arabic fricatives and emphatics.

CHAPTER THREE

CONTRASTIVE ANALYSIS

3.1 Introduction

Major (2008) commented that “without an L1 description, it is evident that identification of transfer is impossible” (p. 81). This section explores briefly the similarities and differences between Mandarin, Urdu, Tagalog and English as L1s and Arabic as L2 on their phonemic systems. The comparison aims at detecting phonetic features that are missing from learners’ L1s and exist in the target language and vice versa. Consequently, L2 learners’ pronunciation errors can be identified based on these differences.

Choosing these four particular languages in this study was based on two reasons. First, speakers of Mandarin, Urdu, Tagalog and English are the majority L2 learners of Arabic in the Arabic language institutes in Saudi Arabia. Second, and most importantly, these four languages lack emphatic and some fricative sounds in their phonemic systems. These four languages are the L1s of the participants in the current study. The phonemic systems of Mandarin, Urdu, Tagalog and English are presented in this chapter, along with providing information about the syllable structure and the writing system of each language. The phonemic system of MSA was given in the Literature Review Chapter in Section 2.3.1.1. Information about the language learning context of the participants in this study are presented at the end of this chapter.

3.2 The Phonemic System of Mandarin

Mandarin is one of the largest among seven groups of dialects in China, with more than 387 million speakers (Kratochvil, 1968) from northern China and Taiwan (Howie, 1976). It is a tonal language, in which each syllable has a particular tone. Changing the tone of a syllable results in changing the semantics of a word. Mandarin is written from left to right in a morpho-syllabic way, in which characters can be segmented using orthographic, morphological, and syllabic information (e.g., 诶, 比, 西, 迪) (Leong & Tamaoka, 1998).

Mandarin has 22 consonants, and they are divided into two groups: 21 initial consonants and two final consonants, /n/ (also found in initial position) and /ŋ/ (Cai & Lee, 2015). The consonant phoneme inventory of Mandarin is shown in Table 3.1.

	Bilabial	**Labiodental**	**Dental**	**Alveolar**	**Palatal**	**Retroflex**	**Velar**
Stop	p p^{h}			t t^{h}			k k^{h}
Fricative		f	s		ɕ	ʐ ʂ^{h}	χ
Affricate			ts ts^{h}		tɕ tɕ^{h}	tʂ tʂ^{h}	
Nasal	m			n			ŋ
Liquid				l			

Notes: Voiced consonants are presented on the left and voiceless consonants on the right.

Table 3.1: Inventory of Mandarin consonant phonemes (Cai & Lee, 2015, p. 724)

Mandarin has 35 vowels, comprised of eight monophthongs, nine diphthongs and four triphthongs. Mandarin monophthongs are [a], [o], [ɤ], [ɛ], [i], [u], [y], [ɚ], diphthongs are [ai], [ei], [au,] [ou], [iɛ], [yɛ], [ia], [ua], [uo] and triphthongs are [uei], [iou], [iau], [uai] (Cai & Lee, 2015). There are variations between researchers regarding Mandarin's vowel inventory. Some researchers consider some vowels to have allophonic variations which are /i y a u/ (Lin, 2007; Mok & Hawkins, 2004). Overall, Mandarin has eight monophthongs, as shown in Figure 3.1.

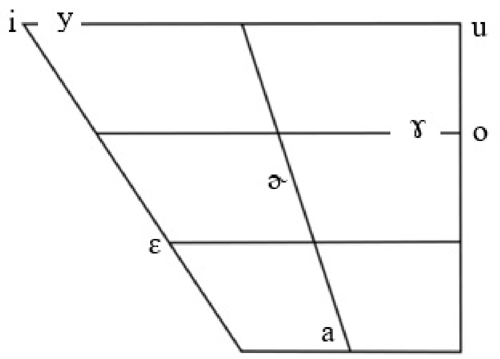


Figure 3.1: Inventory of Mandarin monophthongs (Cai & Lee, 2015, p. 724)

As well as nasal consonants /n/ and /ŋ/, the glide element of a diphthong can also be in the consonantal coda position. Mandarin does not have initial or final consonant clusters, possible syllable structures being V, CV, CVN, CVG, CGV, CGVG, and CGVN, where C = consonant, G = glide /j, w, ɥ /, N = /n, ŋ/, V = /i, y, u, ɚ, ɛ, o, ɤ, a/ (Mok & Hawkins, 2004; Wu & Kenstowicz, 2015).

For a more comprehensive description of Mandarin, see Xu (1980) and Cai and Lee (2015).

3.3 The Phonemic System of Urdu

Urdu is classified as Indo-Aryan, a major sub-branch of Indo-European. Urdu is the national language of Pakistan and is spoken in other countries such as India and Bangladesh with different dialects (Saleem et al., 2002), with more than 60 million L1 speakers and more than 100 million speakers in more than 20 countries (Gordon &

Grimes, 2005). Urdu is written in Arabic script using Arabic characters (e.g., أ, ب, ت, ث) and it is written from right to left, like Arabic.

Urdu is rich with sounds, having, 38 consonants and 11 vowels. The consonants inventory of Urdu is presented in Table 3.2.

	Bilabial	**Labiodental**	**Dental**	**Alveolar**	**Palatal**	**Velar**	**Uvular**	**Retroflex**	**Glottal**
Stop	b p b^h p^h		d̪ t̪ d̪^{h} t̪^{h}	ɖ ʈ ɖ^h ʈ^h		g k g^h k^h	q		ʔ
Fricative		v f		z s	ʒ ʃ	ɣ χ			h
Affricate					dʒ tʃ dʒ^h tʃ^h				
Nasal	m			n		ŋ			
Liquid				l					
Tap/Flap				r				ɽ	
Approximant					j				

Notes: Voiced consonants are presented on the left and voiceless consonants on the right.

Table 3.2: Inventory of Urdu consonant phonemes (Saleem et al., 2002, p. 2)

Similar to Mandarin, researchers have different views on Urdu's short and long vowels (Kachru, 1990). Figure 3.2 illustrates the vowels of Urdu.

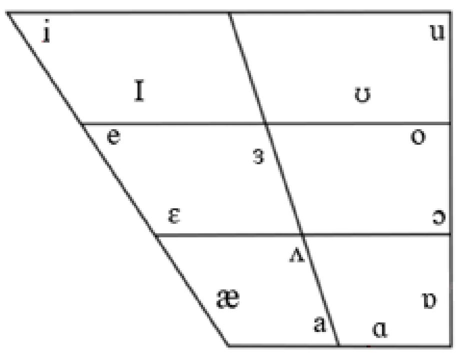


Figure 3.2: Inventory of Urdu vowels (Saleem et al., 2002, p. 3)

Similar to Arabic, Urdu has diacritics that reflect vowels. Native speakers of Urdu use consonants and diacritics that indicate vowels only, without using vowels explicitly in writing. Therefore, they write diacritics instead of writing vowels, but this is not the case with all speakers of Urdu (Raza, Hussain, Sarfraz, Ullah, & Sarfraz, 2009). The syllable structure for Urdu is CVV, CVC, CVVC, CV, CVVCC, VV, VVC, V, VCC, CVCC, and VC (Nazar, 2002).

For a more comprehensive description of Urdu, see Saleem et al. (2002) and Raza et al. (2009).

3.4 The Phonemic System of Tagalog

There are more than 80 indigenous languages spoken in the Philippines, eight by the majority of speakers. These languages are Cebuano, Tagalog, Hiligaynon, Ilokano, Bicolano, Waray, Kapampangan, and Pangasinan (Reid, 1971). Tagalog has more than 28 million speakers, and 96% of Filipinos can speak it as L1 or L2. According to Reid and Schachter (2009), Tagalog is the language of Manila, the largest city of the Philippines, and it is considered as the lingua franca in other cities. Tagalog speakers use Latinised script from left to right (e.g., a, b, c, d).

Tagalog has 16 consonants and five vowels occurring in native words. Table 3.3 and Figure 3.3 show the consonant and vowel inventories for the Tagalog language.

	Bilabial	**Dental**	**Alveolar**	**Palatal**	**Velar**	**Glottal**
Stop	b p	d t			g k	ʔ
Fricative			s	ʒ ʃ		h
Nasal	m	n			ŋ	
Lateral			l			
Tap/Trill			r			
Glide	w			y		

Notes: Voiced consonants are presented on the left and voiceless consonants on the right.

Table 3.3: Inventory of Tagalog consonant phonemes (Reid & Schachter, 2009, p. 835)

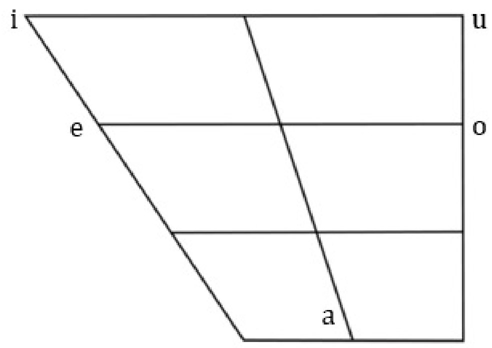


Figure 3.3: Inventory of Tagalog vowels (Reid & Schachter, 2009, p. 834)

These five vowels developed out of a three-vowel system. That is, [i] and [e] were allophones of a single phoneme and also [o] and [u] were allophones of a single phoneme (Reid & Schachter, 2009). The most common syllable structures of Tagalog include CV and CVC. The minimum syllable is V, and the maximum is CCVCC or CS-VVS-VC, where S-V = semi-vowel (Llamzon, 1966).

For a more comprehensive description of Tagalog, see Reid and Schachter (2009).

3.5 The Phonemic System of English

English is an Indo-European language group and belongs to the West Germanic group of the Germanic languages (Bech & Walkden, 2016). It is the official language of Britain, the United States, Australia, Canada, Ireland, and New Zealand, and the majority speak English in these countries. There are between 470 and more than 1,000 million speakers of English as L2 in the world (Graddol, 2003). English is written from left to right in the Latin alphabet (e.g., a, b, c, d).

English has 24 consonant sounds, 12 monophthongs and 8 diphthongs. The consonant and vowel inventories of English are presented in Table 3.4 and Figure 3.4.

	Bilabial	**Labiodental**	**Dental**	**Alveolar**	**Post-alveolar**	**Palatal**	**Velar**	**Glottal**
Stop	b p			d t			g k	
Fricative		v f	ð θ	z s	ʒ ʃ			h
Affricate					dʒ tʃ			
Nasal	m			n			ŋ	
Lateral				l				
Tap/Flap					r			
Approximant	w					J		

Notes: Voiced consonants are presented on the left and voiceless consonants on the right.

Table 3.4: Inventory of English consonant phonemes (Ohata, 2004, p. 6)

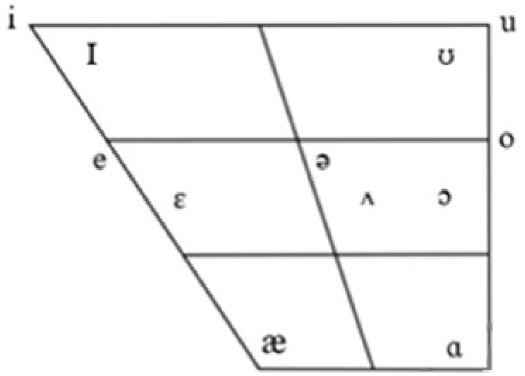


Figure 3.4: Inventory of American English vowels (Roach, 2010, pp. 13, 16)

English has a number of allophones. For example, the phoneme /l/, which has been classified into two allophones, the velarised or dark [ɫ] and the light or plain [l] (Sproat & Fujimura, 1993). In addition, the phonemes /p, t, k/ have been classified into aspirated [p^h, t^h, k^h] and non-aspirated [p, t, k] (Lisker, 1984). The post-alveolar /r/ has also many allophones in specific phonological environments such as the alveolar approximant [ɹ]. The syllable structure of English includes V, CV, VC, CVC, CVCC, CCV, CCVC, CCCV, CCCVCCC, and CCVCCCC (Collins & Mees, 2013).

For a more comprehensive description of English, see Roach (2010) and Carr (2013).

3.6 CA of Arabic with Mandarin, Urdu, Tagalog and English

This section summarises the phonemic inventories of the four languages above and compares them with the phonemic system of Arabic. The comparison here is based only on three phonetic features that are related to the target phonemes in this study because the focus is to know whether these four languages share the same fricatives and pharyngealised consonants and vowels with Arabic, and, if not, whether they have any fricative or pharyngealisation features in their phonological space at phonemic or allophonic levels. Table 3.5 shows the phonemes of Arabic and their corresponding phonemes in Mandarin, Urdu, Tagalog and English.

Features	Place of Articulation	Arabic	Mandarin	Urdu	Tagalog	English
Stops	Dental			d̪, t̪ dʰ, tʰ	d, t	
	Alveolar	d, t dˤ, tˤ	t, tʰ	ɖ, ʈ ɖʰ, ʈʰ		d, t
Fricatives	Labiodental	f	f	v, f		v, f
	Dental	ð, ðˤ, θ	s			ð, θ
	Alveolar	z, s, sˤ		z, s	s	z, s
	Postalveolar					ʒ, ʃ
	Palatal	ʃ	ɕ	ʒ, ʃ	ʒ, ʃ	
	Retroflex		ʐ, ʂʰ			
	Velar		χ	ɣ, χ		
	Uvular	ɣ, χ				
	Pharyngeal	ʕ, ħ				
	Glottal	h		h	h	h
Pharyngealised consonants and vowels (phonemes or allophones) or equivalents	Consonants	dˤ, tˤ ðˤ, sˤ (phonemes)				ɫ (allophone)
	Vowels	ɨ, ʊ, ɑ (allophones)		ɑ (phoneme)		ɑ (phoneme)

Table 3.5: CA of Arabic with Mandarin, Urdu, Tagalog and English

Table 3.5 above presents fricative, emphatic and non-emphatic Arabic phonemes and pharyngealised vowels and their equivalents in Mandarin, Urdu, Tagalog and English, which share the same place and manner of articulation. It can be seen that these four languages lack emphatic sounds and some fricatives. The pharyngealisation feature exists in English only in the dark allophone /ɫ/ (Recasens, 2004; Recasens & Espinosa, 2005), which differs from Arabic emphatics in the manner of articulation (i.e., it is lateral). Tagalog and Urdu lack pharyngealisation phonemes or allophones, even in the Arabic loanwords, which have lost their phonetic value and were substituted by native sounds (Mangrio, 2016; Potet, 2013). Research that discussed the history of Chinese languages has noted that pharyngealisation was a prominent feature in old Chinese and that this feature no longer exists (Baxter & Sagart, 2014; Norman, 1994; Pulleyblank, 1996).

The equivalent to the Arabic pharyngealised allophone [ɑ] in Urdu and English is the vowel phoneme [ɑ]. The vowel [ɑ] is not pharyngealised but carries similar acoustic features with the Arabic pharyngealised vowel [ɑ]. Both low back vowels occupy similar F2 positions, which indicates lower F2 values than the rest of the vowels (Hayes-Harb & Durham, 2016; Hillenbrand, Getty, Clark, & Wheeler, 1995).

Another comparative aspect of Mandarin, Urdu, Tagalog, English and Arabic is in the syllable structures, which have similarities and differences. They all have the simple structure CV and CVC; stimuli with this structure are used in both Study 1 and 2 in this thesis. In addition, the writing system of Arabic is very similar to Urdu but completely different from Mandarin, Tagalog and English. It is also observed that Urdu has some similar sounds to Arabic, such as /x, ɣ, ʔ, q/ that do not exist in Mandarin, Tagalog and English. Hence, Urdu is considered the closest in its sounds and writing system to Arabic.

For Study 1, based on the theory of language transfer and the contrastive analyses of Arabic with Mandarin, Urdu and Tagalog, it is expected that Mandarin native speakers would face difficulties in producing the fricatives /ð, ðˤ, θ, z, sˤ, ʃ, ɣ, ʕ, ħ, h/ because these sounds do not exist in Mandarin. There have been different views in some studies of Arabic phonetics on whether the place of articulation of the Arabic /χ/ is uvular or velar (Abushihab, 2010; Aziz, 1989). The Mandarin velar /χ/ is relatively similar to the Arabic uvular /χ/, therefore it is expected that Mandarin speakers would find no difficulty in the pronunciation of the Arabic /χ/. Urdu speakers would also face difficulties in pronouncing the fricatives /ð, ðˤ, θ, sˤ, ʕ, ħ/ because these sounds do not exist in Urdu. Furthermore, Tagalog speakers would face difficulties in pronouncing the fricatives /f, ð, ðˤ, θ, z, sˤ, ɣ, χ, ʕ, ħ/ because these sounds do not exist in Tagalog. Based on these expectations, there is a possibility that Urdu speakers would perform better than Mandarin and Tagalog speakers because the Urdu phonetic system is closer to the Arabic phonetic system than Tagalog and Mandarin.

For Study 2, Mandarin, Urdu and English lack the emphatics in their phonemic systems. Therefore, the difficulty in perceiving and producing emphatics is expected and speakers of these languages may substitute these sounds with non-emphatics due to the lack of the pharyngealisation feature in their languages.

3.7 Language Learning Context

The current study consists of 46 participants speaking Mandarin, Urdu and Tagalog as L1s in Study 1 and 38 participants speaking Mandarin, Urdu and English as L1s in Study 2. Participants came from their countries to study Arabic for two years in Princess Nourah University in Riyadh, Saudi Arabia. More information about participants, such as proficiency levels and ages are presented in the Methodology for Study 1 Chapter, Section 4.5 and the Methodology for Study 2 Chapter, Section 7.4.

This institution provides a late immersion programme and is intended for adult female Muslim students only. The Arabic linguistic institute at Princess Nourah University teaches only the Standard Arabic including the vocabulary of the Quran and Hadith. Using other Arabic dialects is prohibited in the institution and the focus is only on developing knowledge of Standard Arabic without mixing it with other vernacular Arabic dialects. Therefore, the institution set a rule for Arabic native speakers in other university departments to speak only the Standard Arabic with the immersion students in the Arabic institution.

Moreover, female students in the institution live in buildings that belong to Princess Nourah University. They speak with each other in their native languages or Standard Arabic; even the employees in the buildings speak the Standard Arabic. Therefore, participants in this study are expected to pronounce the emphatic and fricative sounds according to their pronunciation in the Standard Arabic because the access to language learning resources is restricted only to learning Arabic in its standard version. However, it was not possible to control for participants coming into contact with speakers of other Arabic dialects prior to and during their participation in the study.

The primary purposes for teaching Arabic in the institution are to understand vocabulary and norms related to Islam and the Quran, and to recite daily prayers in Arabic. Since practicing Islam requires regular reciting of the Quran and prayers in Arabic, developing accurate pronunciation is one of the major goals in the institution.

The Quran contains a number of minimal pairs that have different meanings. Mixing those words could change the meaning of a whole verse of the Quran, for example:

1) In Surat Al-‹Kahf Aya 62 (سورة الكهف آية 62):

(فَلَمَّا جَاوَزَا قَالَ لِفَتَاهُ آتِنَا غَدَاءَنَا لَقَدْ لَقِينَا مِنْ سَفَرِنَا هَذَا **نَصَبا**)

(When they had passed on (some distance), Musa said to his attendant: "Bring us our early meal; truly we have suffered much fatigue at this (stage of) our journey)[1]. The word (**نَصَبا**) /nas^{ʕ}aba/ means ‘fatigue’.

[1] The Quran translation is taken from King Fahd Glorious Quran Printing Complex website.

2) In Surat Al-Furqan Aya 54 (سورة الفرقان آية 54):

(وَهُوَ الَّذِي خَلَقَ مِنَ الْمَاءِ بَشَرًا فَجَعَلَهُ نَسَبا)

(And it is He Who has created man from water, and has appointed for him kindred by blood)[1]. The word (**نَسَبا**) /nasaba/ means 'kindred by blood'.

Muslims treat the Quran with immense respect and reverence because it is the sacred word of God. When reciting the Quran, Muslims should behave with reverence and adhere to specific manners such as thinking about and pondering over its meaning and pronouncing its words faithfully and accurately. This example shows how mispronouncing minimal pairs when reciting the Quran could change the meaning and be considered unacceptable. However, in ordinary speech, the context would most likely disambiguate the meanings of the minimal pair but in Quranic recitation, pronunciation accuracy is highly important.

Teaching Arabic learners for religious purpose is different from teaching for communicative purposes. In communicative language classrooms, conveying a meaningful message is a priority (Spada, 2011), in which the focus, to a great extent, is on developing system of L2 morphosyntax at both controlled and spontaneous levels (Spada & Tomita, 2010).

One of the main objectives of teaching Arabic to non-native speakers in Islamic schools is to develop the phonetic aspects of Arabic and production accuracy (Sabri, 2018). The importance of developing production accuracy lies in having specific sets of permitted reading and pronunciation variants (Tajweed and Qira'at) that require rigorous training. These pronunciation variants receive a great attention by Islamic scholars. Furthermore, the focus is also on understanding concepts and terminologies used in Islamic sciences including Quranic studies, studies in Hadith and the use of specialised terms in the discussion of various Islamic topics in writing and conversation. Therefore, this kind of programme concentrates on exercises that raise learners' understanding of Islamic norms and vocabulary and minimize communicative tasks such as role-play, problem solving and discussions.

The majority of L2 studies that investigated speech perception and production in immersion and non-immersion L2 learning programs looked at developing pronunciation skills in communicative classrooms and for communicative purposes (Foote et al., 2016; Muranoi, 2000; Saito, 2015). That is unlike this study, which looks at developing perception and production in a completely different environment for religious purposes. The difference can be found in the types of activities which, in the case of Princess Nourah University, are always related to Islamic norms and concepts, while activities in communicative classrooms are usually about communicative tasks and socialization in the target language environment. Therefore, what was discussed and investigated in previous studies may not agree with what is found and discussed in the current study due to differences in the aims and types of learners and the types of learning environment.

CHAPTER FOUR

METHODOLOGY FOR STUDY 1

4.1 Introduction

This chapter describes an exploratory study in testing L2 Arabic learners' productive abilities in pronouncing a group of Arabic phonemes. It was carried out as a preliminary study to detect whether L2 learners of Arabic in different proficiency levels who study in Arabic language institutions in Saudi Arabia experience difficulties in pronouncing Arabic fricatives. It also endeavoured to measure the performances of L2 learners of Arabic after receiving two different teaching methods: traditional and technology. The reason for choosing fricatives to be investigated in Study 1 was because of their difficulty to L2 learners of Arabic, as noted in (Abdul-Kadir & Sudirman, 2011), and the absence of most of these sounds in Mandarin, Urdu and Tagalog phonemic systems. The Arabic fricative phonemes which were tested are /z/, /θ/, /f/, /ʃ/, /ħ/, /h/, /χ/, /ɣ/, /ʕ/, /sˤ/, /ðˤ/, /s/ and /ð/.

The exploratory experiment is designed based on testing the production only of sounds before and after receiving two pronunciation instruction methods that were assigned to two groups. Although there were many limitations, which will be clarified later in this chapter, this experiment helped in testing the proposed approach, showed how the instructions and materials can be well-designed to meet the teaching objectives, and helped in overcoming several shortcomings for Study 2.

This chapter provides a description in detail about the fundamental research paradigms used. It explains the way of conducting Study 1 including the research framework, the ethical consideration, the participants involved, the materials and the procedure. In addition, it describes the process of piloting the study, and data collection and analysis.

4.2 Research Questions

The research questions set for this exploratory experiment are:

1- To what extent do L2 learners of Arabic face difficulties in pronouncing Arabic fricative sounds?
2- Do traditional form-focused instruction and technology form-focused instruction have different effects on L2 learners' learning of Arabic Fricatives?

4.3 Research Design

This study was a 'quasi-experiment' instead of a 'true experiment', given that the assigning and distribution of participants was not fully randomised. The term 'quasi-experiments' was defined as "experiments that have treatments, outcome measures, and experimental units, but do not use random assignment to create comparisons from which treatment-caused change is inferred" (Cook & Campbell, 1979, p. 6). The aims of the randomisation of samples in a research is to provide an effective way to control and minimise bias (Dörnyei, 2007). Similar to true experiments, a quasi-experimental design forms an explicit cause-effect relationship (Dörnyei, 2007). Choosing students in an educational setting at random and placing them in specific groups and classes, mostly in classroom experiments, is not easily achievable (Campbell & Stanley, 2015).

The wider purpose of this study was to examine the degree of difficulty of some Arabic phonemes and to see how learners' L1s played a role in their acquisition of novel Arabic sound features. In order to find a suitable teaching approach to facilitate the acquisition of these novel sound features, an experiment was carried out that used two selected groups to investigate the efficacy of technology instruction compared to traditional instruction. The process of conducting this quasi-experimental design consists of two groups of learners receiving different pronunciation instruction. The first group (traditional group) received explicit form-focused instruction including traditional teaching techniques. The second group (technology group) received explicit form-focused instruction including technology teaching techniques by using Praat. Any learning gains were measured by testing learners' productive skills before and after the treatment has been finished, i.e., by using a pre- and post-test. A comparison between the two groups is made by a statistical procedure (Dörnyei, 2007). A quantitative approach was used in the current study, which aimed at calculating the frequency of errors in participants' utterances and examining possible difference within and between the two groups in their pre- and post-test scores.

Johnson and Christensen (2008) pointed out that experimental design consists of certain manipulated processes occurring in a controlled environment, in which all variables are constant except the target variable. This experiment included several independent variables, which are the teaching methods, learners' proficiency levels and language backgrounds. The teaching methods will be the main variable investigated in Study 1, while the language backgrounds and proficiency levels of the participants will be presented and discussed in the results and discussion chapters to add more clarification to the rationale for some pronunciation errors that learners in certain language groups or proficiency levels make. The teaching methods comprise of two approaches: a) technology-based instruction using Praat software (n = 23); and b) traditional-based instruction using traditional pronunciation teaching methods (n=23).

The dependent variable is students' errors in the pronunciation of 13 words in both pre- and post-tests.

4.4 Ethical Consideration

Ethical issues of data collection from and about individuals must be inevitably taken into account (Punch, 2013). The policies and relevant administrative processes related to the research ethics were followed. An application to undertake this experiment was submitted to the University of Reading's research ethics committee (see Appendix A). After the approval was received from the university's ethics committee, the Deanship of Scientific Research in Princess Nourah University received an approval request for conducting the study in the Arabic linguistic institute on Arabic L2 learners. The approval was gained after explaining the methodology of the study (see Appendix B). After collecting the data, a confirmation letter was received from the institution confirming the completion of the study (see Appendix C).

Cohen, Manion, and Morrison (2000), mentioned the issue of 'deception' in experimental research. They argued that the real purpose and settings of the research must be explained to the participants and they should not be misinformed about the procedure of the study. Therefore, participants were informed through the questionnaire and also face to face in the introductory session about the main purpose of the study which was investigating the pronunciation of Arabic phonemes. They were also informed that their participation was entirely separate from any graded components of their official Arabic course and would not have a direct bearing on grades for that course. Participants were asked to sign a consent form contained explanation of the purpose and procedure of the study (see Appendix D).

4.5 Participants

The participants for Study 1 were 46 female learners of Arabic who were all enrolled in Arabic linguistic institution at Princess Nourah University in Saudi Arabia at the time of collecting the data in April 2015. This institution is intended only for female students and the access to male participants was restricted because of religious and cultural boundaries in Saudi Arabia. The participants' age ranged from 20 to 30 years old and they were from elementary, intermediate and advanced levels of Arabic proficiency. They were assigned into three proficiency levels based on a formal placement test, which was given to them by the institute prior to their enrolment in the Arabic programme. The placement test is explained next in this chapter. Participants had spent between four months to two years studying Arabic in Saudi Arabia.

The religion of all the participants is Islam, and their main motivation in learning Arabic was to understand Islam and read the Quran in a correct and intelligible way. Arabic was only used in class and between students who speak different native languages; most of the remaining time, participants used their native languages.

14 Indians, 12 Chinese, and 20 Philippines gave their consent to participate. The participants spoke either Urdu, Mandarin, or Tagalog respectively. Participants who spoke these three languages were chosen particularly for two reasons: first, because they were the majority in the institution in the time of collecting the data; and second because these three languages lack some of the fricatives that exist in Arabic (see Chapter Three, Section 3.7).

According to the questionnaire, some students spoke English besides their native languages and Arabic. Furthermore, their abilities to use computers ranged from poor to excellent. Based on the self-report background questionnaire (see section 4.7.1), Table 4.1 provides more information about the participants.

Background information	**Number of participants**
Gender	Females (n= 46)
Proficiency level	Beginners= 4 Intermediate= 23 Advanced= 19
Age	20-25 = 31 26-30= 15
Native language	Mandarin= 12 Urdu= 14 Tagalog= 20
Other spoken languages	English= 7
Time spent learning Arabic	0-<1 year=17 >1-2 years= 5 >2-3 years= 22 >3= 2
Time spent in Arabic countries	0-<1 year=18 >1-2 years= 7 >2-3 years= 17 >3= 4
Language used daily	Native language= 43 Arabic= 3
Motivation for learning Arabic	Islam= 46
Ability in using computers	Poor= 6 Good= 27 Excellent=13

Table 4.1: Study 1 participants' background information

As discussed in Section 4.3, the only variables that will be discussed are learners' language backgrounds and proficiency levels. Although there were variations found between participants in the factors mentioned in the background information questionnaire, they will not be investigated as variables in this study. However, presenting the wide variation between participants, such as their age, duration of Arabic learning and computer abilities is to show other factors that could influence learners' performance in the results, which are difficult to control for in the current study due to the lack of large enough groups of participants who share similar L1s.

4.5.1 Groups Selection

The participants were divided into two groups, 23 students in each group. They were assigned into groups based on their proficiency levels and language backgrounds in an attempt to control the effect of these variables on the results. Table 3.2 below shows the number and native languages in each group.

Speakers	**Beginner**		**Intermediate**		**Advanced**	
	Traditional	Technology	Traditional	Technology	Traditional	Technology
Mandarin	0	1	4	5	1	1
Urdu	1	2	3	5	1	2
Tagalog	0	0	4	2	9	5
Total	1	3	11	12	11	8

Table 4.2: Study 1 number of participants, proficiency levels and language backgrounds

4.6 Arabic Linguistic Institute at Princess Nourah University

This research took place at the Arabic Linguistic Institute at Princes Nourah University in Riyadh, Saudi Arabia. At the time the data were collected, it had 246 female students of different proficiency levels from 55 countries. The majority were from Philippines, India, China, Pakistan, Guinea, and Thailand.

A formal placement test is given to learners by the institute prior to their enrolment in the Arabic programme. The test consists of a short passage with questions, an aural comprehension and writing parts. There is also an interview consists of personal questions such as the reason for choosing this particular institution. Unfortunately, the access to those placement tests and interviews was restricted and cannot be explained further.

The Arabic programme in Princess Nourah University is divided into four courses based on learners' proficiency of Arabic; each course is one-semester long, which lasts four months. The subjects taught in the classrooms are listening, grammar, reading, writing, speaking and Islamic studies. There are also computer labs, where students get access to Arabic learning materials and practice individually.

The speaking class is taken four hours a week at the first level, three hours in the second level, two hours in the third level, and only one hour in the fourth level. As one of the Arabic teachers in the institution explained, the speaking class is based on implicit instruction that focuses more on meaning rather than form, and leads to incidental learning without explaining specific sound features or grammar rules. It includes activities such as conversations, listening to audio or video recordings and describe what they hear or see, and telling or completing stories.

4.7 Instruments

Three research instruments were designed for this study; a demographic information questionnaire, teaching materials, and the pre-and post-tests.

4.7.1 The Demographic Information Questionnaire

At the beginning of the study, a questionnaire was given to all participants (see Appendix E). It contained questions about participants' proficiency level, age, native language, other languages they speak, years spent learning Arabic, years spent in Saudi Arabia, their motivation in learning Arabic and their ability in dealing with computers (Table 3.1 above). The purpose of using the questionnaire was to know more about the participants' experience and knowledge, which could contribute positively or negatively to students' pronunciation accuracy.

4.7.2 Teaching Materials

For both groups, instruction papers were designed, which contained a table of 13 fricative sounds with sentences, small passages and examples of minimal pairs. The minimal pairs were words with fricative sounds and other equivalent Arabic sounds that share similar acoustic and phonetic features with the fricatives and were chosen based on Al Mahmoud (2013). Most of the examples and minimal pairs were taken from an existing Arabic language learning series of three parts called (العربية بين يديك), /ʔl ʕarabˈjah bajna jadajk/, *Arabic is in your hands* created by professionals in teaching Arabic as L2 (Alfozan, Husain, & Fadhel, 2007).

The reasons for choosing this series were because of its efficacy in learning Arabic according to previous Arabic studies (Ahmadi, 2012; Pathurrahman, 2016), and because the Arabic Language Institute at Princess Nourah University uses this series in the curriculum for teaching Arabic. The words used with the traditional group were the same words used with the technology group. Table 3.3 presents the target sounds with examples that were used in the training sessions.

Sounds الأصوات		Minimal pairs كلمة وما يشابهها في النطق	Sentences الجمل
/z/ (ز)	زار - سار	/sa:r/ (walked) - /za:r/ (visited)	رأى محمد زرافة /raʔa: muħaˈmad zara:fah/ Mohammed saw a giraffe
/s/ (س)	سورة – صورة	/su:rah/ (verses from the Quran) - /sˤu:rah/ (Picture)	حنان تسقي النباتات /ħana:n tasqi: ʔaˈnaba:ta:t/ Hanan is watering the plants
/sˤ/ (ص)	عصير - عسير	/ ʕasˤi:r/ (juice) - / ʕasi:r/ (difficult)	ذهبت سارة إلى المصرف /ðahabat sa:rah ilal masˤrif/ Sarah went to the bank
/θ/ (ث)	نثر – نذر	/naθar/ (sown) - /naðar/ (promised)	خالد يجري مثل الثعلب /χa:lid jadʒri: miθlaˈθaʕlab/ Khalid runs like a fox
/f/ (ف)	فأر – ثأر	/faʔr/ (mouse) - /θaʔr/(revenge)	وجدت مفتاحي /wadʒadtu miftaħi:/ I found my key
/ʃ/ (ش)	شبح – سبح	/ʃabaħ/ (ghost) - /sabaħ/ (swam)	شعري طويل /ʃaʕri: tˤawi:l/ My hair is long
/ħ/ (ح)	حالك – هالك	/ħalik/ (very dark)- /halik/ (mortal)	ذهبت إلى الحديقة /ðahabtu elal ħadi:qah/ I went to the garden
/h/ (هـ)	كاهل – كاحل	/ka:hil/ (shoulders) - /ka:ħil/ (ankle)	أحب الطهي /ʔuħibuˈtˤahi:/ I like cooking
/χ/ (خ)	خبير – كبير	/xabi:r/ (expert) - /kabi:r/ (big)	خسر الفريق المباراة /χasiral fariqul muba:ra:h/ The team lost the game
/ɣ/ (غ)	غاوي – خاوي	/ɣa:wi/ (seducer) - /χa:wi/ (empty)	بقيت في غرفتي /baqi:tu fi ɣurfati:/ I stayed in my room
/ʕ/ (ع)	علم – ألم	/ʕalam/ (flag) - /ʔalam/ (pain)	نحن نحترم معلمتنا /naħnu naħtarimu muʕaˈlimatana:/ We respect our teacher
/ð/ (ذ)	ذاب - ثاب	/θa:b/ (return) – /ða:b/ (melted)	يجب أن أذاكر /jadʒibu ʔan ʔuða:kir/ I have to study
/ðˤ/ (ظ)	نظر - نذر	/naðˤar/ (looked)- /naðar/ (promised)	قلّمت أظافري /qaˈlamtu aðˤa:firi:/ I cut my nails

Table 4.3: Fricatives with examples used in the training sessions.

For the technology group, an introductory presentation was designed by using PowerPoint software. It explained the way of dealing with Praat and showed how students can record and analyse their voices, and understand their utterance by reading the spectrogram. Pictures of spectrograms and waveforms were also given in the presentation.

Furthermore, PowerPoint slides for each of the five days of the technology pronunciation training course were prepared. Each slide contained waveform and spectrogram pictures of minimal pairs of one fricative sound pronounced by an Arabic native speaker (see example in Figure 4.1).

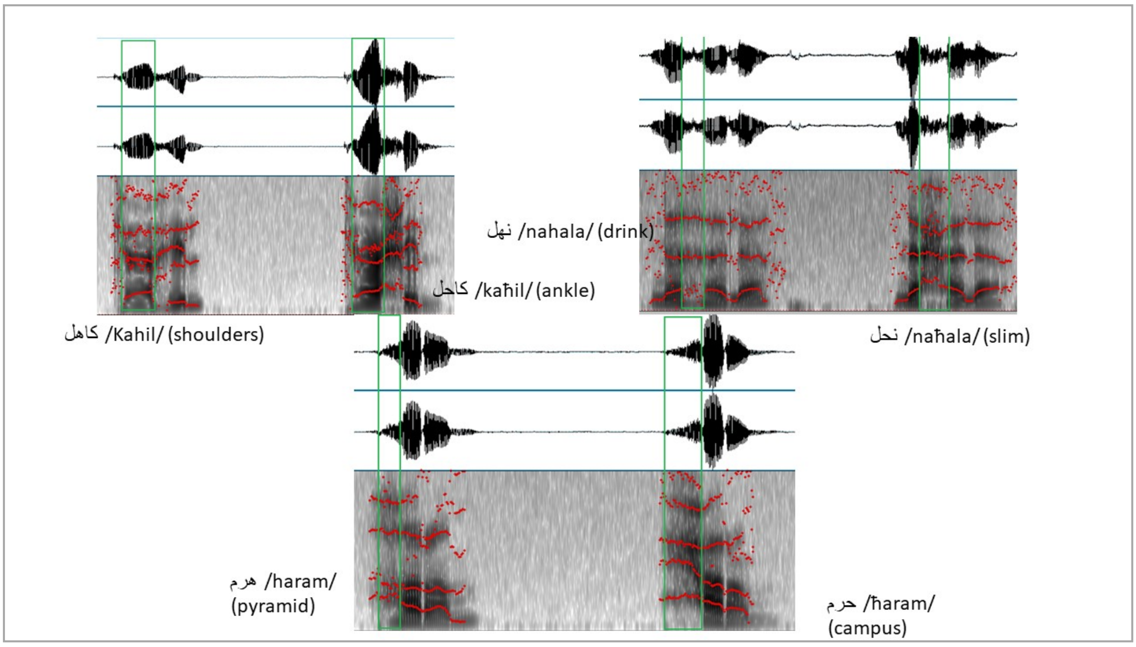


Figure 4.1: A PowerPoint slide of the technology pronunciation training course

4.7.3 The Pre-test and the Post-test

As mentioned above, this experiment had a pre- and post-test design. Each test contained 13 words in Arabic and each word contained one fricative sound in word-initial or word-medial position. The reason for having tokens with the fricative in initial or medial position in the word is because it was observed that the shape of fricative sounds in word-final position are not always clear in the spectrograms. The words chosen were frequently used in Arabic and were not used as examples during the course. Table 4.4 presents the words used in the pre-test and the post-test.

It has been taken into account that the words contained simple and common syllable structure CVC and CV.CVC (Levelt & Van de Vijver, 2004). The words in the pre- and post-tests were not similar in pronunciation and meaning; however, the phonological environments were the same. For example, the pre-test had the word /nasˤab/ (fatigue) while the post-test had the word /qasˤab/ (cane). The syllable structure and vowel contexts were the same in both tests to minimise the chances of generating errors owing to unfamiliarity with the sounds. All words in both tests were written in Arabic by computer using Times New Roman 14-point script.

	Pre-test words		**Post-test words**	
1	خاب	/χaːb/ disappointed	خلد	/χalad/ immortalise
2	مسن	/masan/ hitting	رسم	/rasam/ draw
3	نحت	/naħat/ carving	سحب	/saħab/ pull
4	بذل	/baðl/ exert	نذل	/naðl/villainous
5	شرب	/ʃarab/ drink	شكر	/ʃakar/thank
6	ظبي	/ðˤabi/ deer	ظمأ	/ðˤamaʔ/ thirst
7	فجر	/faʤr/ dawn	فطر	/fatˤr/ eat
8	مهر	/mahar/ dowry	نهر	/nahar/ river
9	غني	/ɣani/ rich	غلي	/ɣali/ boil
10	نصب	/nasˤab/ fatigue	قصب	/qasˤab/ cane
11	عبر	/ʕabar/ cross	عمر	/ʕamar/ build
12	ثور	/θawr/ bull	ثوب	/θawb/ dress
13	جزر	/ʤazar/ carrot	نزل	/nazal/ get down

Table 4.4: Words used in the pre- and post-tests for Study 1

4.8 Procedure and Data Collection

Study 1 began by introducing the researcher to all the participants. They were given details about the procedure of the study including the pre-and post-tests. The participants were asked to fill in the demographic questionnaire that was explained earlier in this chapter in Section 4.7.1. After they completed the questionnaire, they were asked to do the pre-test.

The test took place in a private and quiet room. Participants took the test individually in turns. During the test, the researcher gave the participant headset microphone (Sony MDR-ZX110AP Stereo Headphone) and asked her to read the 13 words in a clear and loud voice. A headset microphone was used to record the sounds in this study to reduce the risk of picking up breath sounds, ‘popping’, and other noises that are difficult to control for. In addition, an attempt was made to control the background noise and keep the place as quiet as possible.

Participants voices were recorded using Praat software at frequency 44100 Hz 16-bit stereo, and the sound files were saved as WAV files. Overall, the introduction, the questionnaire, and pre-test took approximately 3 hours in total for all participants to complete.

The production test was intended to measure pronunciation accuracy and not learners’ reading abilities. Learners’ ability to read similar words was not tested before conducting the production test and it was unknown whether there were mispronunciations made owing to differences in script, which may have affected the results. Although the participants were asked to pronounce the target words one time and were not allowed to practice, the words used in the production tests were single, short and frequently used in Arabic to reduce the risk of challenging learners to pronounce unfamiliar words. Studies have shown that lower frequency words could affect learners' performance on reading tasks (Ellis, 2002a; Seidenberg, Waters, Barnes, & Tanenhaus, 1984) and so high-frequency words were used to mitigate any reading effect. The words were selected based on their high frequency in Arabic language learning textbooks taught in the institution.

When rating learners' production of the target sounds, raters looked at the accuracy of pronouncing the target sounds and did not rate learners' fluency or reading abilities at the word-level. However, it is possible to say that learners' reading abilities could affect their pronunciation accuracy (Piske et al., 2001; Thompson, 1991), which is considered a limitation in constructing this test. A reading ability test could have been conducted earlier before constructing the test to identify learners' reading levels and ensure reading was not a confounding factor in the test design.

On the second day, the participants in the traditional group were asked to attend a five-day pronunciation training session starting the following week from Sunday to Thursday, 11 am -12.30 pm. The technology group, on the other hand, were asked to attend a one-day Praat training session first in the computer lab. They then started the pronunciation training on the same day and at the same time as the traditional group. All students received 7.5 hours' pronunciation training on fricatives. The 13 Arabic fricatives were divided into five sections based on the weekdays. Some fricatives were put together due to similarities in some features. Table 4.5 provides the schedule of the training sessions for both groups.

At the end of the pronunciation training course all participants took the post-test, which was similar in its procedure to the pre-test but with different words, as seen in Table 4.5. The whole experiment took eight days.

Day	Time	Procedure
Wednesday	10-12.30	Introduction- questionnaire- pre-test for both groups
Thursday	11-12.30	Training session on using Praat for Technology group
Sunday	11-12.30	/z/, /s/, /sˤ/
Monday	11-12.30	/θ/, /f/, /ʃ/
Tuesday	11-12.30	/ħ/, /h/
Wednesday	11-12.30	/χ/, /ɣ/, /ʕ/
Thursday	11-12.30	/ð/, /ðˤ/
Sunday	10-11	Post-test for both groups

Table 4.5: Timetable of the procedure for Study 1

4.8.1 The Traditional Group

The traditional group was taught by another instructor and not the researcher. The reason for assigning another instructor for the traditional group was because of the lack of time. The researcher wanted the training sessions for the two groups to be in the same days and times, so she sought another instructor's help to teach the traditional group but with a guidance and supervision from the researcher. The instructor is a female Arabic teacher in the institute and holds an MA degree in Arabic language with specialisation in Applied Linguistics and an experience of teaching Arabic as L2.

This course was taught by using explicit instruction based on the analytic-linguistic approach, including basic techniques such as repetition, reading aloud, and practicing minimal pairs. In each training session, the teacher introduced the fricative to the participants and explained in detail its place of articulation by showing a picture of the vocal tract on a paper. Then she asked them to repeat words and sentences after her. Furthermore, the teacher wrote minimal pairs on the board and asked participants about the differences in pronunciation and meaning (see Table 3.3). In addition, they were asked to read aloud small passages individually in turns. The instructor provided explicit corrective feedback to the participants when they mispronounced the fricative sounds. The traditional group worked individually and not as a whole class. There were no classroom activities involving interaction between learners. The interaction was only between the learner and the instructor.

4.8.2 The Technology Group

The course was delivered to the technology group by the researcher in a computer lab. The group started the course one day before the traditional group. Praat was downloaded to the computers in the lab by the researcher prior to the course. As mentioned in section 4.8 above, the first class was a training session about using Praat. A PowerPoint presentation was used to explain the use of speech analysis in understanding sound features. Participants were taught how to open a file, record their voices, and understand waveform and spectrogram with examples.

After the introductory presentation, participants were asked to practice using Praat individually. During the rest of the introductory session, participants opened new files, recorded their voices and looked at the shape and intensity of spectrograms with different sounds. The researcher remained in the lab to answer their questions. This introductory session took approximately 1.5 hour to be completed.

In the following week, the technology group started classes on fricatives the same day and time as the traditional group. The class started by introducing the target fricatives and their place of articulation. Then, participants followed three steps as recommended by Olson (2014) and Offerman and Olson (2016): initial self-recording, guided visual analysis and practice and re-recording, as outlined below.

In the initial self-recording phase, the researcher gave words that have a fricative sound in the initial or middle position and asked the participants to record their voices pronouncing this word using Praat. In the guided visual analysis phase, pictures of the spectrogram and waveform for the same words pronounced were given to each participant. In the practice and re-recording phase, participants were asked to record their voices again and again pronouncing the same words to match those in the pictures given to them. They were asked to compare their spectrograms with the one on the given pictures. Participants worked individually in this group and the feedback was given instantly through the shape of spectrogram in Praat. Figure 4.2 gives a summary of the procedure and the teaching methods used in this study.

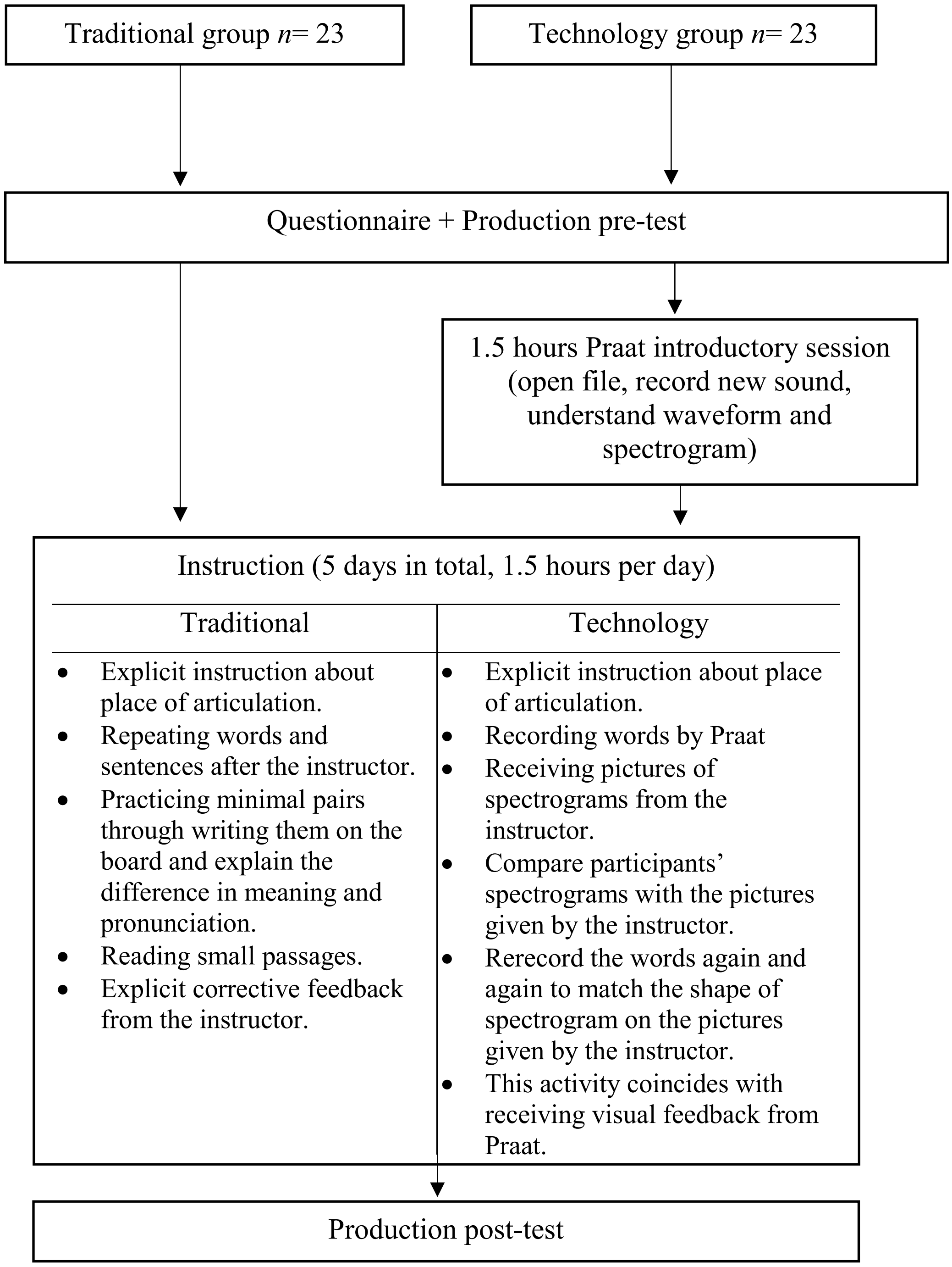


Figure 4.2: Summary of procedure and teaching methods used in Study 1

4.9 Piloting the Study

Creswell (2002) defined a pilot study as "a procedure in which a researcher makes changes in an instrument based on feedback from a small number of individuals who complete and evaluate the instrument" (p. 402). Before data collection took place, part of the study was piloted with five participants in beginner, intermediate and advanced levels of Arabic proficiency and who were not included in the actual study. The pilot study included only the procedure of the technology group for two reasons: (1) to ensure students' understanding of using and dealing with Praat individually; and (2) to measure whether the pre- and post-test word choice were suitable for L2 learners of Arabic with different levels of proficiency.

Because of time constraints, the researcher piloted the study remotely in the United Kingdom and the participants were contacted through email. The participants were from different proficiency levels, studying Arabic in UK universities. Participants were given written instructions in detail about Praat similar to the instructions given to the participants in the actual study.

At the beginning, participants were asked to record their voices pronouncing the pre-test words. After receiving the pre-test recordings, the instructions were sent to the participants along with words and pictures of spectrograms for Arabic native speakers. They were asked to practice and compare their utterance with the native speakers' spectrograms. After one week of practicing, the post-test was given, and participants were asked to record their voices and send them back to the researcher. At the end of the pilot study, the researcher asked the participants for their feedback about the materials used in the instructions and the pre- and post-tests.

Pilot participants evaluated the tests, the instructions and the easiness and convenience of word choice in the test and the use of Praat. As a result of the participants' evaluation, some words used in the training sessions and tests were changed due to their length and complexity. Furthermore, there were sentences that caused difficulty in pronunciation and these were deleted in the actual study. Although this method in collecting the data for the pilot study had limitations, such as the lack of real supervision and feedback from the researcher, it helped in evaluating the materials and tests with the assistance of actual L2 learners of Arabic.

4.10 Raters and Inter-rater Reliability

Data in the form of test scores were collected from the participants' pre- and post-tests. For the ease of data-encoding, every sound file was named with the participants' name and proficiency level and saved in a pre-test or post-test named file. Names are not revealed in the reporting of the results of this study. 92 recordings in total were collected, in which each recording contained 13 words and each word contained one fricative.

In order to evaluate and analyse the tests' results, two female adult native Arabic speakers were recruited as raters. They were teachers in a secondary school in Saudi Arabia who teach Arabic and Islamic studies. They spoke Gulf Arabic and they also used MSA in classrooms. They were recommended to the researcher by a head of a secondary school in Saudi Arabia, Riyadh. The two raters were contacted via Email and they were given instructions and response sheet.

The response sheet has the first name of the participants and the pre- and post-tests words; they were asked to listen to the recordings for each participant and decide whether her pronunciation was correct or not. They were also asked to underline any mispronounced word, circle the incorrect sound and write exactly the sound they heard. The raters were unaware which participant belonged to which group and unaware of whether the recordings were from the pre- tests or post-tests.

Each rater listened to 92 recordings in which each recording contained 13 Arabic words. The agreement between rates was needed to ensure consistency in judging precipitants pronunciation. Strange and Shafer (2008) mentioned "[i]n general, the more agreement among listeners, the less 'subjectivity' there must be in their judgments, and the more evident it is that the listeners share a response to particular stimulus properties" (p. 207).

The inter-rater reliability was calculated for each of the two raters. The level of agreements was obtained using Cronbach's Alpha. Cronbach's Alpha is the most common method to test internal consistency reliability (Stemler, 2004). It measures the agreement between raters when they are rating the same object. The calculation of Cronbach's Alpha inter-rater reliability coefficient was highly significant for the pre-test and post-test, which implies a very high level of agreement between the two raters. Table 4.6 presents the Cronbach's Alpha inter-rater reliability coefficient and the degree of internal consistency for each fricative sound based on Cronbach (1951).

Sounds	Cronbach's Alpha		Internal consistency
	Pre-test	Post-test	
/z/	1.00	1.00	Excellent
/s/	.977	.922	Excellent
/sˤ/	1.00	1.00	Excellent
/θ/	.935	.818	Excellent/ Good
/f/	1.00	1.00	Excellent
/ʃ/	1.00	1.00	Excellent
/ħ/	1.00	.713	Excellent/ Acceptable
/h/	1.00	1.00	Excellent
/χ/	.918	1.00	Excellent
/ɣ/	.848	1.00	Good/ Excellent
/ʕ/	.977	.935	Excellent
/ð/	.939	1.00	Excellent
/ðˤ/	.976	1.00	Excellent

Table 4.6: Cronbach's Alpha inter-rater reliability coefficient for Study 1

4.11 Data Analysis

After receiving the ratings from the two raters, the responses were coded as follows: a correct pronunciation scored 0 and an incorrect pronunciation scored 1. The number of errors was calculated for each fricative sound from all participants and the two groups. The focus in analysing the data was only on fricatives although some L2 learners mispronounced some other sounds.

Quantitative data analyses, including calculating the frequency of errors and comparing participants' test scores within and between groups was conducted. All data was entered and analysed using Statistical Package for Social Sciences (SPSS), version 22. Descriptive statistics were used to provide basic summaries and features of the data. Descriptive statistics were performed to answer the first research question regarding the extent in which L2 learners of Arabic face difficulties in pronouncing the Arabic fricative sounds.

In addition, a between-group comparison on pre- and post-test scores (i.e., pre-test traditional group with pre-test technology group, post-test traditional group with post-test technology group) was needed to examine the difference between the two groups who received different teaching methods to answer the second research question regarding the differences in the efficacy between traditional-based instruction and technology-based instruction in learning Arabic fricative sounds.

To run parametric tests, numerical data must come from normally distributed populations. Many statistical tests such as Analysis of Variance (ANOVA) and *t*-tests rely on the assumption that data is distributed according to a normal bell-shaped curve, and if the data is not normal the parametric tests results may not be valid (Dörnyei, 2007). The normality of the distribution of pre-test and post-test scores was calculated for this study to choose the suitable statistical test.

The normality and homogeneity of variance was checked for each fricative to ensure the data was suitable for parametric analysis. Kolmogorov-Smirnov and Shapiro-Wilk tests are the most common tests in statistics to compare the distribution of the values (Ghasemi & Zahediasl, 2012). The assumption of normality was checked by looking at the p-value of > 0.05. Shapiro-Wilk and Kolmogorov-Smirnov measured ($P < .001$) for all the fricatives in the pre-and post-test and they were significantly lower than 0.05, indicating that non-parametric analysis would provide the most authentic results (see normality results in Appendix K). The non-normality results for all the fricatives in the pre-and post-tests can be seen in the histograms in Figure 4.3.

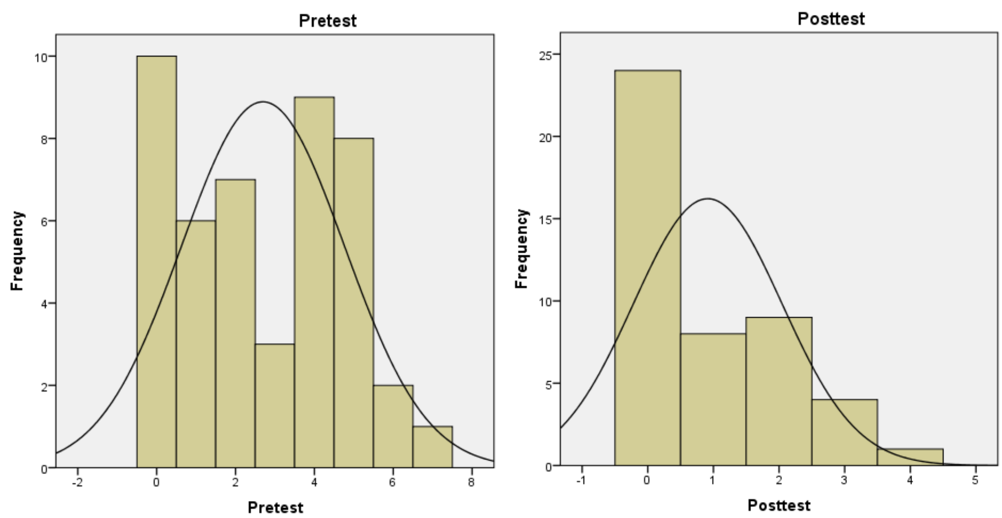


Figure 4.3: Histograms showing the non-normal distribution of error counts in the pre-and post-test results

Due to the non-normality of the data, the non-parametric Wilcoxon signed-rank test was conducted to compare related samples (i.e., between the fricative sounds) to assess their levels of difficulty and whether their means were significantly differing from each other. Furthermore, the Mann-Whitney U test was conducted to compare the traditional and technology groups before and after receiving the phonetic instruction. In this analysis, the dependent variable was the students' errors and the independent variable was the kind of pronunciation instruction. The pre-test was used as covariate to control possible pre-existing differences, thus, the effect of kinds of instruction on post-test scores could be verified (Tabachnick & Fidell, 1996).

As suggested by Field (2009), measuring the effect size of pronunciation instruction on learners' performances was necessary to ensure the robustness of the analysis. The effect size was measured to detect the differences in the means between the two groups. According to Cohen's (1988) interpretation of the effect size values, Cohen's d =.2 is a small effect size, Cohen's d =.5 is a medium effect size, and Cohen's d =.8 is a large effect size. In most SLA research, the significant level is .05, which means that there is a 95% probability level that the results are due to the treatment and only 5% that the results are due to chance alone (Paltridge & Phakiti, 2010).

4.12 Validity of the Study

The pre-and post-tests were examined to detect whether they are measuring what they intended to measure. Prior to conducting the study, two L2 Arabic teachers at Princess Nourah Arabic Language Institute received copies of both tests to examine whether the words in the tests were frequent in Arabic, easy to read, and to measure the intended purpose of the tests.

Moreover, the content validity was improved since most words and sentences used in the materials were taken from the same curriculum used in the institution and many other institutions in Saudi Arabia. Furthermore, a pilot study was conducted prior to the actual study to ensure easiness and full understanding of the instructions and materials, specifically the use of Praat (see section 4.9).

As mentioned previously in Section 4.3, it is difficult to ensure comparability of participants in educational research; however, the researcher tried to minimise participants' dissimilarities. Variance in the effect of language background was controlled by choosing only three language groups. Furthermore, a pre-test was conducted prior the training course to observe participants' previous knowledge and to ensure the equality in the performance between the two groups.

The duration of the training courses and of the tests were similar for both groups. However, the traditional group lacked direct contact and supervision from the researcher. It was impossible to control both time and presence of the researcher for both groups. The effect of the researcher's absence for teaching the traditional group was minimised by choosing a qualified instructor. One-to-one instructions for each of the five one-day training sessions were given to the instructor to ensure her understanding of the procedure in the classroom. Unfortunately, due to cultural matters, it was not allowed to audio or video record students' and instructors' performances in the classroom.

4.13 Summary of Chapter

This chapter presented the quasi-experimental design of Study 1. It provided information on the ethical consideration, participants, instruments, procedure and data collection. Details on the pilot study was shown to assure the validity and reliability of the materials. This chapter also explained the reliability of the raters and how the data was coded and statistically analysed through non-parametric tests. The results of the data analysis obtained for this study are detailed in the next chapter.

CHAPTER FIVE

RESULTS FOR STUDY 1

5.1 Introduction

This chapter presents the results of Study 1 that was done initially, which included obtaining samples from some L2 learners of Arabic pronouncing the Arabic fricative sounds (/z/, /s/, /sˤ/, /θ/, /f/, /ʃ/, /ħ/, /h/, /χ/, /ɣ/, /ʕ/, /ð/, /ðˤ/) before and after receiving certain pronunciation treatments. The two main objectives of this experiment were to investigate the difficulties in Arabic fricative sounds and measure learners' performances before and after receiving two different teaching methods. More specifically, study 1 addresses the research questions presented below:

1- To what extent do L2 learners of Arabic face difficulties in pronouncing the Arabic fricative sounds?
2- Is there a significant difference in efficacy between using speech analysis technology-based instruction and traditional instruction in the production of Arabic fricative sounds by L2 learners of Arabic?

All the analysed statistical data and the SPSS results are presented in Appendix (K).

5.2 Analysis of the Pre-test Results

All Arabic fricative sounds that were pronounced by the L2 learners of Arabic were tested in order to detect the areas of difficulties and to find out the most problematic and challenging fricative sounds in pronunciation. The results that were derived from the production pre-test showed that participants did not face difficulties with some of the Arabic fricatives, especially with the sounds that exist in their native languages. A descriptive statistical analysis was carried out to calculate and analyse the errors in the pronunciation of the fricative sounds at the pre-test.

The pre-test results showed that all the 46 participants pronounced the sounds /s/, /z/, /f/, /ʃ/, /h/ correctly, which means the percentage of the number of errors for these sounds is 0%. Few participants mispronounced the sounds /χ/ (8.7%) and /ɣ/ (10.8%) while more errors were made in the pronunciation of the sounds /ð/ (21.7%), /θ/ (26%), /ħ/ (34.8%) and /ʕ/ (39.2%). Most errors occurred in the pronunciation of the pharyngealised fricative sounds /sˤ/ (63%) and /ðˤ/ (67%). Table 5.1 gives descriptive statistical details about the production pre-test errors of each fricative sound from all participants. Mispronounced target sounds, the frequency of mispronunciation and the way the target sounds were pronounced by the participants are represented in the table.

Sounds	No. occurrence	No. errors	Mean	SD	Cumulative percentage of errors	Participants production (Substitutions)
/χ/	46	4	.9	.285	8.7%	/k/
/ɣ/	46	5	.11	.315	10.8%	/q/, /k/
/ð/	46	10	.22	.417	21.7%	/d/, /z/
/θ/	46	12	.26	.444	26%	/s/, /t/
/ħ/	46	16	.35	.482	34.8%	/h/
/ʕ/	46	18	.39	.493	39.2%	/ʔ/
/sˤ/	46	29	.63	.488	63%	/s/
/ðˤ/	46	31	.67	.474	67%	/ð/, /d/, /dˤ/, /z/

Table 5.1: Descriptive statistical summary of the pronunciation errors of mispronounced fricatives

The number of occurrence in Table 5.1 means that each participant pronounced each fricative sound once. The mean refers to the average of errors. The standard deviation (SD) refers to the amount of variation between participants. Table 5.1 shows that the mean of errors of all the fricative sounds appeared to increase from the sound /χ/ to the sound /ðˤ/. The Minimum pronunciation problems were found with the sounds /ɣ/, /χ/, /ð/, /θ/, /ħ/ and /ʕ/. Major pronunciation problems were found in the pronunciation of the pharyngealised fricatives /sˤ/ and /ðˤ/. Figure 5.1 shows the differences in the pronunciation errors of fricatives among the 46 L2 learners of Arabic when grouped together.

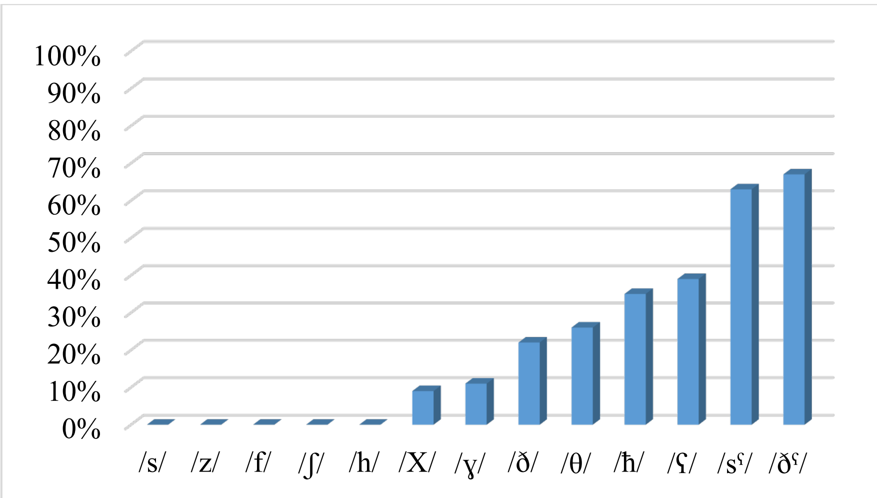


Figure 5.1: Percentage of pronunciation errors of Arabic fricatives among 46 L2 learners of Arabic

Based on the mean of errors, most errors were produced by participants in the beginner level who were Mandarin and Urdu speakers. Moreover, Mandarin speakers produced the highest number of errors. Figure 5.2 shows the mean of errors in all participants from the three language backgrounds and proficiency levels.

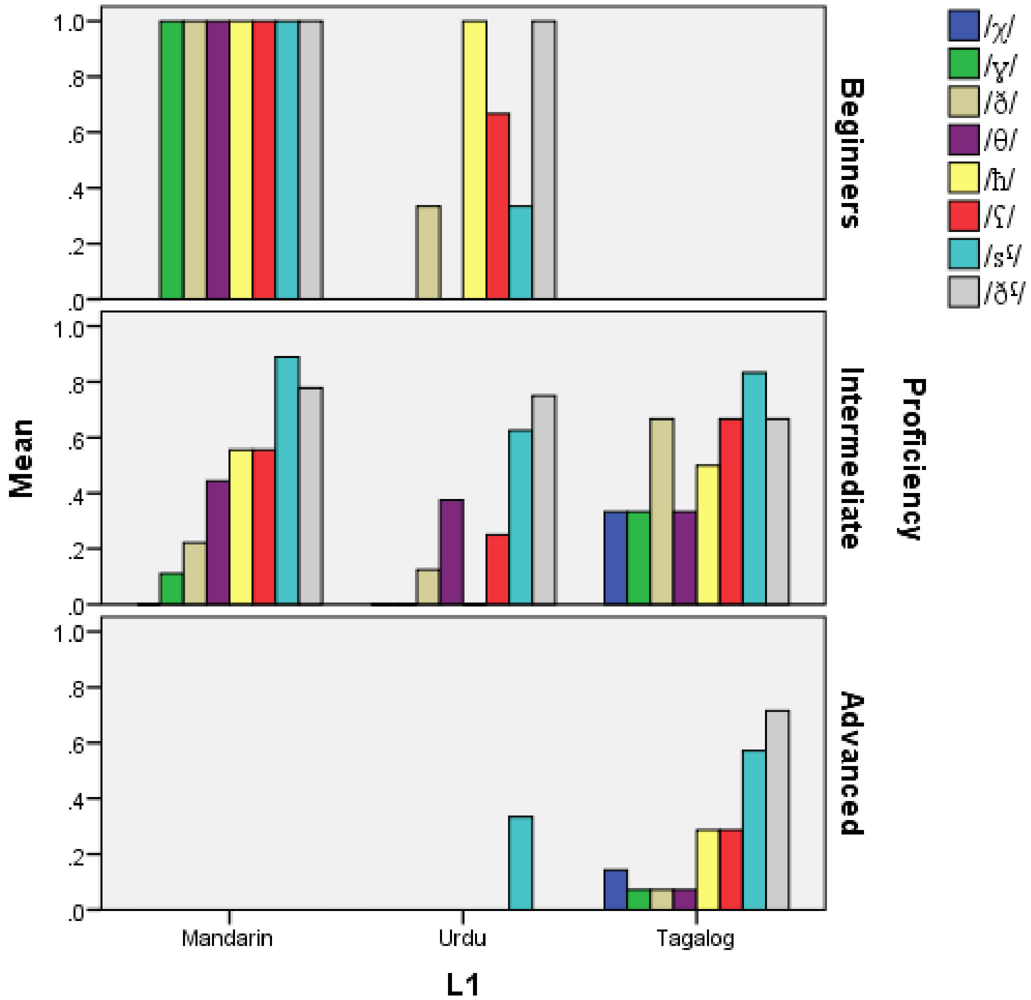


Figure 5.2: Mean of errors among all participants in the three language backgrounds and proficiency levels

There were no Tagalog speakers in the beginner level (see Table 4.2 in the Methodology for Study 1 Chapter, Section 4.5.1). Advanced level Mandarin speakers (n=2) pronounced all fricatives correctly.

5.2.1 Comparison of The Mean Scores Between Fricatives

Since the distribution of scores was not normal, the Wilcoxon signed-rank test is the nonparametric test equivalent to the dependent *t*-test. This test does not assume normality in the data and it can be used when the normality assumption has been violated and the use of the parametric tests, such as the dependent *t*-test, is inappropriate. The Wilcoxon signed-rank test is used to compare two sets of scores produced from the same participants. It was used in this section to compare between each sound and the rest of the fricative sounds to reveal whether there were significant differences in the level of pronunciation difficulties between these sounds and to know the amount of pronunciation difficulty each sound posed to L2 learners of Arabic comparing all fricative sounds.

Wilcoxon signed-rank tests were conducted to compare between the mean of two fricatives at an alpha level 0.05. This non-parametric test is equivalent to the parametric paired samples *t*-test and the aim for choosing it over other tests was to compare between two means without assigning a specific factor or independent variable.

Wilcoxon signed-rank tests showed that some fricative sounds received significantly more errors than other fricatives. The difference in the number of errors between each of these sounds /χ/, /ɣ/, /ð/ and /θ/ was not significant while the number of errors increased and became significant when pronouncing each of these sounds/ħ/, /ʕ/, /sˤ/ and /ðˤ/.

Table 5.2 presents the results of the Wilcoxon signed-rank tests and shows the sounds that are significantly difficult in pronunciation compared with the other fricative sounds.

Pair	Wilcoxon, Z	*p*-value
/χ/-/ɣ/	.378	.705
/χ/-/ð/	1.732	.083
/χ/-/θ/	1.807	.071
/χ/-/ħ/	2.828	.005
/χ/-/ʕ/	3.500	.000
/χ/-/sˤ/	4.811	.000
/χ/-/ðˤ/	5.014	.000
/ɣ/-/ð/	1.890	.059
/ɣ/-/θ/	1.897	.058
/ɣ/-/ħ/	2.840	.005
/ɣ/-/ʕ/	3.357	.001
/ɣ/-/sˤ/	4.899	.000
/ɣ/-/ðˤ/	4.747	.000
/ð/-/θ/	.302	.763
/ð/-/ħ/	1.604	.109
/ð/-/ʕ/	2.138	.033
/ð/-/sˤ/	4.146	.000
/ð/-/ðˤ/	4.041	.000
/θ/-/ħ/	1.387	.166
/θ/-/ʕ/	2.111	.035
/θ/-/sˤ/	4.243	.000
/θ/-/ðˤ/	3.922	.000
/ħ/-/ʕ/	.577	.564
/ħ/-/sˤ/	3.153	.002
/ħ/-/ðˤ/	3.638	.000
/ʕ/-/sˤ/	3.051	.002
/ʕ/-/ðˤ/	3.153	.002
/sˤ/-/ðˤ/	.632	.527

The grey shading indicates significant results $p<0.05$

Table 5.2: Wilcoxon signed-rank test results in the production of fricatives

In Table 5.2 and the rest of the tables in this chapter, the grey shading indicates that the *p*-value was lower than 0.05 and the difference was considered significant. The results revealed significant pronunciation difficulties in some fricatives compared to others.

The errors were significantly high in the pharyngeal and pharyngealised fricatives. Specifically, the major errors occurred with the pharyngeal and pharyngealised fricative sounds, which indicates these two sound categories are the most difficult fricative sounds to pronounce for this group of learners. Furthermore, the errors in the pharyngealised sounds were significantly higher than the pharyngeal sounds. The two pharyngealised sounds did not significantly differ in the number of errors, which made them share the same level of pronunciation difficulty.

On the other hand, the uvular fricatives /χ/ and /ɣ/ and the dental fricatives /ð/ and /θ/ shared relatively the same level of pronunciation difficulty, significantly less than the pharyngeal and pharyngealised sounds. Furthermore, no significant difference was found between the pharyngeal fricative /ħ/ and the dental fricatives /ð/ and /θ/, which means that the pharyngeal fricative /ħ/ less difficult than the pharyngeal fricative /ʕ/. A significant difference was only found with the pharyngeal /ħ/ when comparing it with the uvular fricatives /χ/ and /ɣ/, meaning that the pharyngeal /ħ/ is significantly more difficult than the uvular fricatives but not than the dental fricatives.

Therefore, it can be concluded from these results that Arabic fricatives do not all share the same level of pronunciation difficulty for this group of learners, and that pharyngeal and pharyngealised sounds were the most difficult sounds among fricatives. On the contrary, the uvular fricatives /χ/ and /ɣ/ and the dental fricatives /ð/ and /θ/ were found to be less difficult in pronunciation. Based on the results of the Wilcoxon signed-rank tests, the difficulties of the most problematic fricative sounds comprised three levels of difficulty: uvular and dental fricatives < pharyngeal fricatives < pharyngealised fricatives.

5.2.2 Analysis of Errors from Different Language Groups

The results of the pre-test revealed that Mandarin speakers (N=12) produced 39 pronunciation errors in total (31.2%). Urdu speakers (N=14) produced 28 pronunciation errors (22.4%) and Tagalog speakers (N=20) produced 58 pronunciation errors

(46.4%). The number of Tagalog speakers was greater than Mandarin and Urdu speakers, which probably resulted in the higher number of errors from Tagalog speakers compared to Mandarin and Urdu. Therefore, the Kruskal Wallis test was conducted for the purpose of revealing any significant differences between the three language groups in the pronunciation of fricatives regardless of the disparity in numbers between the groups. This test is the non-parametric equivalent to the one-way between-groups ANOVA, which allows a comparison of three groups. The purpose was to detect the influence of three language backgrounds on the acquisition of Arabic fricatives.

The Kruskal Wallis test results showed no significant effects of L1 on the production of all Arabic fricative sounds among L2 learners of Arabic from different language backgrounds. Particularly, the native language of the learners did not strengthen their ability to produce fricatives more accurately than other native language speakers. Speakers of Mandarin, Urdu and Tagalog did not significantly differ in their proportion of pronunciation errors of fricatives. However, a significant difference was almost reached in the pronunciation of the sound /χ/ (P= .062), which showed that Tagalog speakers made noticeably more errors than Mandarin and Urdu speakers. Table 5.3 shows the results of Kruskal Wallis test for all fricatives from the three language groups.

Sounds	Mandarin speakers (N=12)			Urdu speakers (N=14)			Tagalog speakers (N=20)			Kruskal Wallis test		
	No. error	M	SD	No. error	M	SD	No. error	M	SD	df	Chi-square	*p*-value
/χ/	0	.00	.000	0	.00	.000	4	.20	.410	2	5.571	.062
/ɣ/	2	.17	.389	0	.00	.000	3	.15	.366	2	2.422	.298
/ð/	3	.25	.452	2	.14	.363	5	.25	.444	2	.643	.725
/θ/	5	.42	.515	3	.21	.426	4	.15	.366	2	2.934	.231
/ħ/	6	.50	.522	3	.21	.426	7	.35	.489	2	2.275	.321
/ʕ/	6	.50	.522	4	.29	.469	8	.40	.503	2	1.230	.540
/sˤ/	9	.75	.452	7	.50	.519	13	.65	.489	2	1.753	.416
/ðˤ/	8	.67	.492	9	.64	.497	14	.70	.470	2	.124	.940

Table 5.3: Kruskal Wallis test results in the production of fricatives from three language groups

Although the number of Mandarin speakers (N=12) was less than Urdu (N=14) and Tagalog speakers (N= 20), they had more errors in the pronunciation of most fricatives. However, as seen in Table 4.3, the *p*-values were greater than .05, which indicated no significant difference between language groups in the production of all fricatives. Figure 5.3 presents the pronunciation errors of each fricative from each language group.

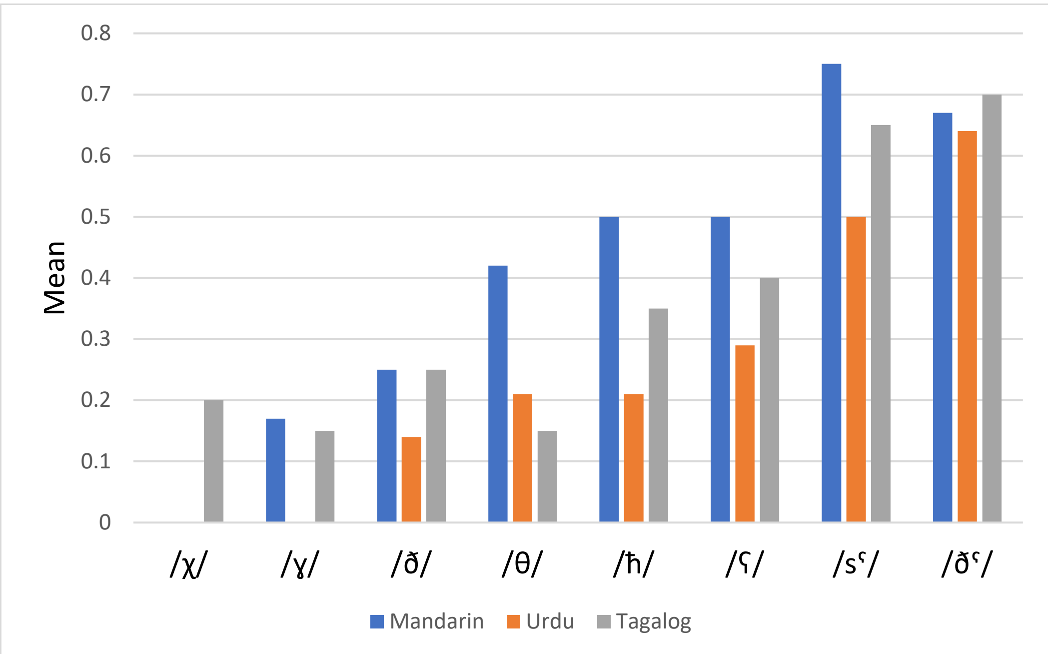


Figure 5.3: Pronunciation errors of fricatives from the three language groups

Figure 5.3 presents only the fricative sounds that posed pronunciation difficulties for the participants. Not all fricatives posed problems to the three language groups, even the sounds that are missing from the phonological inventories in their native languages, such as the sound /ʃ/ for Mandarin speakers and /z/ for Mandarin and Tagalog speakers. It can be seen from this graph that most errors occurred in the pronunciation of the pharyngealised fricatives from the three groups, which indicated that these sounds posed major difficulties despite learners' language backgrounds.

5.2.3 Types of Errors from Mandarin Urdu and Tagalog Speakers

After analysing the frequency of errors in the production of the fricatives from the three language groups, specific types of errors were determined. The types of production errors were analysed, based on the language backgrounds of the participants. The types and number of errors are presented in Table 5.4.

Fricatives	Participants production (Substitutions)	Mandarin speakers	Urdu speakers	Tagalog speakers
/χ/	/k/	0	0	4
/ɣ/	/q/	2	0	2
	/k/	0	0	1
/ð/	/d/	3	1	5
	/z/	0	1	0
/θ/	/s/	3	3	3
	/t/	2	0	1
/ħ/	/h/	6	3	7
/ʕ/	/ʔ/	6	4	8
/sˤ/	/s/	9	7	13
/ðˤ/	/ð/	6	6	10
	/d/	1	0	1
	/dˤ/	1	2	3
	/z/	0	1	0

Table 5.4: Types of errors of fricatives from Mandarin, Urdu and Tagalog speakers

5.2.4 Analysis of Errors from Different Proficiency Levels

This study also tested the production of fricatives from three proficiency levels: beginners, intermediate and advanced. The purpose of examining the differences between proficiency levels was to reveal whether learners in advanced level of proficiency still find fricative sounds to be obstacles in pronunciation learning, and whether there was a proficiency level that performed significantly differently (i.e., better or worse) than the others.

The results of the pre-test revealed that Beginners (N=4) had 17 pronunciation errors in total and the percentage of errors within this group was 13.8%. In addition, intermediate learners (N=23) had 75 pronunciation errors and the percentage of errors within this group was 60.4%. Advanced learners (N=19) had 32 pronunciation errors and the percentage of errors within this group was 25.8%.

A Kruskal Wallis test results revealed a significant difference in the production of the sounds /ħ/ ($p < 0.05$) and /θ/ ($p < 0.05$) between the three proficiency levels, but no significant difference between proficiency levels in the production of the rest of the problematic fricatives. Table 5.5 shows the results of Kruskal Wallis test in the three proficiency levels.

Sounds	Beginners (N=4)			Intermediate (N=23)			Advanced (N=19)			Kruskal Wallis test		
	No. error	M	SD	No. error	M	SD	No. error	M	SD	df	Chi-square	*p*-value
/χ/	0	.00	.000	2	.09	.288	2	.11	.315	2	.451	.798
/ɣ/	1	.25	.500	3	.13	.344	1	.05	.229	2	1.519	.468
/ð/	2	.50	.577	7	.30	.470	1	.05	.229	2	5.803	.055
/θ/	1	.25	.500	9	.39	.499	1	.05	.229	2	6.419	.040
/ħ/	4	1.00	.000	8	.35	.487	4	.21	.419	2	8.882	.012
/ʕ/	3	.75	.500	11	.48	.511	4	.21	.419	2	5.378	.068
/sˤ/	2	.50	.577	18	.78	.422	9	.47	.513	2	4.482	.106
/ðˤ/	4	1.00	.000	17	.74	.449	10	.53	.513	2	4.171	.124

The grey shading indicates significant results p<0.05

Table 5.5: Kruskal Wallis test results in the production of fricatives from three proficiency levels

Table 5.5 presents the mean of each proficiency level. Advanced level produced fewer errors compared with the beginner and intermediate levels. In order to find out exactly between which proficiency groups these differences in the sounds /ħ/ and /θ/ were, Mann-Whitney U pairwise comparisons with *post hoc* Bonferroni correction were carried out. The analyses showed that in the production of the sound /θ/, advanced learners performed significantly better than intermediate learners (U=144.500; *p*=.011). Furthermore, no significant difference was found between beginners and advanced learners (U=30.500; *p*=.557) and between beginners and intermediate learners (U=39.500; *p*=.669) in the production of the sound /θ/.

In the production of the sound /ħ/, significant differences were found between beginners and intermediate learners (U=16; *p*=.041) and between beginners and advanced learners (U=8; *p*=.012). No significant difference was found between advanced and intermediate learners in the production of the sound /ħ/ (U=188.500; *p*=.333). Figure 5.4 presents the production of errors for all problematic fricatives from the three proficiency levels.

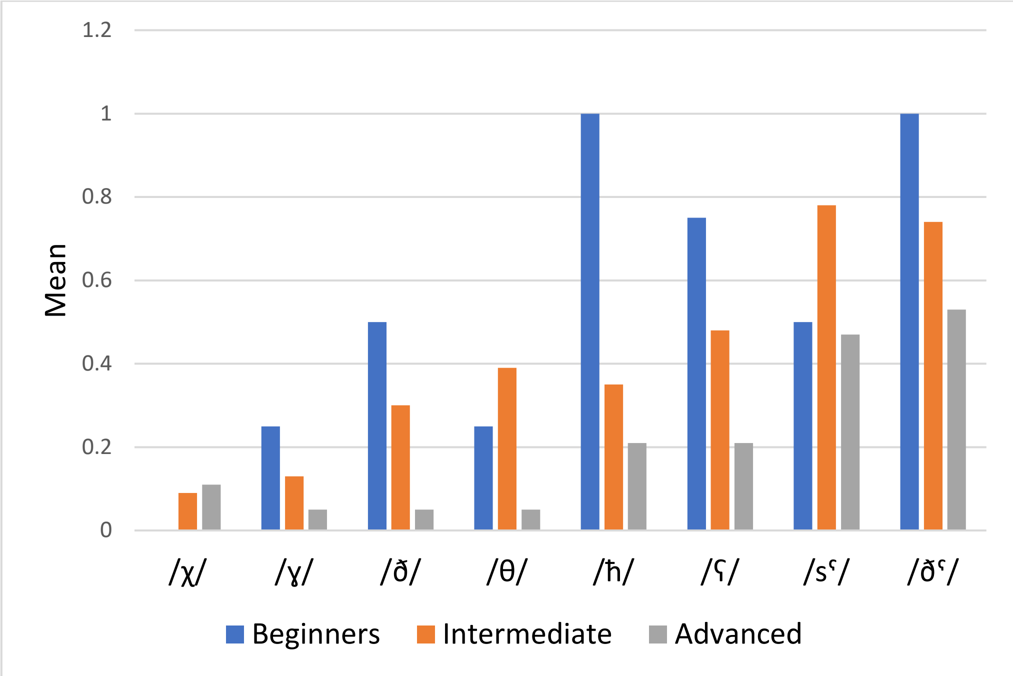


Figure 5.4: Pronunciation errors of fricatives from the three proficiency levels

The results and Figure 5.4 showed that pronunciation errors decreased as the learners became more proficient in Arabic. However, the differences in these errors between the three proficiency groups were not significant for most fricatives, which indicated that learners in the advanced level of proficiency did not significantly improve in pronunciation and that fricatives still posed problems for them. Nevertheless, the significant difference between the three proficiency groups in the pronunciation of the two fricatives /ħ/ and /θ/ posed the assumption that significant discrepancy in the production of Arabic fricatives may exist between proficiency levels but not between language groups.

5.3 Traditional-based Instruction and Technology-based Instruction

This section investigated the effects of traditional-based instruction vs. technology-based instruction in enhancing the production of Arabic fricative sounds. With this objective in mind, the participants were divided into two groups, technology and traditional, each group containing 23 participants. As described in the methodology section 4.8, the technology group was taught by using speech analysis techniques, while the traditional group was taught by using traditional methods such as, reading aloud, minimal pairs and repetition. The participants received a pre-test, special treatment, then a post-test. The independent variable here is the teaching method while the dependent variable is participants' pronunciation errors.

The word list used in the pre-test was the baseline assessment measure used to evaluate participants' performance individually and to test whether the two groups had the same level of Arabic pronunciation ability. In addition, exactly the same test was used for the post-test after five days of extensive training on fricatives, so any possible improvement in their pronunciation can be observed by examining the scores statistically.

Since the data was not normally distributed, a Mann-Whitney U test was conducted to reveal any significant difference in the production of fricatives between the traditional and the technology groups. From the figures in Table 5.6, it can be seen that the errors from the pre-test in the traditional group were at relatively the same level with the technology group, therefore, indicating that the two groups were at approximately the same proficiency level in Arabic pronunciation. The results also showed that the differences between the two groups in the pronunciation of the fricative sounds in the post-test were not significant. Table 5.6 presents the results of Mann-Whitney U test between the two groups in the production of the problematic fricatives.

Test		Traditional group (N=23) No. error	M	SD	Technology group (N=23) No. error	M	SD	Mann-Whitney U test U	z	*p*-value
/χ/	Pre	2	.09	.288	2	.09	.288	264.500	.000	1.000
	Post	1	.04	.209	0	-	-	253.000	-1.000	.317
/ɣ/	Pre	2	.09	.288	3	.13	.344	253.000	-.469	.639
	Post	1	.04	.209	0	-	-	253.000	-1.000	.317
/ð/	Pre	5	.22	.422	5	.22	.422	264.500	.000	1.000
	Post	1	.04	.209	1	.04	.209	264.500	.000	1.000
/θ/	Pre	5	.22	.422	6	.26	.449	253.000	-.342	.732
	Post	3	.13	.344	2	.09	.288	253.000	-.469	.639
/ħ/	Pre	7	.30	.470	9	.39	.499	241.500	-.612	.540
	Post	4	.17	.388	2	.09	.288	241.500	-.866	.386
/ʕ/	Pre	9	.39	.499	9	.39	.499	264.500	.000	1.000
	Post	7	.30	.470	4	.17	.388	230.000	-1.026	.305
/sˤ/	Pre	15	.65	.487	14	.16	.499	253.000	-.302	.763
	Post	5	.22	.422	2	.09	.288	230.000	-.1.218	.223
/ðˤ/	Pre	15	.65	.487	16	.70	.470	253.000	-.311	.756
	Post	6	.26	.449	3	.13	.344	230.000	-1.103	.270

Table 5.6: Mann-Whitney U test results of fricatives in both groups

It can be seen in Table 5.6 that no *p*-value was less than .05 which indicated no significant differences in the production of the fricative sounds among traditional and technology groups in either pre- or post-test scores. However, it was realised by looking at the mean for each sound and group that the technology group performed slightly better than the traditional group in the pronunciation of fricatives after the phonetic instruction.

Figure 5.5 is a high-low chart presented to explain visually the decrease in the number of errors between the two groups before and after the pronunciation instruction.

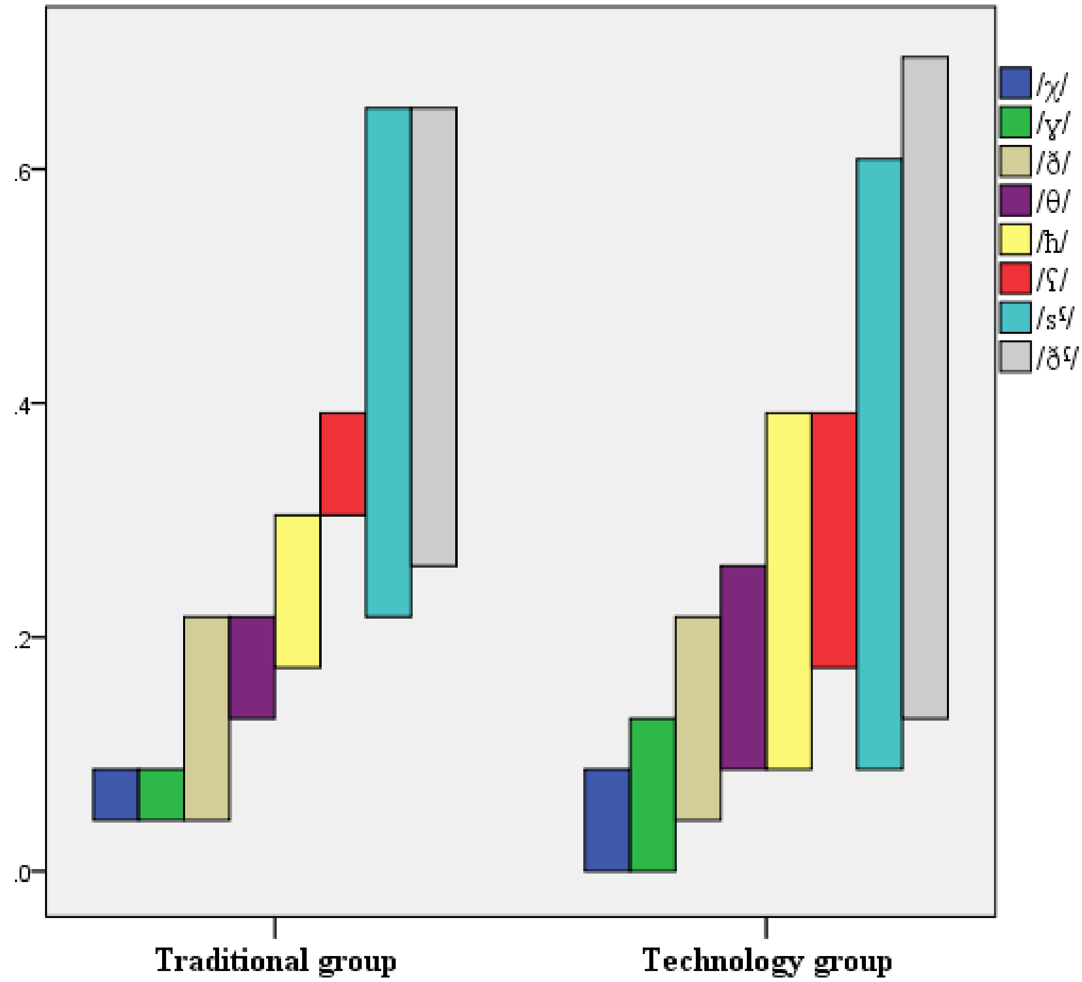


Figure 5.5: Comparing the mean of participants' errors for both groups before and after pronunciation instruction

In Figure 5.5, each vertical bar on the chart represents the mean of errors for each sound. The tip of the bar indicates the mean of errors before the instruction (i.e. pre-test), whereas the lower end of the bar indicates the mean of errors after the instruction (i.e. post-test). Both groups had approximately similar competency in the production of most of the fricatives before the instruction. Moreover, they both produced fewer errors after the instruction. However, the technology group had lower means in most of the fricatives in the post-test and the distance between the beginning and the end of most of the bars is larger (i.e., the difference between pre- and post-tests scores), which indicates that the technology group improved more than the traditional group, but the difference was not statistically significant. This result will be explained later in the Discussion for Study 1 chapter, Section 6.5.

5.3.1 Comparison of The Mean Scores Before and After the Instruction

The previous section showed that, although the number of errors decreased after receiving specific phonetic training, the difference between the two groups who received different teaching methods was not statistically significant in either the pre- or post-tests. This section tested each group separately to reveal if they improved significantly after the pronunciation instruction, whether it was done by using technology or traditional techniques. Participants' performance in this section was examined by looking at the scores of pre- and post-tests in each group. Consequently, Wilcoxon signed-rank test was chosen to compare between the pre-test and the post-test scores for each group at alpha 0.05 without assigning any independent variable.

5.3.1.1 Traditional Group Test Results

Wilcoxon signed-rank test results for the traditional group revealed significant improvements after taking the traditional-based training for three difficult fricative sounds, but not for all of them. The mean scores of the post-test indicated that there was a difference after five days of extensive traditional pronunciation teaching.

This group improved significantly in the pronunciation of /ð/ (p= .046), /sˤ/ (p= .002) and /ðˤ/ (p= .003). There were still noticeable improvements in the pronunciation of the sounds /χ/, /ɣ/, /θ/, /ħ/ and /ʕ/; however, the difference in number of errors between the pre-and post-tests was not statistically significant (See Figure 5.5 above). Table 5.7 shows the Wilcoxon signed-rank test statistical results for the traditional group in the production of the fricative sounds before and after taking the traditional-based instruction.

	Pre-test			Post-test			Wilcoxon signed-rank	
Sounds	No. error	M	SD	No. error	M	SD	Wilcoxon, Z	*p*-value
/χ/	2	.09	.288	1	.04	.209	1.000	.317
/ɣ/	2	.09	.288	1	.04	.209	1.000	.317
/ð/	5	.22	.422	1	.04	.209	2.000	.046
/θ/	5	.22	.422	3	.13	.344	1.414	.157
/ħ/	7	.30	.470	4	.17	.388	1.732	.083
/ʕ/	9	.39	.499	7	.30	.470	1.000	.317
/sˤ/	15	.65	.487	5	.22	.422	3.162	.002
/ðˤ/	15	.65	.487	6	.26	.449	3.000	.003

The grey shading indicates significant results $p<0.05$

Table 5.7: Wilcoxon signed-rank test results in the production of fricatives from the traditional group

As shown in the previous section in Table 5.7, the mean of errors of all fricative sounds in the post-test were less than the mean of errors in the pre-test. This indicated that the number of errors were less after the traditional training course. However, while there was improvement in all cases, Table 5.7 shows that improvement in the production of only three sounds was statistically significant after the traditional-based instruction.

5.3.1.2 Technology Group Test Results

Wilcoxon signed-rank test results for the technology group revealed significant improvements after taking the technology-based training for most of the difficult fricative sounds. This group improved significantly in the pronunciation of /ð/ (*p*= .046), /θ/ (*p*= .046), /ħ/ (*p*= .008), /ʕ/ (*p*= .025), /sˤ/ (*p*= .001) and /ðˤ/ (*p*= .001). There were still noticeable improvements in the pronunciation of the sounds /χ/ and /ɣ/; however, the difference in number of errors between the pre- and post-test was not statistically significant (See Figure 5.5 above). Table 5.8 shows the Wilcoxon signed-rank test statistical results for the technology group in the production of the fricative sounds before and after taking the technology-based instruction.

	Pre-test			Post-test			Wilcoxon signed-rank	
Sounds	No. error	M	SD	No. error	M	SD	Wilcoxon, Z	*p*-value
/χ/	2	.09	.288	0	.00	.000	1.414	.157
/ɣ/	3	.13	.344	0	.00	.000	1.732	.083
/ð/	5	.22	.422	1	.04	.209	2.000	.046
/θ/	6	.26	.449	2	.09	.288	2.000	.046
/ħ/	9	.39	.499	2	.09	.288	2.646	.008
/ʕ/	9	.39	.499	4	.17	.388	2.236	.025
/sˤ/	14	.61	.499	2	.09	.288	3.464	.001
/ðˤ/	16	.70	.470	3	.13	.344	3.357	.001

The grey shading indicates significant results $p<0.05$

Table 5.8: Wilcoxon signed-rank test results in the production of fricatives from the technology group

It can be seen from Table 5.8 that participants produced fewer errors in the post-test than the pre-test and most of the improvements were statistically significant. By comparing the results from the two groups it was realised that the technology group improved significantly more in some fricatives compared with the traditional group. The pharyngealised fricatives /sˤ/, /ðˤ/ and the interdental fricative /ð/ were the only three sounds that differed significantly after taking the traditional training course for the traditional group. The pronunciation of the rest of the sounds improved, too, but the difference in pronunciation before and after the traditional-based instruction was not significant.

5.4 Conclusion

Although the technology group improved in some fricatives significantly more than the traditional group as The Wilcoxon signed-rank test showed, the Mann-Whitney U test results showed that the difference between technology group and traditional group was not significant in the pronunciation of the fricatives /χ/ (p= .317),

/ɣ/ (p= .317), /ð/ (p= 1.000), /θ/ (p= .639), /ħ/ (p= .386), /ʕ/ (p= .305), /sˤ/ (p= .223), /ðˤ/ (p= .270). Figure 5.6 shows the small difference between groups before and after the treatments. It also shows a major and significant difference in performance for some sounds in both groups after the treatments.

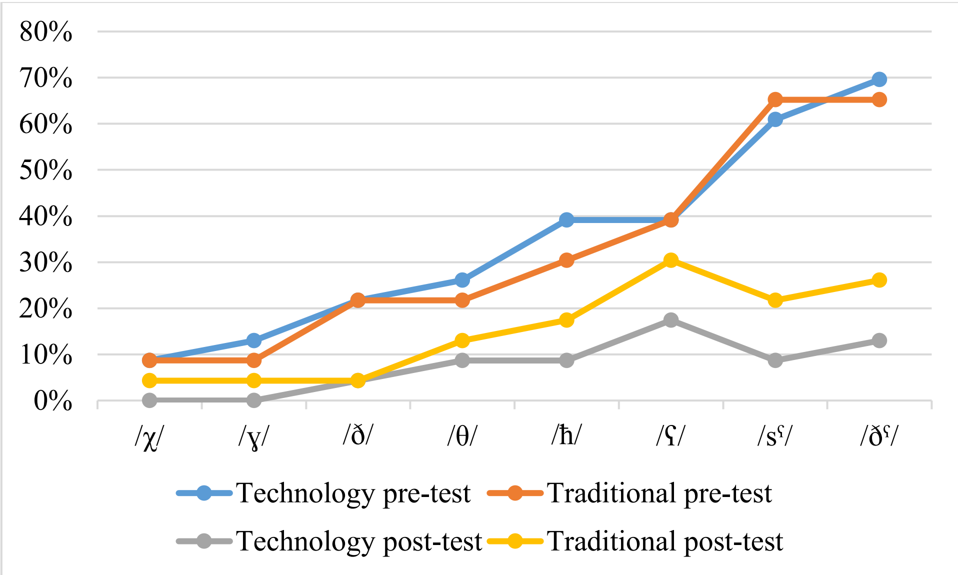


Figure 5.6: Pronunciation errors of fricatives of both groups before and after the treatments

Figure 5.6 above shows the production of errors in percentages among the two groups before and after the pronunciation instruction. The blue and orange lines indicate the performance of the two groups before the treatment. The number of errors for both groups was high before receiving the instruction while errors decreased measurably in both groups after receiving the phonetic explicit training, which can be seen in the yellow and grey lines.

In addition, the grey line that represents the technology group went slightly lower than the yellow line which represents the traditional group. This indicated that technology group performed better with fewer errors in producing the fricatives specially the pharyngeal and pharyngealised sounds while the traditional group had more errors. However, the improvement of the technology group was not significantly higher compared to the traditional group.

The differences in the uvular sounds /χ/ and /ɣ/ in both traditional and technology groups was not significant due to the low number of errors. The /χ/ and /ɣ/ errors decreased in the traditional group and disappeared in the technology group in the post-test, but the low values in the pre-test would not allow the results to be significant.

Overall, the results showed that the technology group improved significantly in the production of six fricative sounds, while the traditional group improved significantly only in three fricatives. The improvement in the production of fricatives might be explained by the general positive effects of the teaching techniques used for both groups. The instructors' feedback, reading aloud and repetition may have significantly improved learners' productive skill in the traditional group, although not as successfully as in the technology group. Similarly, the use of the visual and audio representation of sounds, the time spent repeating these sounds many times and the amount of feedback learners were getting from Praat may have significantly improved learners in the technology group. However, it is likely to be that adding the visual representation of sounds has benefited learners in the technology group in producing a larger range of fricatives more accurately than the traditional group, who did not use this technology in their pronunciation training.

However, the data is missing a lot of important information about individual learners, their fluency, reading abilities, and previous knowledge and experience of Arabic or other languages. Each fricative was tested once in one phonological environment, which is insufficient to make a generalizable claim about participants' learning gain. Many factors were not taken into consideration, such as learners' age, computer abilities and length of residence and learning in an Arabic country. The possibility of L2-L3 influence and knowledge of English prior to learning Arabic were not accounted for in this study and could affect the results. As the group sizes were small, any single error could also skew the results. The limited data and the short period of instruction reduced the accuracy and reliability of the results, as it cannot be confirmed whether the technology group actually improved more than the traditional group or that the results occurred by chance.

5.5 Summary of Chapter

This chapter has presented the results and discussed the findings in relation to the initial research questions of this exploratory study. The first part presented the purpose of the study and the two research questions. The second part showed the difficulty levels in the pronunciation of fricatives. The third part provided the results of using traditional-based and technology-based instruction in enhancing learners' pronunciation of fricatives and various comparisons between groups. The next chapter discusses the results and presents the conclusion and limitations of study 1.

CHAPTER SIX

DISCUSSION FOR STUDY 1

6.1 Introduction

This chapter explains the findings and answers the research questions for Study 1. This exploratory study aimed at assessing learners' productive abilities in pronouncing Arabic fricative sounds and facilitating the difficulties of these sounds by examining the effect of two different teaching methods. This study was set out initially to experiment the research design and to investigate whether L2 learners of Arabic in Princess Nourah Arabic Institution in Saudi Arabia encounter pronunciation difficulties.

The first part of the chapter discusses the first research question, i.e., "To what extent do L2 learners of Arabic face difficulties in pronouncing the Arabic fricative sounds?" The answer to this question provides thorough analysis about the degrees of difficulties of fricative sounds and discusses the reasons behind those difficulties. The second part of this chapter answers the second research question, i.e., "Do traditional form-focused instruction and technology form-focused instruction have different effects on L2 learners' learning of Arabic Fricatives?" this part shows the differences in efficacy between using traditional teaching techniques and speech analysis technology, particularly visual feedback paradigm, in drawing learners' attention to specific phonetic features in the pronunciation of fricatives, which helped them significantly to pronounce these sounds correctly.

6.2 Summary of Major Findings

The major result of this exploratory study was identifying the areas of difficulty in the pronunciation of fricatives. Analysis of the data showed that L2 learners of Arabic face difficulty in producing some Arabic fricative sounds that do not exist in their native languages' phonetic systems. As presented in the Results for Study 1 Chapter, Section 5.2, it was found that the sounds /s/, /z/, /f/, /ʃ/, /h/ were pronounced correctly from all the 46 participants. Fewer participants mispronounced the sounds /χ/ (*n*= 4) and /ɣ/ (*n*= 5), while more errors were made in the pronunciation of the sounds /ð/ (*n*= 10), /θ/ (*n*= 12), /ħ/ (*n*= 16) and /ʕ/ (*n*= 18). Most errors occurred in the pronunciation of the pharyngealised fricative sounds /sˤ/ (*n*= 29) and /ðˤ/ (*n*= 31).

The results in Section 5.3 showed that both traditional and technology-enhanced methods of instruction, contributed significantly to improving learners' pronunciation of fricatives. Furthermore, the results also revealed no significant difference in the pronunciation of fricatives between learners who received either traditional or technology-enhanced instruction. Overall, the findings of this study helped in shaping the further investigations for the main study, which is discussed at the end of this chapter.

6.3 The Difficulty of Fricatives in Light of Previous Literature

Before discussing the difficulty of fricatives and answering the first research question, it is worth discussing the influence that language backgrounds posed to learners' progress in learning Arabic sounds. In this preliminary study, data provided tentative support for the notion that the native languages of L2 learners influence the way they pronounce L2 sounds. The errors that were produced from participants in this study may partially result from the differences between the phonetic systems of Arabic and their native languages.

According to the SLM (Flege, 1995), if the L1 and L2 phonetic systems share similar phonological space, it will cause L2 learners confusion between some L1-L2 phonemes that partially share similar phonetic features. The phonetic categories of the L1 are powerful attractors of L2 phonemes, especially in initial stages of L2 learning, which can be seen in the current study in the frequency of errors from beginners compared to intermediate and advanced learners. The results reinforced the SLM claim that says the more similar the L2 phonemes are to the phonemes of the L1, the more difficult it is to pronounce them (Burgos et al., 2014; Flege, 1995). An example in the current study can be found in the production of the pharyngealised fricative /sˤ/, which had a great number of errors among fricatives. This sound has an equivalent /s/ in Mandarin, Urdu and Tagalog, which shares the same distinctive features except the pharyngealisation feature that is missing in these three languages phonological space.

In general, the participants from the three proficiency levels and language backgrounds involved in the current study tended to fall back on their L1 phonemes. They produced some L2 sounds using L1 phonetic segments. The SLM here was discussed to reveal the role of learners' language background in acquiring Arabic fricatives and to briefly explain why L2 learners of Arabic in this current study mispronounced some fricative sounds that are similar but not identical to L1.

Many studies demonstrated that MDH was able to predict difficulty in learning L2 sounds based on their frequency in the world languages (Eckman, 1985; Hume, 2003; Major, 1987). It supported the notion of CAH by adding a relative degree of difficulty of each L2 phoneme or sound feature that partially or completely differs from L1s phonetic system (Eckman, 1977). It is found in the current study that some similar but not identical L1-L2 sounds were pronounced accurately from L2 learners of Arabic such as /z/ and /f/ although the CA between Arabic and Mandarin and Tagalog showed that these sounds could pose pronunciation difficulty. The results of the current study were congruent with MDH and showed that marked sounds such as the pharyngeal and pharyngealised fricatives /ħ, ʕ, sˤ, ðˤ/ were more difficult to pronounce than unmarked sounds, such as /z/ and /ʃ/.

The next sections discuss three kinds of production; the first one result from highly similar L1-L2 sounds, which led to positive transfer, the second one was the L2 sounds that do not exist in learners' L1s but were pronounced correctly and the third one result from different L1-L2 sounds, which led to negative transfer.

6.3.1 The Easy Production of Highly Similar L1-L2 Sounds

The findings demonstrated that Arabic fricative sounds that existed in Mandarin (/f/, /s/, /χ/), Urdu (/f/, /s/, /ʃ/, /χ/, /ɣ/) and Tagalog (/s/, /ʃ/, /h/) did not pose pronunciation difficulties to Mandarin, Urdu and Tagalog speakers. Positive transfer can be seen with these sounds which mainly occurred because of L1-L2 sounds' conformity (Broselow, 1984; Flores & Rodríguez, 2015; Odlin, 1989; Rustipa, 2011).

Based on the Contrastive Analysis that was conducted in Chapter Three, Section 3.7, these sounds were predicted to pose no difficulties to Mandarin, Urdu and Tagalog native speakers and L2 learners of Arabic due to the existence of these sounds in their native languages (Aoyama, Flege, Guion, Akahane-Yamada, & Yamada, 2004; Flege, 1995; James, 1980). These sounds mentioned above and the sounds in learners' native language are phonetically related to one another, and the L2 categories for these sounds were already established (Flege, 1987a; Flege, 1995; Schmidt, 1996). Therefore, the results confirmed that the highly similar sounds in Arabic and the three languages did not pose any difficulty to L2 learners in the three proficiency levels which concurred with the SLM.

6.3.2 The Easy Production of Different L1-L2 Sounds

The findings demonstrated that some Arabic fricative sounds that are missing in Mandarin /z, ʃ, h/ and Tagalog /z, f/ did not pose pronunciation difficulties to Mandarin and Tagalog speakers respectively. Apparently, there was no transfer in this situation, which showed that L1 transfer (or L1 background) is not the only cause for the presence of errors. However, two supporting hypotheses can be inferred in this case; the SLM and the MDH.

First, the SLM proposes that as these L2 novel sounds do not appear at all in the learners' native languages, and do not overlap and share similarities with other L1 phoneme categories, they are likely to be easier to acquire than sounds which do have overlap with existing L1 categories and that resulted in successful production (Flege, 1987b; Flege, 1995; Munro & Derwing, 2008). The successful production of fricatives that were different from learners' native languages suggested that these phonemes were not assimilated by L2 learners to their L1 phonemes, and, as predicted by the SLM, this appears to have created a new phonetic category for these sounds that do not overlap with any L1 or L2 sounds.

Second, despite the difference in the L1 backgrounds between the three language groups, they showed similar production patterns, in terms of frequencies, when producing these particular sounds. MDH explained that there are some sounds that are more easily acquired than other sounds (Eckman, 1985). The criteria of sounds' acquisition difficulties are governed by the universality of their features and whether they are learnable with no or minimum efforts and guidance (Eckman, 1977, 1985; Rutherford, 1982).

One of the unmarked sounds that are easily acquired, according to the MDH, are the coronal sounds that are pronounced by raising the tongue towards the hard palate of the teeth in the frontal part of the mouth (Paradis & Prunet, 1991). The coronal sounds in this study are /s/, /z/, /ʃ/, /ð/, /θ/, /sˤ/ and /ðˤ/. All participants pronounced the sounds /s/, /z/ and /ʃ/ correctly. Urdu speakers had less difficulty with /ð/ and /θ/ than Mandarin and Tagalog speakers. The glottal sound /h/ did not receive any errors from Mandarin speakers although it is missing from Mandarin phonetic system. However, it is considered easy to learn according to previous studies, which indicated that the Arabic sound /h/ does not pose pronunciation difficulties for native speakers of other languages (Alsulaiman et al., 2014; Shehata, 2015).

However, it remained uncertain whether learners had these phonemes in their phonological space before their enrolment in the Arabic programme since their exposure to other languages or dialects was not carefully examined. Hence, the shortcoming of investigating leaners language backgrounds in this current study prevented us from detecting whether the easiness of these sounds is relative to universals of Markedness or learners' language experience. Yet, the data that were gathered from the self-report background questionnaire indicated that all the 46 learners did not speak languages other than their native languages, except seven Urdu speakers who spoke English at an unknown level of proficiency. This indicated that

Arabic could be their L3. Therefore, it can be said that the prior exposure to English may have influenced the learners' performance in pronouncing Arabic sounds, as discussed in the Literature Review Chapter in Section 2.6.1.2. That is, Urdu speakers (n=7) who learnt English before Arabic may have already constructed new phonetic categories for the dental fricative sounds /ð/ and /θ/, which are missing in their native language.

6.3.3 Difficulty in the Production of Different L1-L2 Sounds

The findings demonstrated that there are other Arabic fricative sounds that are missing in Mandarin /ɣ, ð, θ, ħ, ʕ, sˤ, ðˤ/, Urdu /ð, θ, ħ, ʕ, sˤ, ðˤ/ and Tagalog /χ, ɣ, ð, θ, ħ, ʕ, sˤ, ðˤ/ and posed considerable difficulty to Mandarin, Urdu and Tagalog speakers. The sounds /ð/, /θ/, /sˤ/ and /ðˤ/ received pronunciation errors in the current study although they are coronal sounds, which contradicts the concept of MDH discussed in the previous section.

First, the sounds /ð/ and /θ/ are considered marked sounds based on MDH and posed pronunciation problems in this study. Wester, Gilbers, and Lowie (2007) mentioned that these two sounds are relatively rare in languages of the world, only being found in 7% of languages. Many previous pedagogical studies that targeted English consonants found that /ð/ and /θ/ were difficult for many L2 learners, e.g., Japanese speakers (Bada, 2001; Saito, 2011b), French speakers (Jamieson & Morosan, 1986; Picard, 2002), Dutch speakers (Wester et al., 2007), Chinese speakers (Deterding, 2006) and speakers of other languages.

Second, regarding the sounds /sˤ/ and /ðˤ/, [+pharyngealisation] is the distinctive feature that distinguishes these sounds. The pharyngealisation is considered marked based on MDH and rare in the languages of the world (Amayreh, 2003; Norman, 1994). The rarity of these pharyngealised sounds could, therefore, result in pronunciation difficulties among L2 learners due to the lack of this distinctive feature in their L1s.

Participants produced a high number of errors in the production of the pharyngeal sounds /ħ/ and /ʕ/. Due to their difficulties in pronunciation, they have often been observed to be late acquired in L1 by native Arabic-speaking children (Al Amayreh, 1994; Amayreh, 2003; Amayreh & Dyson, 1998, 2000; Dyson & Amayreh, 2000). Furthermore, based on the MDH, pharyngeal places of articulation are marked (Colarusso, 1985; De Lacy, 2007).

As discussed in Chapter Two, the SLM suggested that learners would find pronunciation difficulty if the sounds in L1 and L2 are similar in some features but not identical (Flege, 1995). These target sounds have corresponding sounds in learners' native languages that share similar place or manner of articulation. For example, for Mandarin speakers, both Arabic /ɣ/ and /χ/ might be assimilated to Mandarin /χ/, resulting in difficulty pronouncing the Arabic /ɣ/. For Urdu and Tagalog speakers, both Arabic /ħ/ and /h/ might be assimilated to Tagalog and Urdu /h/, resulting in difficulty pronouncing the Arabic /ħ/. The same explanation applies to the pharyngealised sound /sˤ/ that has the equivalent /s/ in the three languages. The results here supported the SLM with regard to the difficulty of similar but not identical L1-L2 fricative sounds.

The results showed that some of these very different L1-L2 sounds were even more difficult in pronunciation than L1-L2 similar sounds. For example, the sound /ðˤ/, which is different from any sound in the three languages, received more errors than the sound /sˤ/, which is similar to the sound /s/ in the three languages.

MDH might have an influence here on learners' production of different L1-L2 sounds. These Arabic sounds that are different from learners' L1s hold uncommon characteristics among world languages and considered, to a great extent, marked (Eckman, 1977; Hume, 2003). The MDH might be able to account for the difficulty of Arabic sounds that are very different from learners' L1s. The results showed that the relative degree of difficulty corresponded to the relative degree of Markedness (De Jong, Silbert, & Park, 2009). By comparing between the difficult fricatives here, it was found that the sounds /ð/ and /θ/ are less marked and had less errors than the sounds /χ/ and /ɣ/, which, in turn, are less marked and had less errors than the sounds /ħ/ and /ʕ/. The pharyngealised sounds /sˤ/ and /ðˤ/ are the most marked sounds among these fricatives and had the highest number of errors. Therefore, determining the degree of sounds difficulty does not only depend on the distance between L1-L2 sound categories and the phonetic and articulatory features but also on the level of Markedness and other factors such as frequency.

Overall, the results suggested a noticeable role of the learners' language backgrounds and the existence of language transfer. The findings of the current study agreed with the findings obtained by Shehata (2015), who demonstrated that Arabic sounds that exist in learners' native languages were considered easy to learn. Furthermore, the results obtained here were reminiscent of those obtained by Alsulaiman et al. (2014). Their analysis of non-native speakers of Arabic pronunciation of all Arabic sounds suggested that pharyngeal and pharyngealised sounds were the most difficult sounds to pronounce by non-native speakers of Arabic.

6.4 Degrees of Difficulty in the Production of Arabic Fricatives

This section answers the first research question regarding the amount of pronunciation difficulties that fricative sounds pose to L2 learners of Arabic. According to the comparisons of the mean scores between fricatives in Section 5.2.1, Arabic fricatives can be classified into three main groups in terms of the degree of pronunciation difficulty: most difficult (/ħ/, /ʕ/, /sˤ/, /ðˤ/), moderately difficult (/χ/, /ɣ/, /ð/, /θ/) and least difficult fricatives (/s/, /z/, /f/, /ʃ/, /h/). Explanation of each group of fricatives is provided next.

First, the frequency of errors in this study showed that both pharyngeal fricatives /ħ/ and /ʕ/ and pharyngealised fricatives /sˤ/ and /ðˤ/ belong to the most difficult group of sounds. They can be considered the most challenging fricatives (75.2% of errors in total). This finding was consistent with other studies that have emphasised the difficulty in the acquisition of both pharyngeal and pharyngealised consonants (Abdul-Kadir & Sudirman, 2011; Al Mahmoud, 2013; Alsulaiman et al., 2014; Alwabari, 2013).

Second, interdental fricatives /ð/ and /θ/ and uvular fricatives /χ/ and /ɣ/ belong to the moderately difficult group; the overall number of errors was 24.8%. Learners' number of errors indicated that uvular and interdental fricatives were significantly easier to acquire than those in the first group. The data obtained in the current study showed that interdental fricative sounds received more errors than uvular fricative sounds, but they were not significantly different, which made them share the same level of difficulty. It must be taken into account that the classification in the degree of difficulty of these sounds mainly depends on learners' language backgrounds. More specifically, Shehata (2015) showed through surveying a number of American learners of Arabic that uvular sounds were thought to be moderately difficult, while interdental sounds were easy to learn because English has the interdental sounds /ð/ and /θ/.

Third, the least difficult group included all fricatives that did not receive any pronunciation errors (/s/, /z/, /f/, /ʃ/, /h/). Those sounds were also found to be the easiest sounds for Arabic L2 learners in a number of studies (Abdul-Kadir & Sudirman, 2011; Alsulaiman et al., 2014; Shehata, 2015).

To answer the first research question in the current study from data that contained the pronunciation of fricatives from 46 L2 learners of Arabic from three different language backgrounds and proficiency levels, it was found that the difficulty ranged from none to substantial. The main reason that governed the difficulty of these sounds was learners' L1s. The sounds that posed no difficulties either existed in the three languages or are universally unmarked and easily acquired. The sounds that posed difficulties were considered marked sounds based on MDH, and what made these sounds more difficult was that they shared similarities in their phonetic features with certain L1 sounds.

Notwithstanding that learners in this study varied regarding their proficiency levels and the number of years they have lived in Arabic countries and studied Arabic, their pronunciation errors revealed that the pharyngeal and pharyngealised fricatives were the most difficult fricative sounds to pronounce. The pharyngealised sounds received the major pronunciation errors from speakers in all three language groups and proficiency levels. To the knowledge of the researcher, no previous studies have extensively investigated these sounds in L2 Arabic production, and so this forms the basis of the second investigation presented in this thesis.

6.5 The Differences in Efficacy Between Technology Instruction and Traditional Instruction

The Study 1 experiment included testing two different approaches in teaching the Arabic fricatives; traditional and technology. The technology group was taught by using speech visual forms that represent visual information of the sounds properties through Praat software. The traditional group, on the other hand, received traditional instruction using minimal pairs training, reading aloud and repetition techniques. The participants received explicit interpretations of the shape of sounds and their counterparts to enhance their understanding and to make distinctions between them.

The second research question asked whether technology instruction in teaching L2 phonetics would improve learners' ability to produce accurate fricative sounds in comparison with traditional-based instruction. The results showed a major improvement from both groups in the pronunciation of each fricative at the end of the five days' course. The results also served to confirm the efficacy of the technological form-focused teaching approach using Praat in effectively achieving pedagogical aims, in support of studies such as Olson (2014), Offerman and Olson (2016) and Gorjian et al. (2013), but not that using technology produced significantly better results than traditional methods.

Explicitly, based on the generally positive effects of using visual speech analysis tools in teaching pronunciation found in the literature (Gorjian et al., 2013; Le & Brook, 2011; Offerman & Olson, 2016; Olson, 2014; Shimizu & Taniguchi, 2005;

Taniguchi & Abberton, 1999), it was assumed that technology-based instruction that included using visual representation of sounds would prove beneficial for learners' pronunciation of fricatives. However, while there was an overall improvement in the learners' production of fricatives, the data did not show that the technology-based instruction outperformed traditional based-instruction.

The current study replicated much of what had been reported in previous pronunciation research. Even though the procedure and instruction followed in this experiment resembled the study of Offerman and Olson (2016) to some extent, the results obtained from the current study were different. The next paragraphs explain the differences between this current study and Offerman and Olson (2016), who used the same tool of pronunciation instruction (i.e., Praat) but received relatively different results from the current study.

Offerman and Olson (2016) and this current study investigated the same teaching approach and the usefulness of Praat in teaching pronunciation. However, Offerman and Olson focused on teaching 17 English native speakers the VOT of Spanish intervocalic stops [p, t, k]. Their study involved experimental and control groups. The experimental group received explicit pronunciation training including repetition, recasts, clarification requests and explicit correction and the control group did not receive any explicit pronunciation training. The significant difference that was found between the two groups in their study could be a result of not giving any explicit pronunciation training to the control group. The experimental group was a big step ahead from the control group by receiving explicit instruction plus visual feedback, while the control group did not receive any pronunciation training outside of what is usually found in language teaching classrooms (which, as discussed earlier, is usually minimal if present at all).

Unlike the study of Offerman and Olson (2016), this current study treated the two groups similarly by giving them the same type of instruction (i.e., explicit form-focused instruction) including feedback. The only difference experienced by the two groups is the use of visual representation of speech rather than explaining, listening and repeating after the instructor.

What the current study added to the study of Offerman and Olson (2016) was that the improvement in participants' pronunciation in this study might due to the interpretation of the characteristics of sounds and not to their visual shapes on Praat. To put it another way, the role of speech visual displays alone might not have contributed to accurate production of fricative sounds, as the explanations of the properties of sounds and repeating the sounds many times – which took place in both groups – helped the participants improve as well. Nevertheless, this result cannot be confirmed without the use of a control group to test whether the explicit instruction is the significant factor for increasing students' learning gains.

It should be noted that the traditional group did not involve working as a whole class and that students in both groups worked individually. There were no classroom activities involving interaction between learners, and the interaction was only between the learner and the instructor in the traditional group and between the learner and the instructor and Praat in the technology group. Each learner in both groups worked independently and did not communicate with other classmates in the training sessions.

The current study was the first study that showed the potential usefulness for speech analysis software on the pronunciation learning of Arabic sounds. Moreover, while many of the previous research in speech analysis pronunciation teaching have either focused on teaching suprasegmentals (Gorjian et al., 2013; Le & Brook, 2011) or concerned advanced learners (Lord, 2005; Saito, 2007), this study illuminated the effect of visual forms on teaching segmentals to all proficiency levels from beginners to advanced L2 learners.

This study addressed previous calls for more research in implementing the visual acoustic forms in teaching segmentals (Chun, 2007; Offerman & Olson, 2016; Olson, 2014). The initial results gained from this study suggested that the use of Praat in teaching pronunciation could be practical and convenient for L2 learners at different proficiency levels. This tool can be added to pronunciation teaching materials and can be one of the supportive techniques to provide information about some intangible sound features.

6.6 Limitations of Study 1

There were several limitations of the study, which may limit the generalisability of the findings. The present study included a sample of 46 female Arabic learners who spoke three different languages and attended Princess Nora University in Saudi Arabia at the time of the data collection. The sample size was small with large variations among samples, which prevented getting enough data or adding a control group. This was due to the difficulty finding groups of students who share similar language backgrounds and proficiency levels in the institution. The results cannot, therefore, be generalised to make inferences about all learners of Arabic. The selection of groups was not completely random as it was attempted to assign groups based on learners' language backgrounds and proficiency levels. The external variables and individual differences were not controlled or discussed in this initial study. Furthermore, the majority of the participants were from upper-intermediate and advanced levels of proficiency, which made the results limited to experienced Arabic learners only. Only one student who spoke Mandarin and two students who spoke Urdu were found in the beginner level in the institution at the time of collecting the data.

The data was collected through recordings of limited number of words, which contained the target fricatives; this is not enough to judge learners' production in a number of contexts. The data were obtained through two small tests with single words and not through natural conversations or words with carrier phrases. The researcher was given very limited time and resources to do her study in the institution with only one and a half hours per day over a period of two weeks.

The researcher was involved as a teacher in giving the instructions for the technology group only, which may raise 'Pygmalion effect'. Maclachlan (1993, p. 167) defined 'Pygmalion effect' as "the likelihood that a teacher's expectations of a pupil's performance will shape the pupil's behaviour to coincide with the teacher's expectations" (p. 167). Additionally, having different instructors for each group has the disadvantage of controlling for instructor effects. To reduce any potential bias, someone else, other than the researcher, rated participants' performances in the pre- and post-tests.

In terms of Praat, the pronunciation training cannot be done without instruction and feedback from the teacher, and the time taken for training on Praat was only one and a half hours. In the training sessions, the instructions were given in Arabic and beginners were treated the same as advanced learners, which may have affected beginners' understanding. Although it was taken into account the necessity to use simple Arabic words and sentences, it was not guaranteed that beginners have completely understood Arabic vocabularies used in the training sessions. Unfortunately, this study was not followed by a survey to question learners' understanding after the training sessions. The study was limited to the examination of the effects of Praat and traditional methods on pronouncing certain sounds. Hence, it is unlikely that the results can be generalised to the production of other sounds or other pronunciation teaching programs or approaches.

6.7 Conclusion

This exploratory study has attempted to address the areas of difficulties in the production of Arabic fricatives by L2 learners of Arabic. The results revealed that not all fricatives posed problems to L2 learners of Arabic, the least challenging sounds being those that exist in their native languages and the sounds that are considered universally unmarked.

It can be concluded that pharyngeal and pharyngealised sounds poses major problems to some L2 learners of Arabic. L2 learners find difficulties in distinguishing between pharyngealised and non-pharyngealised sounds. The role of the L1 adds confusion to the learners as the L1 phonological space of L2 learners plays a great role in the production of L2 sounds.

The need of systematic pedagogical tools for Arabic pronunciation instruction was met by planning and conducting this experiment that covered different proficiency levels of L2 learners. The results demonstrated that speech analysis can be effective at segmental level of sounds and the efficacy of using it is the same or slightly better than the traditional methods. Further investigation about the differences between the technology-based and traditional-based instruction are presented in the next chapters.

6.8 Preface and Rationale for Conducting Study 2

The investigations in the main study, which follow, include the functionality and outcomes of using Praat in teaching only the pharyngealised sounds. The reasons for limiting the experiment to include only the pharyngealisation and expanding the investigations and analysis to include multiple variables are presented and discussed in this section. As shown in the previous chapter, the results indicated that there were pronunciation difficulties among L2 learners of Arabic speaking different languages, specifically in the production of the Arabic fricative pharyngealised sounds.

A number of aspects from the results of Study 1 helped in shaping and expanding the research questions and methodology for Study 2. First, the results from Study 1 showed that the major errors among all Arabic fricatives were in the emphatic fricative sounds /sˤ/ and /ðˤ/. The emphatic sounds /sˤ/ and /ðˤ/ were substituted for the non-emphatic sounds /s/ and /ð/ by the majority of learners. As mentioned in the Literature Review Chapter, what distinguishes the emphatic fricatives among all fricative sounds is the pharyngealisation feature that affects the neighbouring vowels. The shapes of the emphatic fricatives /sˤ/ and /ðˤ/ in spectrograms were not significantly different than the non-emphatics /s/ and /ð/. However, the adjacent vowels for the emphatics can be clearly distinguished from the non-emphatics because of the visible degree of F2 lowering in the spectrogram. This feature can also be seen in the emphatic stops /tˤ/ and

/dˤ/, which share similar phonetic features with the non-emphatic stops /t/ and /d/ except in the pharyngealisation. Therefore, it is interesting to include all the Arabic pharyngealised sounds, including all the four emphatics /sˤ/, /ðˤ/, /tˤ/ and /dˤ/, in the three vowels contexts /_ɑ/, /_ʊ/ and /_ɨ/ in Study 2.

Second, the results from Study 1 showed differences in the production of the fricative sounds based on learners' L1s. The influence of L1 on the acquisition of L2 is well known and discussed widely in the field of SLA (Cook, 2003; Crowther, Trofimovich, Saito, & Isaacs, 2015; Derwing & Munro, 2013; Feldman & Healy, 2013; Ortega, 2013). Nevertheless, there is no study that provides data that shows differences in the L2 learners' pronunciation of Arabic pharyngealised sounds based on learners' language backgrounds. Therefore, the influence of the language backgrounds on L2 learners of Arabic pronunciation of pharyngealised sounds was examined in Study 2 to demonstrate to Arabic language researchers and teachers the influence of one of the major causes of individual variations between learners. Knowing the influence of learners' language backgrounds on learners' pronunciation of emphatics can lead Arabic teachers to understand the causes of some pronunciation errors and help them to be focused in dealing with different kinds of L2 learners.

Third, Study 1 tested learners' production of sounds before and after pronunciation instruction. In fact, many studies have shown a strong relationship between speech perception and production (Baese-Berk, 2016; Saito, 2013a). Other studies have demonstrated that perception must precede production (Escudero, 2007). The training courses in Study 1 aimed at enriching learners' knowledge of sound features by giving form-focused pronunciation instruction. Study 1 did not measure the perception of the sounds examined, although it was necessary to track learners' understanding of sounds before and after training. Study 2 included the investigation of the perception of pharyngealised sounds and studied learners' progress in discriminating sound features before and after the training courses.

Fourth, the results of Study 1 showed that most pronunciation errors came from learners in the beginner level of proficiency in both pre-and post-tests. On the contrary, advanced L2 learners of Arabic made few errors compared to intermediate and beginner learners. This issue of proficiency levels has to be addressed in depth regarding perceiving and producing the pharyngealised sounds among learners of Arabic. Furthermore, the effect of speech analysis technology on different proficiency levels has to be investigated to measure learners' performance with respect to their levels of proficiency and whether this teaching method, in comparison with a more traditional approach, is more suitable for specific proficiency levels.

Fifth, Study 1 focused only on one question concerning the differences in the pronunciation of fricatives after being exposed to one of the two types of training: the traditional teaching method, and the technology teaching method using speech analysis technology. Study 2 provided further details about the impact of this technological tool on learners from different language backgrounds and different proficiency levels by conducting this experiment on speakers of Mandarin, Urdu and English who are in three different proficiency levels, beginners, intermediate and advanced. The purpose of doing this is to explore the performance of each language group and proficiency level to know if this method is beneficial to different types of learners. It also investigated the power of using this technology in teaching specific phonological environments and whether learners benefited more from using it with certain vowel contexts.

6.9 Summary of Chapter

This chapter has attempted to discuss the findings in relation to the initial research questions of Study 1. First, learners' errors and their relationship to learners' native languages were discussed. Second, the difficulty levels in the pronunciation of fricatives were explained based on learners' number of errors of each fricative. The difference in the outcomes between traditional-based and technology-based instruction in enhancing learners' pronunciation of fricatives was discussed and supported by previous studies. The limitations of the study were also discussed in this chapter. The last section presented the conclusion, which summarised the main findings of this initial study followed by a preface and a rationale for conducting Study 2.

CHAPTER SEVEN

METHODOLOGY FOR STUDY 2

7.1 Introduction

The main purpose of this study was to investigate two aspects: (1) the accuracy of speech perception and production of the Arabic pharyngealised sounds among L2 learners of Arabic; and (2) the efficiency of using speech analysis technology in improving learners' perception and production of these sounds. The previous three chapters presented and discussed the methodology and results of Study 1 that was conducted initially to examine learners' production errors and performance before and after using speech analysis technology in learning the pronunciation of fricatives.

This chapter presents the methodology of Study 2 that was conducted, based on the established experimental paradigm in Study 1, but with further modifications and additions. As shown in the previous chapter, the results indicated that there were pronunciation difficulties among L2 learners of Arabic speaking different languages, specifically, in the production of the Arabic fricative pharyngealised sounds.

Looking at the research method used in the exploratory study, it can be seen that some limitations have affected the reliability and validity of Study 1, which were addressed previously in Chapter Six. Some of these limitations were addressed and carefully examined in Study 2.

This chapter describes the methodology for Study 2. The research framework for Study 1 was followed for Study 2 and is presented in Chapter Four. Similar to Study 1, the quasi-experimental design presented in Chapter Four was applied in Study 2 because of the lack of randomisation of sample selection. Furthermore, the data was collected from the same institution as Study 1. Information about the Arabic language institute at Princess Nourah University is presented in Chapter Four.

The next sections provide details about the main research questions for Study 2, participants, materials, procedure, data collection and data analysis. It also shows the procedure of conducting a pilot study and discusses the validity and reliability of the materials, tests, and procedure, along with inter-rater reliability.

7.2 Research Questions

The research questions for Study 2 are:

1- What are the frequency and type of errors perceived and produced by L2 learners of Arabic in pronouncing the Arabic pharyngealised sounds:
   a) in different phonological environments,
   b) in different proficiency levels, and
   c) from different L1 backgrounds?

2- Do traditional form-focused instruction and technology form-focused instruction have different effects on L2 learners' learning of Arabic emphatics across different vowel contexts?

3- To what extent do traditional form-focused instruction and technology form-focused instruction affect the perception and production of emphatics on L2 learners of Arabic in different language groups and proficiency levels?

7.3 Ethical Consideration

The same approval for Study 1 was used in Study 2 from the university's research ethics committee (see Appendix A). Moreover, an approval letter was received from the Deanship of Scientific Research at Princess Nourah University to perform the experiment on students of the Arabic linguistic institute (see Appendix F). At the end of the study, a confirmation letter was received from the Deanship, confirming the completion of the study (see Appendix G).

Participants were informed initially through an introduction meeting and the questionnaire that their participation was voluntary and would in no way affect their grades. A consent form was given to the participants, containing an explanation of the purpose and procedure of the study (see Appendix D).

7.4 Participants

The participants for Study 2 were 38 female students of Arabic who were all enrolled in the Arabic linguistic institute at Princess Nourah University in Saudi Arabia at the time of collecting the data in April 2016. As mentioned previously in Study 1, this institution is intended for female students only, and we could not obtain access to male participants for religious and cultural reasons. The small number of participants was due to the difficulty finding students with similar language backgrounds in the institution.

The information which follows is based on participants' responses to a questionnaire.

The participants' ages ranged from 20 to 26 years old and they were from elementary, intermediate and advanced levels of Arabic proficiency. The time they had spent studying Arabic in Saudi Arabia ranged from three months to more than three years.

Islam was the major motivation for participants to learn Arabic. Moreover, three participants were intending to study for a bachelor's degree at Princess Nourah University after they finished their Arabic course. Participants mostly used their native languages on a daily basis.

The participants were from China, India, the United Kingdom and the United States. 14 Urdu speakers, 13 Mandarin speakers, and 11 English speakers were selected to participate in the study. An attempt was made for Study 1 and 2 to be similar in participant numbers and language backgrounds. However, securing the same number and language backgrounds of participants was impossible, due to difficulties in finding enough participants for Study 2 that were not involved in Study 1. Moreover, there were not enough Filipino participants in the institute, as the majority of them had graduated in 2015. Therefore, it was decided to replace Filipino participants with English participants. In the end, all participants were new to the study and had not been involved in any way in Study 1.

Mandarin, Urdu and English were chosen because they were the majority languages in the institution at the time of collecting the data in 2016. Furthermore, these three languages do not have the pharyngealised sounds in their phonemic inventories or pharyngealised allophones.

Based on the self-reported background questionnaire, a few of the Mandarin and Urdu native speakers spoke English in addition to their native languages and Arabic. The participants have come from their countries temporarily, having obtained a scholarship from Princess Nourah University to study Arabic. Their ability to use computers ranged from poor to excellent.

Details of the participants of Study 2 are summarised in Table 7.1.

Background information	**Number of participants**
Gender	Females (n = 38)
Proficiency level	Beginners = 9 Intermediate = 14 Advanced = 15
Age	20-25 = 36 26-30 = 2
Native language	Mandarin = 13 Urdu = 14 English = 11
Other spoken languages	English= 6
Time spent learning Arabic	0-<1 year =10 >1-2 years = 13 >2-3 years = 14 >3 = 1
Time spent in Arabic countries	0-<1 year =17 >1-2 years = 14 >2-3 years = 6 >3 = 1
Language used daily	Native language = 36 Arabic = 2
Motivation for learning Arabic	Islam = 38 Studying an academic degree in Saudi Arabia = 3
Ability to use computers	Poor = 9 Good = 26 Excellent = 3

Table 7.1: Study 2 participants' background information (self-reports)

7.4.1 Group Selection

The 38 participants were divided into two groups. 19 students were assigned in the technology group and 19 in the traditional group (see Table 7.2). The language backgrounds and proficiency levels were taken into account for Study 2 to accurately answer the research questions. The table below shows the number and native languages in each group.

Speakers	Beginner		Intermediate		Advanced	
	Traditional	Technology	Traditional	Technology	Traditional	Technology
Mandarin	2	2	2	1	3	3
Urdu	2	2	3	3	2	2
English	0	1	2	3	3	2
Total	4	5	7	7	8	7

Table 7.2: Number of participants, proficiency levels and language backgrounds in each group

As with Study 1, Study 2 did not include a control group to evaluate learners' outcomes before and after form-focused explicit instruction in comparison with those who had received implicit instruction. This was due to the small size of participants in each group and the difficulty of finding learners with similar language backgrounds. Therefore, this study is solely about comparing the use of traditional and technology techniques in teaching pronunciation and does not offer insights into the benefit of pronunciation instruction in general. As Study 2 did not concern investigating students' learning gain in comparison with students who received no targeted pronunciation instruction, it does not allow us to make a direct comparison to Offerman and Olson's (2016) study, which compared the results for learners who received explicit pronunciation instruction through using Praat with a control group who did not receive explicit pronunciation training (see the Literature Review chapter, Section 2.5.3).

It was decided to assign a traditional group instead of a control group because one of the major purposes of conducting this experiment was to help in facilitating the perception and production of emphatics by using different explicit pronunciation instruction techniques more than revealing only the effect of speech analysis in teaching pronunciation. Furthermore, typical pronunciation teaching classrooms apply one or more of these traditional techniques. Therefore, comparing these commonly used techniques with more modern techniques would be more beneficial than comparing the technology group with learners who did not receive any type of training at all to expose the influence of adding the technology component to the whole traditional teaching pronunciation process. Moreover, the benefit of explicit instruction had already been demonstrated in previous studies, although the focus was not on Arabic L2 learning (Ghorbani et al., 2016; Gordon et al., 2012; Kissling, 2013; Saito, 2007, 2011a).

7.5 Materials for the Training Courses

Most of the materials in Study 1 were used in Study 2 but a number of amendments and additions were made.

7.5.1 The Demographic Information Questionnaire

The same questionnaire as Study 1 was used in Study 2 (see Appendix E). It contained questions about participants' level of proficiency, age, native language, other languages they speak, years spent learning Arabic, years spent in Saudi Arabia, their motivation for learning Arabic and their computer skills. It was believed that the questions in the demographic information questionnaire used in Study 1 about participants' backgrounds were sufficient and suitable to be reused for Study 2.

7.5.2 Teaching Materials for the Traditional Group

Unlike in Study 1, the researcher taught both groups. The materials for the traditional group included four handouts, and each paper had information about the features of one particular pharyngealised sound and its place of articulation. It also contained a picture of the vocal tract, along with examples of sentences, a small passage and minimal pairs (see example Appendix H).

Most of the examples, passages and minimal pairs were taken from the same reference used in Study 1, which was (العربية بين يديك) *Arabic is in your hands* /al ʕrabˈjah bajna yadaik/ (Alfozan et al., 2007).

7.5.3 Teaching Materials for the Technology Group

An introduction presentation for this group was designed, using PowerPoint software, which was the same as Study 1. For the training course, PowerPoint slides were designed for each of the four days. Each slide contained three waveform and spectrogram pictures of three syllables that have the same pharyngealised sound but in three different environments (e.g., [sˤɑ], [sˤʊ], [sˤɨ]) (see example Appendix I). Four sound files were prepared for this group, which contained minimal pairs and isolated syllables that have the emphatic and non-emphatic sounds pronounced by an Arabic native speaker. The words used with the technology group were part of the words used with the traditional group. Table 7.3 shows the Arabic minimal pairs used with the technology group.

Sounds	Words used in Arabic	English translation and transcription
/sˤ/ and /s/	صَفر – سَفر عَصِير- عَسِير صُحُب- سُحُب	/sˤafar/ ‘a name of an Arabic month’ vs. /safar/ ‘travel’ /ʕasˤiːr/ ‘juice’ vs. /ʕasiːr/ ‘difficult’ /sˤuħub/ ‘friends’ vs. /suħub/ ‘clouds’
/dˤ/ and /d/	ضَلال – دَلال دُر- ضُر حَضِيض- حَدِيد	/dˤalaːl/ ‘delusion’ vs. /dalaːl/ ‘pamper’ /dˤur/ ‘harm’ vs. /dur/ ‘pearls’ /ħadˤiːdˤ/ ‘bottom’ vs. /ħadiːd/ ‘iron’
/ðˤ/ and /ð/	ظَرف – ذَرف ناظِر – ناذِر ظُلّل – ذُلّل	/ðˤarf/ ‘envelope’ vs. /ðarf/ ‘shedding’ /naːðˤir/ ‘principle’ vs. /naːðir/ ‘professed’ /ðˤulˈil/ ‘overshadow’ vs. /ðulˈil/ ‘approach’
/tˤ/ and /t/	طابِع – تابِع عاطِي – عاتِي طُحال – تُحال	/tˤaːbiʕ/ ‘stamp’ vs. /taːbiʕ/ ‘follower’ /ʕaːtˤi/ ‘giver’ vs. /ʕaːti/ ‘strong’ /ˤtuħaːl/ ‘spleen’ vs. /tuħaːl/ ‘transmitted’

Table 7.3: Minimal pairs used with the technology group in Study 2

7.6 Procedure and Data Collection

The study began with an introduction about it to the participants. The procedure of the study was explained, and it was clarified that the purpose of the courses was to examine the perception and production of Arabic sounds and it would not affect their grades in any class.

On the first day, the questionnaires were distributed to the participants, and they were asked to step forward after they had finished the questionnaire, to do the perception pre-test. On the following day, the participants took the production pre-test. After examining the information in the questionnaire, the participants were divided into two groups of 19 participants each, based on their native language and proficiency levels. The participants received instructions about the time and the place of the training courses. The traditional group took the training course in a regular classroom and the technology group took the training course in a computer lab.

After four days of training, the participants retook the perception and production tests. The eighth day included taking the perception post-test, which followed the same procedure as the perception pre-test. On the ninth day, participants took the production post-test, which also followed the same method as the production pre-test. Table 7.4 summarises the procedure for Study 2.

Day	Time	Procedure
Tuesday	9-12	Introduction, questionnaire and perception pre-test for both groups
Wednesday	10-12	Production pre-test for both groups
Sunday	10 -12	Training session on using Praat for technology group
Monday	A = 9-10.30 B = 11-12.30	/sˤ/ vs. /s/
Tuesday	A= 9-10.30 B = 11-12.30	/ðˤ/ vs. /ð/
Wednesday	A = 9-10.30 B = 11-12.30	/tˤ/ vs. /t/
Thursday	A = 9-10.30 B = 11-12.30	/dˤ/ vs. /d/
Sunday	10-12	Perception post-test for both groups
Monday	10-12	Production post-test for both groups

A= traditional group, B= technology group

Table 7.4: Summary of the procedure for Study 2

7.6.1 Test Administration

The perception and production pre- and post-tests were administered by means of the DMDX display software, which employed specific scripts and codes designed carefully to fit into the program (see Appendix J). This free software was designed for language-processing experiments. It has the ability to measure reaction time and present texts, audios, graphs and videos (Forster & Forster, 2003). It presents stimuli materials and records participants' responses via keyboard input. It also has the ability to automatically randomise the order of stimuli. A detailed review of DMDX design and the accuracy of results and timing can be referred to in Forster and Forster (2003).

There are many reasons for choosing DMDX software over a number of programs that measure subjects' responses via computer, such as E-Prime (Brunelle, 2011). First and most importantly, it supports and allows Arabic language inputs. Second, it is free software, easy to download and set up, with simple operating system requirements. Third, the scripting language is not difficult, and with the help of a few online resources, the scripts for both perception and production tests were successfully created and managed.

7.6.1.1 Stimuli

The perception and production pre- and post-tests each included 30 Arabic words placed in a carrier phrase, which allowed the words to be pronounced in a more natural way. The carrier phrase was (.... الكلمة هي) 'This word is….' and the reason for placing the words in a carrier phrase was for the purpose of eliciting speech similar to that produced in normal conversation. The idea of placing stimuli in carrier phrases was taken from many studies that tested the perception and production of certain sound patterns (Embarki et al., 2007; Hassan & Esling, 2007; Hawkins & Midgley, 2005; Lipińska, 2013; Na, Yuan, & Bin, 2012; Offerman & Olson, 2016; Strange & Shafer, 2008). The words included either emphatic (e.g. /sˤ/ in /sˤar/ 'became'), non-emphatic (e.g. /s/ in /sar/ 'walk') or unrelated sounds for distraction (e.g. /χ/ in /χabiːr/). Three phrases for each of the eight emphatics and non-emphatics and six phrases which served as distracters were included in the tests. The emphatic and non-emphatic words in the tests were minimal pairs in order to test participants' ability to discriminate between sound contrasts.

The stimuli for all perception and production tests were similar but they were in different and random order for each participant to eliminate some sources of systematic variation such as practice effect (i.e., familiarity with the test) and boredom effect (i.e., tiredness or boredom from having completed the first test) (Field, 2009). Moreover, participants took the perception and production tests on different days. The carrier phrase and words chosen in the tests were all frequently used in Arabic and they had been examined and approved by an experienced L2 Arabic instructor. The words in the tests were not part of the set of words that was included in the training (see Table 7.5).

One of the limitations of this study is the number of tokens used in the tests. Unfortunately, the quantity of tokens was not sufficient to comprehensively judge learners' perceptive and productive skills. The original intention was to conduct follow-up interviews with learners to collect conversational spontaneous speech data and record them reading a small part of the Quran aloud. These had to be cancelled owing to time constraints which were out of the researcher's control, and the necessity to train learners and collect recordings of the target items.

Sounds	**Words in Arabic**	**English translation and transcription**
/sˤa/ and /sa/	صار - سار	/sˤa:r/ 'became' - /sa:r/ 'walk'
/sˤu/ and /su/	صورة - سورة	/sˤu:rah/ 'picture' - su:rah 'verse from Quran'
/sˤi/ and /si/	مصير - مسير	/masˤi:r/ 'fate' - /masi:r/ 'walk'
/ðˤa/ and /ða/	حظر - حذر	/haðˤara/ 'forbid' - /haðara/ 'cautious'
/ðˤu/ and /ðu/	منظور - منذور	/manðˤu:r/ 'perspective' - /manðu:r/ 'promised'
/ðˤi/ and /ði/	نظير - نذير	/naðˤi:r/ 'counterpart' - /naði:r/ 'harbinger'
/dˤa/ and /da/	ضال - دال	/dˤa:l/ 'lost' - /da:l/ 'guided'
/dˤu/ and /du/	موضوع - مودوع	/maudˤu:ʕ/ 'subject' - /maudu:ʕ/ 'deposited'
/dˤi/ and /di/	ناضل - نادل	/na:dˤil/ 'struggle' - /na:dil/ 'waiter'
/tˤa/ and /ta/	طاب - تاب	/tˤa:b/ 'recovered' - /ta:b/ 'repented'
/tˤu/ and /tu/	طُب - تُب	/tˤub/ 'heal' - /tub/ 'repent'
/tˤi/ and /ti/	طين - تين	/tˤi:n/ 'mud' - /ti:n/ 'figs'
Distractors	نحب – نهب عين – أين خبير - كبير	/naħaba/ 'cry' - /nahaba/ 'steal' /ʕain/ 'eye' - /ʔain/ 'where' /χabi:r/ 'expert' - /kabi:r/ 'big'

Table 7.5: Words used in perception and production pre- and post-tests

The auditory stimuli for the perception test were recorded by a 36-year-old female PhD student and native speaker of Arabic who specialises in applied linguistics. Recordings were made in a quiet room digitally directly on to a computer by Praat at a sampling rate of 44100 Hz, 16 bit. The speaker was asked to pronounce the phrases clearly in MSA. After the recording, each uttered phrase was selected and saved separately, then the phrases were coded and embedded in the DMDX software. Two Arabic native speakers (35 and 32 years old), who were instructors at the Arabic linguistic institute at Princess Nourah University and hold a master's degree in applied linguistics listened to the recordings to ensure their clarity and suitability for the perception test.

7.6.1.2 The Perception Pre- and Post-tests

For the perception tests, a forced choice identification task was conducted using the DMDX software. There are other perception measuring tasks that were presented and discussed in the Literature Review Chapter. However, this perception test was chosen because it is simple and serves the main purpose of the study, which is examining perception errors and knowledge of sound contrasts (McGuire, 2010).

All the 30 phrases were presented to the participants using DMDX software on a laptop. Two buttons were labelled on the keyboard by stickers, red and yellow. The participant's name, language background and proficiency level were written as the subject ID prior to starting the test, to facilitate identifying and organising the responses later in the analysis. The test started with Arabic written instructions about the procedure of the test and the way to choose the answers. The English translation of the instructions are:

> "You will hear phrases in Arabic. Two words will appear in the middle of the screen. You have to decide which word you hear: the right or the left word. Press the right red button to choose the right word or press the left yellow button to choose the left word. Press

> SPACE to move to the next sentence. Now press SPACE when you are ready to start the test”.

During the perception test, one audio file was played, producing a phrase, and at the same time, two words appeared on the screen. Participants had unlimited time to think and decide which word they thought they had heard: the left or the right one. After they chose one of the words, they pressed the space bar to move to and listen to the next phrase. At the end of the test, a message appeared, thanking participants for their cooperation. Each participant spent approximately less than five minutes on the perception test.

A limitation of this study is that each participant heard one token per target sound. From a statistical point of view, this increased the possibility of the participants choosing the correct answer by chance. To mitigate this, a more thorough design could involve participants being exposed to the same target sound a larger number of times. This would, however, increase the amount of time need to complete the task, which could lead to participant fatigue.

7.6.1.3 The Production Pre- and Post-tests

The production test used the same stimuli and software as the perception test. Arabic written instructions appeared on the screen at the beginning of this test. The English translation of the instructions are:

> “Arabic sentences will appear on the screen and you are asked to read each one in a very clear and loud voice. Read each sentence twice then press SPACE to move to the next sentence. Your voice will be

recorded. Please keep your head close to the recording. Press SPACE when you are ready to begin the test".

During the production test, the phrases appeared on the screen in a random order for each participant whenever the participant pressed the button SPACE. The recorder used was an Edirol R-09HR, which has a built-in stereo microphone, and the recordings were at a sampling rate of 44100 Hz, 16-bit. The recorder was placed on a desk, in front of the participant at close range, approximately 10-12 cm. Each participant spent approximately three minutes on the production test. After the 30 phrases were shown on the screen, a message appeared at the end of the test, thanking participants for their cooperation.

7.6.2 The Introductory Session for the Technology Group

On the third day, the introductory session was set up for the technology group by giving them a training session about analysing sounds through Praat. Praat was introduced and its features were explained through a projector and PowerPoint slides. Participants were shown steps with pictures about downloading and installing the software, along with creating and opening sound files. Furthermore, instructions about recording new sounds and editing them to visualise waveforms and spectrograms were given to the participants (see Figures 7.1, 7.2 and 7.3).

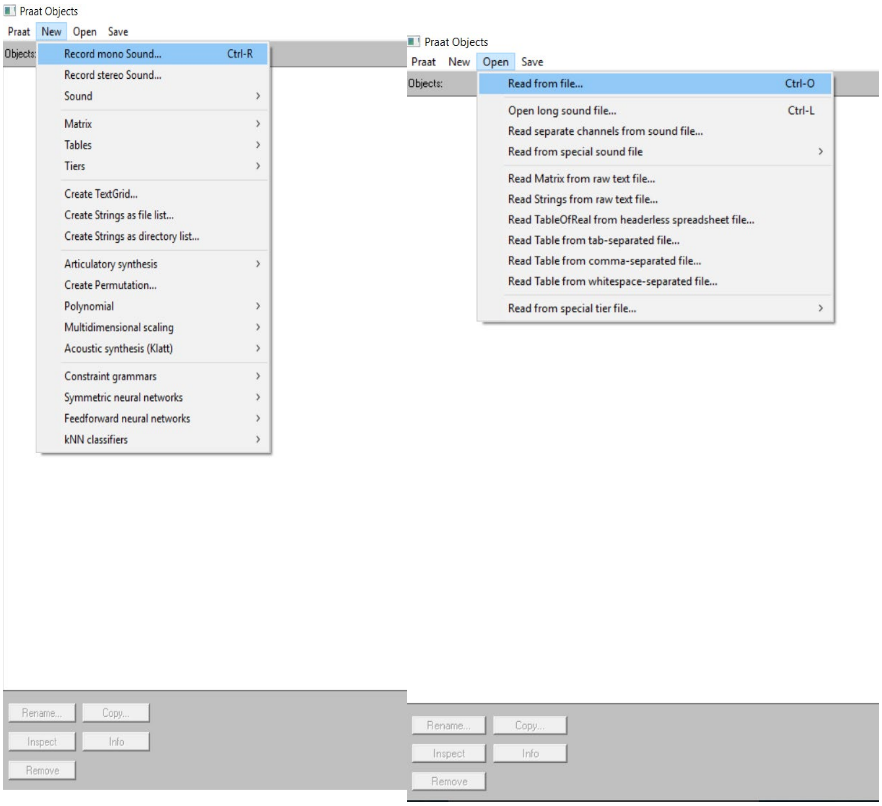


Figure 7.1: Praat screenshot explaining recording and opening sounds

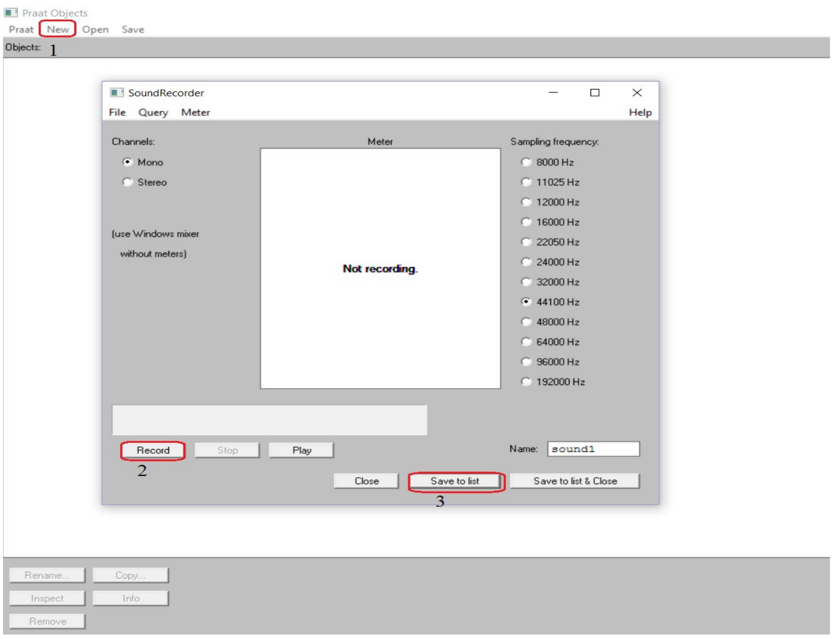


Figure 7.2: Praat screenshot explaining recording a new sound

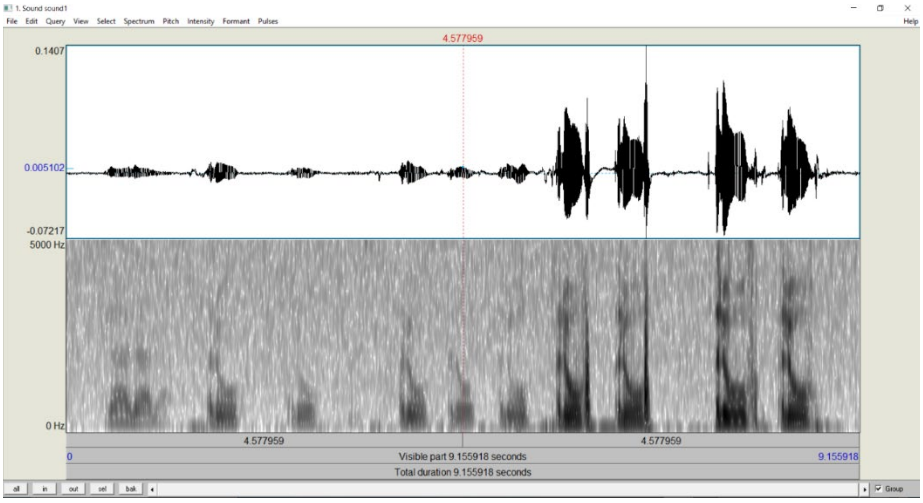


Figure 7.3: Waveform and spectrogram after recording a new sound

The focus was on explaining the spectrograms with regard to two aspects: the intensity and amplitude of the consonants and the lowering formants of the adjacent vowels. The idea was explained to the participants that the sounds that require more pressure and energy to produce are much darker than any other sounds. This point was clarified by providing pictures of spectrograms showing differences between minimal pairs that differed in stress or emphaticness.

The term ‘formants’ was introduced to the participants and was explained by showing how these formants determine the quality of the sounds. The focus was on understanding the position of F2 between two sound contrast that has pharyngealised and non-pharyngealised features and how the F2 lowering affects the quality of the adjacent vowels. The term ‘formants’ was referred to as ‘lines’ /xutˤʊ:tˤ/ in Arabic to facilitate pronouncing and understanding it.

The introductory session took two hours, during which instructions were given in the first hour, and the second hour was for self-learning, allowing participants to work individually, and ask questions. By the end of this introductory session, participants were able to create, open and edit sound files. Moreover, they had the ability to compare two sounds in minimal pairs through spectrograms, based on the intensity and formants of the sounds.

7.6.3 The Training Courses

On the fourth day, both groups started the training course in pharyngealisation. The researcher taught both groups on the same day at different times. The traditional group received instruction only on the emphatic sounds, while the focus in the technology group's sessions was on the emphatic sounds and the adjacent vowels, because the pharyngealised vowels are clearly observable in spectrograms and can be taught through the positions of the F1 and F2. Explaining the difference between pharyngealised and non-pharyngealised vowels verbally to the traditional group could be difficult without visual explanations. Moreover, traditional techniques used in Arabic institutions in Saudi Arabia do not explicitly explain phonological rules in pronunciation classes. In general, Table 7.6 clarifies the techniques used in teaching the pharyngealisation to both groups.

Procedure	Traditional group	Technology group
Technological tools	No	Power point and Praat
Picture of the vocal tract	Yes	Yes
Pictures of analysis of speech	No	Yes
Oral description of the sound features	Yes	Yes
Instructor's feedback	When needed	No
Technology feedback	No	Yes, immediate feedback
Written examples of words and sentences	Yes	Yes
Presenting minimal pairs	Oral presentation	Through pictures of waveforms and spectrograms and audio files of sample sounds opened through Praat
The focus in teaching	The emphatics	The emphatics and adjacent vowels
Reading aloud	Yes	No
Working individually	No	Yes
Repeating after a native speaker	One or two times	As many times as wanted

Table 7.6: Teaching techniques used with the traditional and the technology groups

7.6.3.1 The Traditional Group

The traditional group took the training session in the morning from 9 to 10:30 am. The course was started for the traditional group by introducing the emphatic sound, the way it is pronounced and a picture of the vocal tract showed the position of the tongue. After that, minimal pairs were written on the board and participants were asked to discriminate between them and describe the difference between the two sounds, such as:

/dˤalaːl/ 'delusion' vs. /dalaːl/ 'pamper'

/ðˤarf/ 'envelope' vs. /ðarf/ 'shed'

/tˤaːbiʕ/ 'stamp' vs. /taːbiʕ/ 'follower'

The participants were asked to read aloud sentences and a small passage individually in turn, and feedback was provided when necessary. The participants spent one and a half hours per day for four days reading passages and sentences aloud, discriminating minimal pairs, and receiving verbal pronunciation instructions and feedback.

7.6.3.2 The Technology Group

The technology group took the training session from 11 to 12:30 pm. This group started their training course by being introduced to the emphatic sounds through Praat. The three steps used in the training course included initial self-recording, guided visual analysis, and practice and re-recording (Offerman & Olson, 2016; Olson, 2014).

In the initial self-recording stage, three syllables in isolation and three words (e.g., /sˤɑ/, /sˤʊ/, /sˤɨ/, /qasˤɑd/, /nusˤʊb/, /sˤɨːn/) were given on each of the four days. Participants were asked to record their voices through Praat, then edit the recording to see the visual form.

In the guided visual analysis, sound files of a native speaker pronouncing the same words and syllables were provided. The participants opened these sound files through Praat. Participants were asked to compare both utterances, with regard to the shape of the emphatic and the adjacent vowel. Participants in this stage were aware of the differences in the second formants of the vowels before and after the emphatics. The lowering of the second formant was explained, and pictures of the formants for the emphatic and non-emphatic sound were shown. To enhance participants' understanding, pictures of the vocal tract were used, and the articulation of these sounds was explained to justify the lowering of F2.

The practice and re-recording stage is done by the participants, in which they record the required words again to compare them with the native speaker's spectrograms. This allowed the participants to imitate the pronunciation of the native speaker many times, receive immediate feedback and recognise the differences between the emphatic and non-emphatic sounds and adjacent vowels. In the technology group, the participants spent one and a half hours per day for four days recording their voices, comparing them with the native speaker's voice, receiving immediate feedback many times from Praat, imitating the native speaker's utterances, and recognising the intensity of the emphatics and the F2 of the vowels.

7.7 Piloting the Study

Some parts of Study 2 were piloted to ensure their suitability and appropriateness to be used for a larger sample. The technology training course and the perception and production pre- and post-tests were piloted using a sample of six participants taken from King Saud University in Saudi Arabia. Three Chinese, one American and three Indian learners of Arabic volunteered to receive the training course and were tested both before and after training.

At the beginning of the pilot study, the study was introduced to the participants and their consent was received to take the training course and the tests. Due to the lack of time, the training course took two days, with one hour each day. There was a one-hour introductory session about Praat, prior to the training course on pharyngealisation, which took place in the computer lab.

The whole pilot study took four days, of which two days were for the pre- and post-test, and two days for the training course. The first day included the introductory session, along with the perception and production pre-test. The second day included a training course on Praat with the pharyngealised sounds /sˤ/ and /ðˤ/. The sounds /tˤ/ and /dˤ/ were taught on the third day. An attempt was made to make the training sessions as brief and as informative as possible, due to the lack of time. The last day included the perception and production post-test.

The progress of the participants' behaviour and understanding was observed. The outcome of the pilot study was positive and showed that the materials and the content of the tests used were understandable and applicable. The participants were asked for their oral feedback after taking the post-tests, and they endorsed the usability and feasibility of Praat in learning the pronunciation of the pharyngealised sounds.

7.8 Raters and Inter-rater Reliability

The production pre- and post-test raters, who were secondary school teachers in Saudi Arabia, were obtained through heads of secondary schools in Saudi Arabia and were contacted via email. Sixteen teachers gave their consent to work on the study but only 13 responses were subsequently received. Two uncompleted ratings were excluded and only 11 raters were included in the study.

All raters were adult native speakers of Arabic who hold Bachelor's or Master's degrees in the Arabic language. The reason for choosing raters who specialise in the Arabic language was because of their knowledge and awareness of the accurate pronunciation of MSA, especially Arabic vowels. They worked individually and did not know each other.

The raters were asked to rate all the sounds in the words, not only the emphatic sounds. The ratings included circling the incorrect sounds and writing the sounds they thought they heard.

Each of the 11 raters rated the 38 participants' responses in the production pre- and post-tests (N=76). A total of 836 responses were received from the raters and entered through SPSS to calculate the inter-rater reliability. The circles around the pharyngealised sounds referred to wrong pronunciation and were entered as 1, whereas 0 was entered for the sounds without circles.

In order to calculate the inter-rater reliability of the 11 raters, an intra-class correlation coefficient (ICC) was chosen because it provides a measurement of consistency between multiple raters, while Cohen's kappa calculates agreement between only two raters (McGraw & Wong, 1996). The results of the ICC showed a high degree of reliability between raters' measurements. The average measure of ICC was r_{ICC} =.981, with a 95% confidence interval (α = 0.05) from .971 to .989, F (570.1) = 37).

7.9 Validity of the Study

Many issues were taken into account to assure the validity of this research. In terms of external validity, the ecological validity was affected when the tests were taken individually in a closed room. This may have negatively affected participants' behaviour and made them feel nervous and under pressure. The population validity was affected by the research engaging a small number of participants that represented only three language backgrounds. Teaching Arabic in the two training courses with real-life settings strengthens – to some extent – the ecological validity of results. The participants were taught in conditions that represent real life, and thus, the results can be generalised to real-life conditions. However, the generalisability of the results is not subject solely to ecological validity (Gliner & Morgan, 2000).

In terms of internal validity, although the selection of the participants and groups was not random, an attempt was made to keep the variances between participants equal by conducting the production and perception pre-tests. The phrases in the pre- and post-test were similar in both the perception and production tests, but in randomised order. The reason for the randomisation of the phrases in the tests was to avoid the possibility of affecting validity through memory or sequenced learning influence that might occur if the phrases were precisely equivalent (Kerr, 2012).

A pilot study was conducted prior to conducting Study 2, to ensure the easiness and understanding of the instructions for the tests and the technology training course. Two native speakers of Arabic – who are instructors at the Arabic linguistic institute at Princess Nourah University and hold a master’s degree in applied linguistics – listened to the audio files for the perception test and the sound files for the technology training course and approved their accurateness in pronouncing the Arabic sounds in MSA.

It was decided that the two training courses in Study 2 would be taught by the researcher, in order to maintain the same method in teaching, and to monitor both groups closely. However, this did not allow the two groups to be taught at the same time, so this factor may affect the validity of the courses. The validity of using the three steps in teaching the technology group has been observed and their efficacy has been proved in previous studies (Offerman & Olson, 2016; Olson, 2014). The words chosen for the tests and in the training sessions are frequently used in Arabic and were partially taken from the known Arabic curriculum used in teaching Arabic to L2 learners in Saudi Arabia.

Moreover, the training courses for the pharyngealised sounds were for only four days, one and half hours each day. Although both courses were enriched with instructions and information, it was preferable to keep the training courses short and concise to maintain participants' interest and presence. A long-time commitment for such a study would affect the internal validity or what Dörnyei (2007) called 'mortality' because of the possibility of losing control of participants' attention, presence and other variables.

7.10 Data Analysis

All data was analysed quantitatively via the SPSS Version 22. Participants' level, teaching group and language backgrounds were entered into the SPSS, along with their results in the perception and production tests. Study 2 included several independent variables, which are the teaching methods, vowel contexts, learners' proficiency levels and language backgrounds. All these variables will be investigated thoroughly to answer the research questions.

To obtain the frequency distributions of errors for the pre- and post-tests in SPSS, the correct pronunciation for the production test and choice for the perception test were coded as (0), and the wrong pronunciation and choice were coded as (1).

First, to answer the initial research question, descriptive statistics for the pre-tests results were employed to analyse the frequency and commonality of perception and production errors among L2 learners of Arabic from the three proficiency levels and language groups.

Second, a normality test using the Kolmogorov-Smirnov and Shapiro-Wilk tests was conducted in order to check the integrity of the data analysis. An alpha level of .05 was used for all statistical tests (Bernard & Bernard, 2013). The criterion Alpha (Error in the Significance Hypothesis) for the normality and other statistical tests used in this study was $p \leq 0.05$, or 5%.

The Kolmogorov-Smirnov and Shapiro-Wilk tests failed to support the normality in the data for the number of pharyngealised sounds in the perception and production tests. The distribution of pronunciation errors in the pre-and post-tests significantly departed from normality (see normality results and histograms for Study 2 in Appendix K). Therefore, nonparametric tests were carried out for both perception and production data.

Third, the non-parametric Wilcoxon signed-rank test was conducted to compare related samples (i.e., between the emphatics and the three vowel contexts) to assess their levels of difficulty and whether their means were significantly differing from each other.

Fourth, the non-parametric Kruskal Wallis tests were conducted to reveal significant differences in the number of errors between the three proficiency and language groups. The significant results underwent a Mann-Whitney U pairwise comparison in order to find out exactly where between the groups these differences were. The purpose was to determine whether participants' responses with respect to their levels of proficiency and language backgrounds were significantly different from each other.

Fifth, two types of tests were used in addressing the second research question: the Mann-Whitney U test and the Wilcoxon signed-rank test. The Mann-Whitney U test was conducted to compare the traditional and technology groups after receiving the phonetic instructions. The Wilcoxon signed-rank test, on the other hand, was conducted to measure participants' performance before and after the form-focused phonetic instruction in perception and production of emphatics in the three vowel contexts. Measuring the effect size for each test was necessary to ensure the robustness of the analysis, as suggested by Field (2009).

Finally, the third research question measured the effect of using the technology-based instruction and the traditional-based instruction for enhancing the perception and production of the emphatic sounds between participants who share similar proficiency language groups. Therefore, a Mann-Whitney U test was conducted between equivalent groups who received different pronunciation instruction to confirm the effect each teaching method had on participants' results. The comparisons are also supported by providing tables and graphs that clearly present the differences between the two teaching groups.

7.11 Summary of Chapter

This chapter has provided a description of the methodology for Study 2. The ethical consideration, participants, materials and procedure were presented to illustrate the way the study is constructed. Furthermore, details related to piloting the study were discussed. Towards the end of this chapter, inter-rater reliability scores and the validity of the study were presented, along with descriptions of how the data would be analysed.

CHAPTER EIGHT

RESULTS FOR STUDY 2

8.1 Introduction

This chapter presents the results of the main study that investigated L2 learners of Arabic perception and production of Arabic pharyngealised consonants in different vowel contexts. It also draws a conclusion about the differences in efficacy between form-focused technology-based instruction and form-focused traditional-based instruction in enhancing L2 learners' perception and production of emphatics across different vowel contexts. Thus, this chapter seeks to answer the following research questions:

1- What are the frequency and types of errors perceived and produced by L2 learners of Arabic in pronouncing Arabic pharyngealised sounds:
   a) in different phonological environments,
   b) in different proficiency levels, and
   c) from different language backgrounds?
2- Do traditional form-focused instruction and technology form-focused instruction have different effects on L2 learners' learning of Arabic emphatics across different vowel contexts?
3- To what extent do traditional form-focused instruction and technology form-focused instruction affect the perception and production of emphatics by L2 learners of Arabic in different language groups and proficiency levels?

All the analysed statistical data and the SPSS results are presented in Appendix (K).

8.2 Perception and Production Frequency and Types of Errors

This section provides a descriptive statistical analysis of the perception and production frequency and types of errors from participants in total, and with each proficiency level and language background, in order to answer the first research question. The results presented in this section were taken from the perception and production pre-tests. Perception and production errors were tabulated according to proficiency levels and L1 groups, in order to reveal the degree of difficulty of each emphatic sound across different vowel contexts in L2 learners' performance.

Overall, a total of 456 tokens that had emphatics were perceived and produced by all participants in the three vowel contexts (38 participants × 4 emphatics × 3 phonological environments = 456 tokens). Each emphatic was perceived and produced 114 times (38 participants × 3 phonological environments =114 tokens). From the total number of 456 tokens in perception and production, the results showed that emphatics were misperceived 216 times and mispronounced 203 times. The number of errors of each emphatic sound in perception and production and the substitutions are presented in Table 8.1.

Sounds	Skill	No. occurrence	Total No. errors	M	SD	percentage of errors	Participants production (Substitutions)
/sˤ/	Perception	114	41	1.08	.91	36%	/s/
	Production	114	40	1.05	.96	35%	
/ðˤ/	Perception	114	60	1.58	.97	52%	/ð/ and /z/
	Production	114	53	1.39	1.1	46%	
/dˤ/	Perception	114	43	1.13	.96	37%	/d/ and /ðˤ/
	Production	114	43	1.13	1.16	37.7%	
/tˤ/	Perception	114	72	1.89	.86	63%	/t/
	Production	114	67	1.76	1.31	58.7%	

Table 8.1: Descriptive statistical summary of the perception and production pre-test errors of emphatics

Figures 8.1 and 8.2 present the mean of errors in the perception and production of emphatics from Mandarin, Urdu and English speakers in the three proficiency levels.

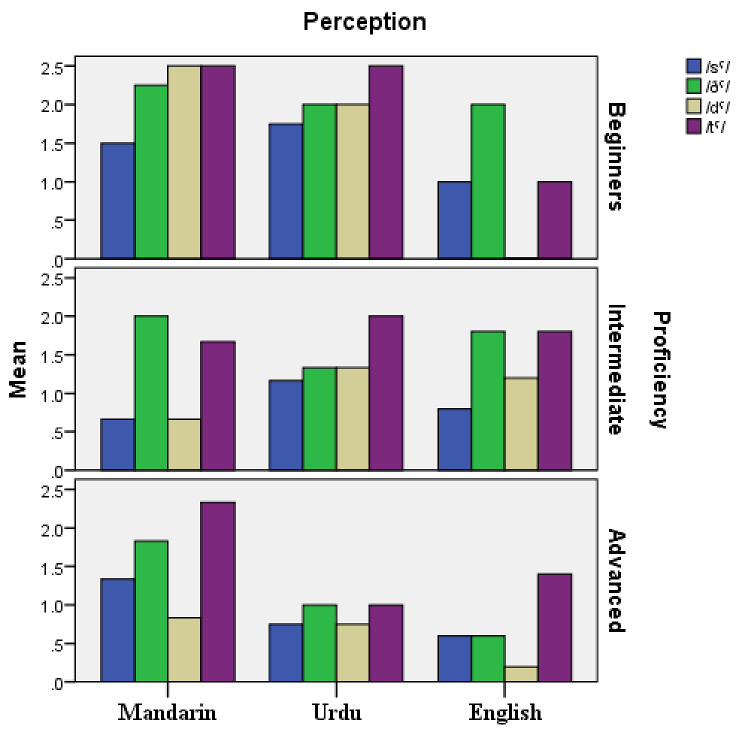


Figure 8.1: Perception pre-test errors of emphatics

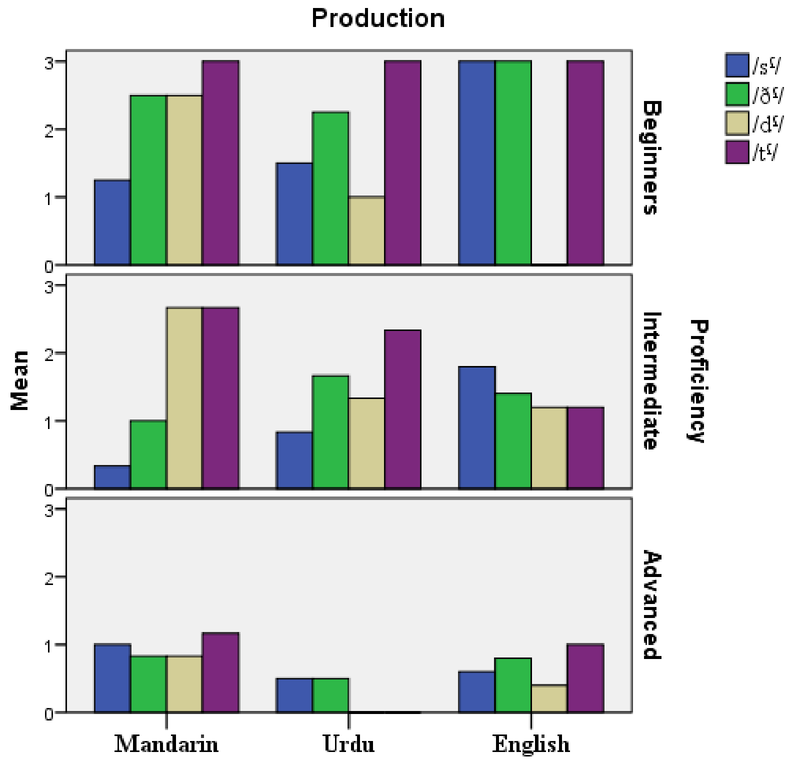


Figure 8.2: Production pre-test errors of emphatics

The next sections analyse in detail participants' errors in perception and production and in the three vowel contexts.

8.2.1 The Perception of the Pharyngealised Consonants

The total number of perception errors for the emphatic stop /tˤ/ was 72 errors (63%). The emphatic fricative /ðˤ/ came in the second place with the number of errors, being misperceived 60 times (52.6%). Fewer errors were found in the perception of the emphatic stop /dˤ/, which had 43 errors (37.7%) and the emphatic fricative /sˤ/, which had 41 errors (36%). A descriptive statistical analysis in the perception of the four emphatics among all participants is summarised in Table 8.2.

Sounds	Participants	No. of errors	Mean	Std. deviation	95% confidence interval for mean	
					Lower Bound	Upper Bound
/sˤ/	38	41	1.08	.91	.78	1.38
/ðˤ/	38	60	1.58	.97	1.26	1.90
/dˤ/	38	43	1.13	.96	.81	1.45
/tˤ/	38	72	1.89	.86	1.61	2.18

Table 8.2: Descriptive statistics of the perception errors of emphatics in the pre-test

The mean and number of errors presented in Table 8.2 showed that L2 learners of Arabic found /tˤ/ the most difficult emphatic sound to perceive, followed by the emphatic /ðˤ/. The emphatics /sˤ/and /dˤ/, on the other hand, received fewer perception errors and were considered the least difficult emphatics to perceive in this study.

8.2.2 The Production of the Pharyngealised Consonants

In terms of production errors, 67 errors were found in the production of the emphatic /tˤ/ (58.7%) and it was also found to be the most difficult emphatic sound to pronounce, followed by the sound /ðˤ/, which had 53 production errors (46%). The sound /dˤ/ had 43 errors (37.7%) and /sˤ/ had 40 errors (35%), and they were found to be the least difficult emphatics in pronunciation. Table 8.3 presents statistical descriptions for the production of the four emphatics among all participants.

Sounds	Participants	No. of errors	Mean	Std. deviation	95% confidence interval for mean	
					Lower bound	Upper bound
/sˤ/	38	40	1.05	.96	.74	1.37
/ðˤ/	38	53	1.39	1.1	1.06	1.73
/dˤ/	38	43	1.13	1.16	.78	1.48
/tˤ/	38	67	1.76	1.31	1.33	2.19

Table 8.3: Descriptive statistics of the production errors of emphatics in the pre-test

By looking at the results, it can be seen that the perception and production errors of each emphatic were very close in number. These results indicate that each emphatic sound had relatively the same level of difficulty in both perception and production. Most of learners' errors were in pronouncing the non-pharyngealised sounds instead of the pharyngealised sounds in the three vowel contexts, which is explained in detail later in this chapter. Figure 8.3 illustrates the percentages of difficulty in perception and production of the four emphatics among all participants.

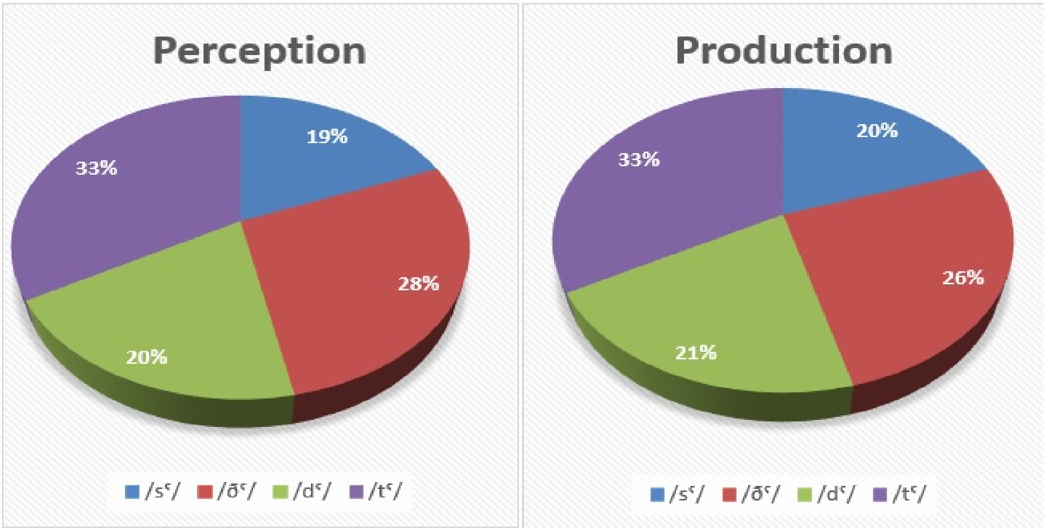


Figure 8.3: The overall perception and production errors of emphatics in the pre-test

The next section presents the difficulty level of each emphatic sound and shows whether there were significant differences in number of perception and production errors between these consonants.

8.2.3 Comparisons of the Mean Scores Between Pharyngealised Consonants

The previous analysis showed that each emphatic received a number of errors in both perception and production. Most errors occurred with the sounds /tˤ/ and /ðˤ/, while the sounds /dˤ/ and /sˤ/ received fewer errors. However, the previous analysis did not show that the sounds /sˤ/ and /dˤ/ were significantly less difficult than the sounds /tˤ/ and /ðˤ/.

Although the number of errors and the mean of each sound revealed the amount of difficulty, statistical tests have to be conducted to find significant differences between each emphatic sound, compared to the rest of the emphatics. The Wilcoxon signed-rank test was conducted to compare the emphatic sounds in both perception and production.

Table 8.4 presents the results of the Wilcoxon signed-rank test for both perception and production. It shows the emphatics that were significantly difficult, compared to the other emphatics. The sounds on the right of the 'Pair' column were more difficult than the sounds on the left. The difference was considered significant if the *p*-value was lower than alpha 0.05. The grey shading in this table and the rest of the tables in this chapter indicate significant differences.

	Pair	Wilcoxon, Z	*p*-value
Perception	/sˤ/-/ðˤ/	-2.160	.031
	/sˤ/-/dˤ/	-.214	.831
	/sˤ/-/tˤ/	-3.216	.001
	/dˤ/-/ðˤ/	-2.017	.044
	/ðˤ/-/tˤ/	-1.728	.084
	/dˤ/-/tˤ/	-3.434	.001
Production	/sˤ/-/ðˤ/	-1.695	.090
	/sˤ/-/dˤ/	-.248	.804
	/sˤ/-/tˤ/	-2.787	.005
	/dˤ/-/ðˤ/	-1.171	.242
	/ðˤ/-/tˤ/	-1.923	.055
	/dˤ/-/tˤ/	-2.822	.005

The grey shading indicates significant results $p<0.05$

Table 8.4: Wilcoxon signed-rank test results in the perception and production of the pharyngealised consonants in the pre-test

In perception, the Wilcoxon signed-rank test showed significant differences between the sounds /sˤ/ and /ðˤ/ (Wilcoxon, Z =-2.160; *p* =.031) and between /sˤ/ and /tˤ/ (Wilcoxon, Z =-3.216; *p* =.001). Furthermore, significant differences were found between /ðˤ/ and /dˤ/ (Wilcoxon, Z =-2.017; *p* =.044) and between /dˤ/ and /tˤ/ (Wilcoxon, Z =-3.434; *p* =.001). No significant difference was found between the sounds /dˤ/ and /sˤ/ (Wilcoxon, Z =-0.214; *p* =.831) and between the sounds /tˤ/ and /ðˤ/ (Wilcoxon, Z =-1.728; *p* =.084). The results indicated that, in perception, the emphatics /dˤ/ and /sˤ/ were significantly easier than the emphatics /tˤ/ and /ðˤ/.

In production, Wilcoxon signed-rank tests showed significant differences in the number of production errors between /sˤ/ and /tˤ/ (Wilcoxon, Z =-2.787; *p* =.005) and between /dˤ/ and /tˤ/ (Wilcoxon, Z =-2.822; *p* =.005). No significant difference was found between the sounds /sˤ/ and /dˤ/ (Wilcoxon, Z =-.248; *p* =.804). Specifically, the sounds /sˤ/ and /dˤ/ were significantly easier than the sound /tˤ/ in pronunciation.

The production difficulty of the emphatic /ðˤ/ lay between /tˤ/ and the two emphatics /dˤ/ and /sˤ/. Particularly, the errors for the emphatic /ðˤ/ did not differ significantly from the number of errors of the sounds /sˤ/ (Wilcoxon, Z =-1.695; *p* =.090) and /dˤ/ (Wilcoxon, Z =-1.171; *p* =.242). The difference between /ðˤ/ and /tˤ/ was near significant (Wilcoxon, Z =-1.923; *p* =.055).

Table 8.4 above shows that the patterns of difficulty in perceiving and producing the emphatics were similar, except for the sound /ðˤ/. This sound was significantly difficult in perception but not in production, compared to the sounds /sˤ/ and /dˤ/. The results indicated that the sound /ðˤ/ was easier to produce than to perceive. The sound /tˤ/, on the other hand, was significantly difficult in both perception and production. Hence, based on the statistical results, it can be concluded that the emphatics had three levels of difficulty: easy /dˤ/, /sˤ/, moderate /ðˤ/ and difficult /tˤ/.

The next section repeats the same analysis but with the three vowel contexts [_ɑ], [_ʊ] and [_ɨ] in order to detect the difficulty of each phonological environment.

8.2.4 The Perception and Production of the Emphatics in Different Vowel Contexts

The perception and production data included testing four emphatics in three different vowel contexts (i.e., [_ɑ], [_ʊ], [_ɨ]). The quality of the adjacent vowels may affect the degree of difficulty of each emphatic sound, as explained in the Literature Review Chapter in Section 2.3.4. The errors were calculated for each vowel context and from all the four emphatics. Each vowel context was perceived and produced four times by each participant and 152 times in total by all participants.

In perception, the results revealed that participants misperceived the emphatic that preceded the vowel [ɨ] (43.1%) more than the vowels [ɑ] (21.8%) and [ʊ] (35.1%). Table 8.5 provides descriptive statistical results in the perception of the pharyngealised sounds in the three vowel contexts.

Vowel contexts	No. of errors	Mean	Std. deviation	95% confidence interval for mean	
				Lower bound	Upper bound
[_ɑ]	47	1.24	1.23	.87	1.61
[_ʊ]	76	2.00	1.09	1.64	2.36
[_ɨ]	93	2.45	1.17	2.06	2.83

Table 8.5: The perception of the pharyngealised sounds in the three vowel contexts in the pre-test

In production, the results showed that learners produced errors with the emphatics that preceded the vowel [ɨ] (43.4%) more than the vowels [ɑ] (22.4%) and [ʊ] (34.2%).

The statistical analysis of all pharyngealised sounds in the three vowel contexts pronounced by all participants are summarised in Table 8.6.

Vowel contexts	No. of Errors	Mean	Std. deviation	95% confidence interval for mean	
				Lower bound	Upper bound
[_ɑ]	46	1.21	1.1	.88	1.55
[_ʊ]	70	1.84	1.19	1.45	2.24
[_ɨ]	89	2.34	1.32	1.91	2.78

Table 8.6: The production of the pharyngealised sounds in the three vowel contexts in the pre-test

In Table 8.5 and 8.6, the number of errors perceived and produced for the vowel context [_ɨ] was more than for [_ʊ] and [_ɑ]. Furthermore, the vowel context [_ɑ] received fewer errors in both perception and production. The results suggested that the quality of the adjacent vowels may have affected the level of difficulty in perception and production of the pharyngealised consonants. To clarify, the emphatics that precede the vowel [ɑ] might be easier to be perceived and produced than the emphatics that precede the vowels [ʊ] and [ɨ].

8.2.5 Comparisons of the Mean Scores Between Vowel Contexts

To detect whether the number of perception and production errors of those vowel contexts were significantly different, Wilcoxon signed-rank tests were conducted (see Table 8.7). This aimed at revealing whether L2 learners of Arabic performed significantly better in certain vowel contexts.

	Pair	Wilcoxon, Z	*p*-value
Perception	[ɑ]-[ʊ]	-3.781	.000
	[ɑ]-[ɨ]	-3.650	.000
	[ʊ]-[ɨ]	-2.124	.034
Production	[ɑ]-[ʊ]	-3.328	.001
	[ɑ]-[ɨ]	-4.265	.000
	[ʊ]-[ɨ]	-2.782	.005

The grey shading indicates significant results p<0.05

Table 8.7: Wilcoxon signed-rank test results in the perception and production of the vowel contexts in the pre-test

In both perception and production, the Wilcoxon signed-rank test results showed that the three vowel contexts [_ɨ], [_ʊ] and [_ɑ] when preceded by pharyngealised consonants were significantly different from each other in the number of errors. Specifically, the vowel context [_ɨ] received significantly more errors in perception (M=2.45, SD=1.189) and production (M=2.34, DS=1.321). Furthermore, the vowel context [_ʊ] received significantly more errors than [_ɑ] and significantly fewer errors than [_ɨ] in perception (M=2.00, SD=1.090) and production (M=1.84, SD=1.197). The vowel context [_ɑ] was the easiest in perception (M=1.24, SD=1.125) and production (M=1.21, SD=1.018), as it received significantly fewer errors than [_ʊ] and [_ɨ]. Figure 8.4 shows the perception and production errors of the three vowel contexts among all participants.

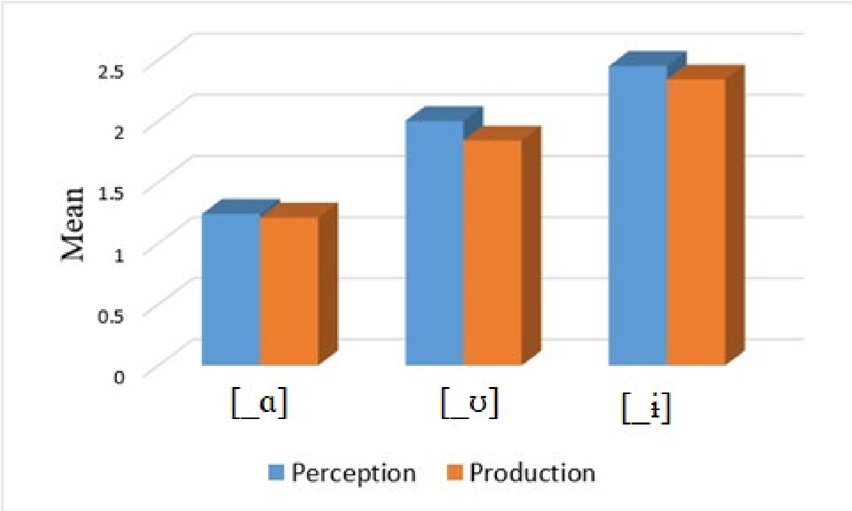


Figure 8.4: The overall perception and production errors of the vowel contexts in the pre-test

As shown in Figure 8.4, the emphatics that precede the vowel [ɨ] were more difficult to perceive and produce, compared to the vowels [ʊ] and [ɑ]. Moreover, the pharyngealised consonants that precede the vowel [ɑ] were significantly easier to perceive and produce, compared to the vowels [ɨ] and [ʊ]. Therefore, it can be concluded that the quality of the adjacent vowels contributed significantly to the perception and production difficulty levels of the emphatics.

After calculating the frequency of errors of each emphatic and vowel context, the results showed that the two most difficult vowel contexts in perception and production were [ðˤɨ] and [tˤɨ], followed by [tˤʊ] and [dˤɨ]. The least difficult vowel context was [dˤɑ]. Figure 8.5 shows the level of difficulty of each emphatic and vowel context in the pre-test.

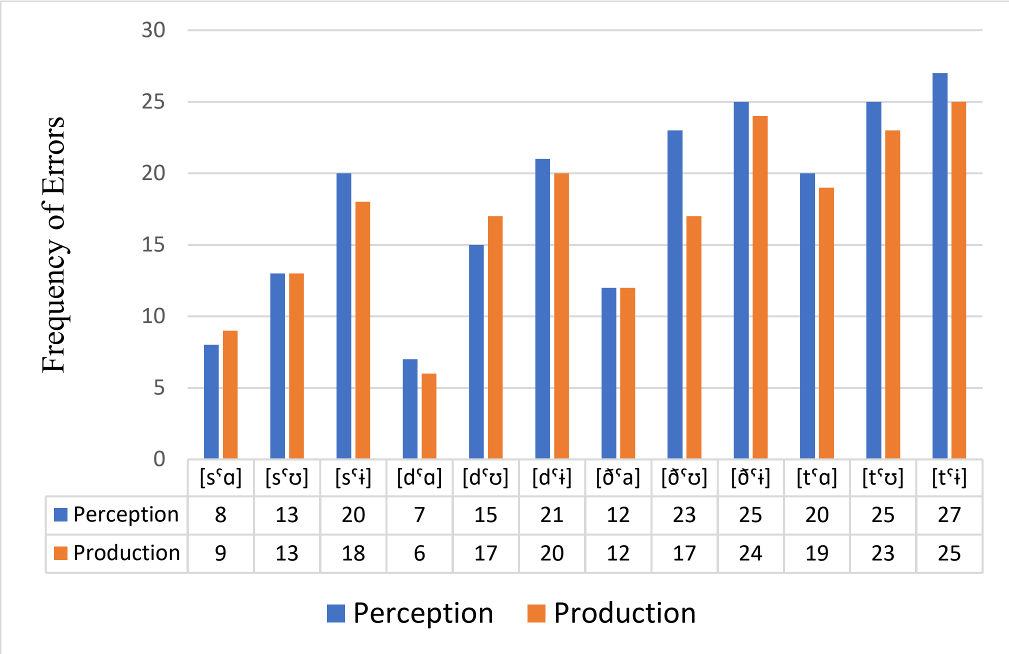


Figure 8.5: Error counts for each emphatic in each vowel context in the pre-test

8.3 Frequency of Errors in Different Proficiency Levels

This study included participants from three proficiency levels: beginners (9), intermediate (14) and advanced (15) L2 learners of Arabic. They all underwent the same procedure in testing their perception and production of the pharyngealised sounds. The reason for testing learners in different proficiency levels was to know if Arabic language proficiency affected the participants' perception and production skills with regard to the target sounds.

The analysis of errors based on learners' proficiency levels included descriptive statistical analysis, along with the non-parametric Kruskal Wallis test, which was carried out to reveal significant differences in the number of errors between the three proficiency groups. Finally, the significant results underwent a Mann-Whitney U pairwise comparison in order to find out exactly between which proficiency groups these differences were.

8.3.1 Perception Errors

The results of the perception pre-test showed that beginner (33%) and intermediate learners (36%) had more errors than learners in the advanced level (31%) in perceiving the four target sounds. Table 8.8 presents the statistical results of the perception errors from all participants in different proficiency levels.

Sounds	Beginners (N=9)			Intermediate (N=14)			Advanced (N=15)			Kruskal Wallis test		
	No. error	M	SD	No. error	M	SD	No. error	M	SD	df	Chi-square	*p*-value
/sˤ/	14	1.56	.726	13	.93	.829	14	.93	1.033	2	3.786	.151
/ðˤ/	19	2.11	.782	23	1.64	1.082	18	1.20	.862	2	5.209	.074
/dˤ/	18	2.00	1.00	16	1.14	.864	9	.60	.632	2	11.068	.004
/tˤ/	21	2.33	.707	26	1.86	.770	25	1.67	.976	2	3.211	.201

The grey shading indicates significant results p<0.05

Table 8.8: Descriptive statistical analysis in the perception of the emphatics in different proficiency levels in the pre-test

As displayed in Table 8.8, beginner and intermediate learners found the emphatic /sˤ/ the easiest to perceive among all emphatics. On the other hand, advanced learners found the emphatic /dˤ/ the easiest in perception. The sound /tˤ/ was considered the most difficult in perception across the three proficiency groups. The Kruskal Wallis test was conducted for the purpose of revealing any significant differences between the three proficiency groups.

The results showed no significant difference between the three proficiency groups in the perception of the sounds /sˤ/ (H (2) = 3.786, *p*=.151), /ðˤ/ (H (2) = 5.209, *p*=.074) and /tˤ/ (H (2) = 3.211, *p*=.201). These three sounds were considered difficult in perception, regardless of the participants' Arabic proficiency. The only significant difference was found in the perception of the sound /dˤ/ (H (2) = 11.068, *p*=.004).

A Mann-Whitney U test showed that beginner learners had significantly more errors than intermediate learners (U=31.500; p=.039) and advanced learners (U=18.000; p=.002) in the perception of the sound /dˤ/. No significant difference was found between advanced and intermediate learners (U=67.500; p=.075).

The results showed that beginner learners found the perception of the sound /dˤ/ very difficult, compared to the other proficiency groups. These results suggested that learners' L2 competence may have an influence on their ability to perceive the emphatic sounds accurately. The distribution of perception errors among the three proficiency groups is presented in Figure 8.6.

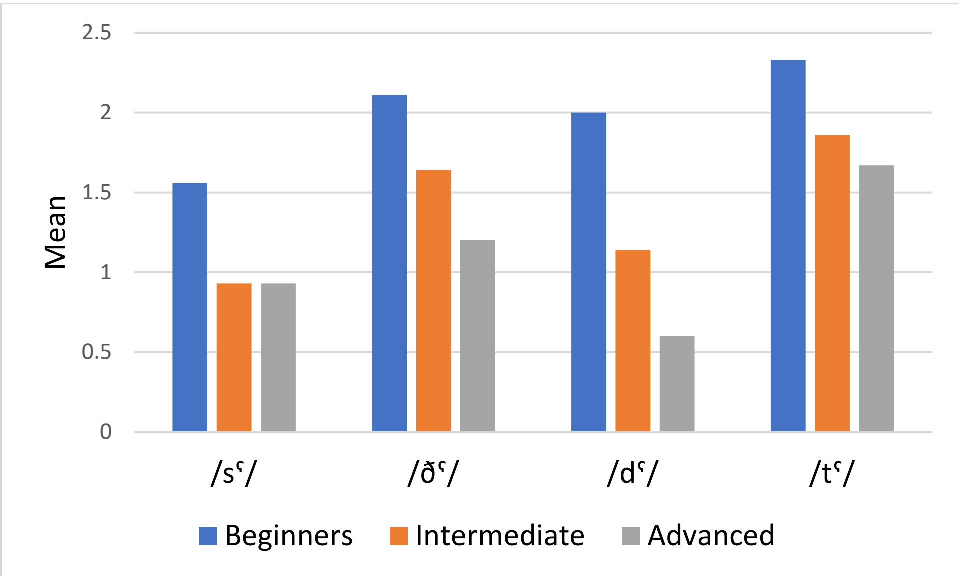


Figure 8.6: Mean error rate in perception of emphatics, by proficiency group

8.3.2 Production Errors

The results of the production pre-test showed that beginners (38%) and intermediate learners (42%) produced more errors than learners in the advanced level (20%). Table 8.9 presents the statistical analysis of the emphatics' production errors in different proficiency levels.

Sounds	Beginners (N=9)			Intermediate (N=14)			Advanced (N=15)			Kruskal Wallis test		
	No. error	M	SD	No. error	M	SD	No. error	M	SD	df	Chi-square	*p*-value
/sˤ/	14	1.56	1.041	15	1.07	.997	11	.73	.997	2	3.763	.152
/ðˤ/	22	2.44	.527	20	1.43	.852	11	.73	.884	2	15.504	.000
/dˤ/	14	1.56	1.130	22	1.57	1.089	7	.47	.640	2	9.440	.009
/tˤ/	27	3.00	.000	28	2.00	1.038	12	.80	1.207	2	16.373	.000

The grey shading indicates significant results $p<0.05$

Table 8.9: Descriptive analysis in the production of the pharyngealised consonants in different proficiency levels in the pre-test

All beginner learners mispronounced the sound /tˤ/. This sound was the most difficult sound for intermediate and advanced learners too. The sound /sˤ/, on the other hand, was the easiest to pronounce among the three proficiency groups. To reveal whether the pronunciation errors between proficiency levels were significantly varied, the Kruskal Wallis test was conducted (see Table 8.9).

The results showed no significant difference between the three groups in the production of the sound /sˤ/ (H (2) = 3.763, *p*=.152). Participants encountered relatively the same amount of difficulty in pronouncing the sound /sˤ/, regardless of their Arabic proficiency. Moreover, the results showed significant differences in the production of the sounds /ðˤ/ (H (2) = 15.504, *p*=.000), /dˤ/ (H (2) = 9.440, *p*= .009) and /tˤ/ (H (2) = 16.373, *p*= .000).

The Mann-Whitney U test showed that beginner learners had significantly more errors than intermediate learners in the production of the sounds /ðˤ/ (U=21.500, *p*=.006) and /tˤ/ (U=22.500; *p*=.003). No significant difference was found between beginner and intermediate learners in the production of /dˤ/ (U=62.500; *p*=.974). Furthermore, beginner learners had significantly more errors than advanced learners in pronouncing the sounds /ðˤ/ (U=10.000; *p*=.000), /dˤ/ (U=29.500; *p*=.015) and /tˤ/ (U=13.500; *p*=.000).

The Mann-Whitney U test also showed that intermediate learners had significantly more errors than advanced learners in the production of the sounds /ðˤ/ (U=61.000; *p*=.043), /dˤ/ (U=44.500; *p*=.005) and /tˤ/ (U=51.000; *p*=.014). The results suggested that learners' proficiency significantly affected their pronunciation of most emphatic sounds.

The distribution of production errors among the three proficiency groups is shown in Figure 8.7. Overall, the results showed that learners in the beginner and intermediate levels were considerably less accurate than learners in the advanced level in the production of the pharyngealised sounds, especially /dˤ/, /tˤ/ and /ðˤ/. However, the sound /tˤ/ still posed a difficulty problem among participants in the advanced level.

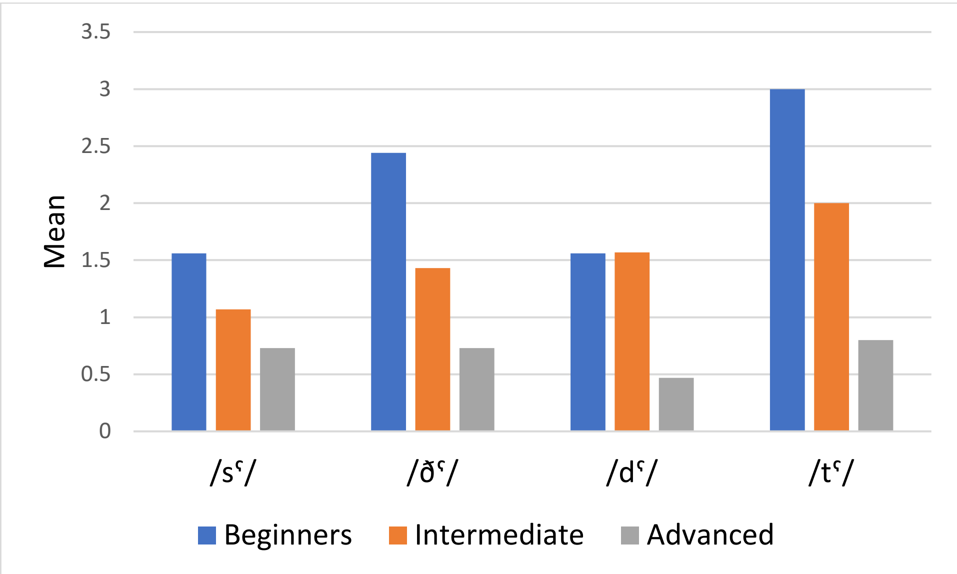


Figure 8.7: Mean error rate in production of emphatics, by proficiency group

The perception and production results showed that the effect of Arabic proficiency was shown clearly in producing the emphatics more than perceiving them. In other words, there were large variances in the number of errors between the three proficiency groups in the production of the target sounds, which did not appear in perception.

8.4 Frequency of Errors from Different Language Backgrounds

Learners from three language backgrounds were employed in this study, being native speakers of Urdu (n=14), Mandarin (n=13) and English (n=11). The language backgrounds of the learners were considered as variables in this study to explore their positive or negative influence on learners' knowledge of sounds.

8.4.1 Perception Errors

The results of the perception pre-test indicated that more errors were found with Mandarin speakers (41%) than with Urdu speakers (38%). On the other hand, English speakers (21%) had fewer errors than both Urdu and Mandarin speakers. To examine the differences in the perception accuracy between the three language groups, the Kruskal Wallis test was conducted (see Table 8.10).

Sounds	**Mandarin speakers (N=13)**			**Urdu speakers (N=14)**			**English speakers (N=11)**			**Kruskal Wallis test**		
	No. error	M	SD	No. error	M	SD	No. error	M	SD	df	Chi-square	*p*-value
/sˤ/	16	1.23	1.013	17	1.21	.893	8	.73	.786	2	2.206	.332
/ðˤ/	26	2.00	.816	20	1.43	.938	14	1.27	1.104	2	3.561	.169
/dˤ/	17	1.31	1.032	19	1.36	.745	7	.64	1.027	2	5.315	.070
/tˤ/	29	2.23	.725	26	1.21	.893	17	.73	.786	2	2.206	.332

Table 8.10: Descriptive analysis in the perception of emphatics from different L1 backgrounds in the pre-test

The results showed that language groups did not differ significantly in the perception of the sounds /sˤ/ (H (2) = 2.206, *p*=.332), /ðˤ/ (H (2) = 3.561, *p*=.169) and /tˤ/ (H (2) = 3.738, *p*=.154). The difference was near significant in the perception of the sound, /dˤ/ (H (2) = 5.351, *p*=.070). The three language groups performed similarly in the perception of emphatics and learners' language backgrounds did not influence their perception abilities.

Based on the mean presented in Table 8.10, English speakers performed consistently better than Mandarin and Urdu speakers. Furthermore, the highest number of errors was found in the perception of the emphatic /tˤ/ across all three groups, which indicated that this sound was difficult to perceive, regardless of the learners' language backgrounds. Figure 8.8 shows the distributions of perception errors among the three language groups.

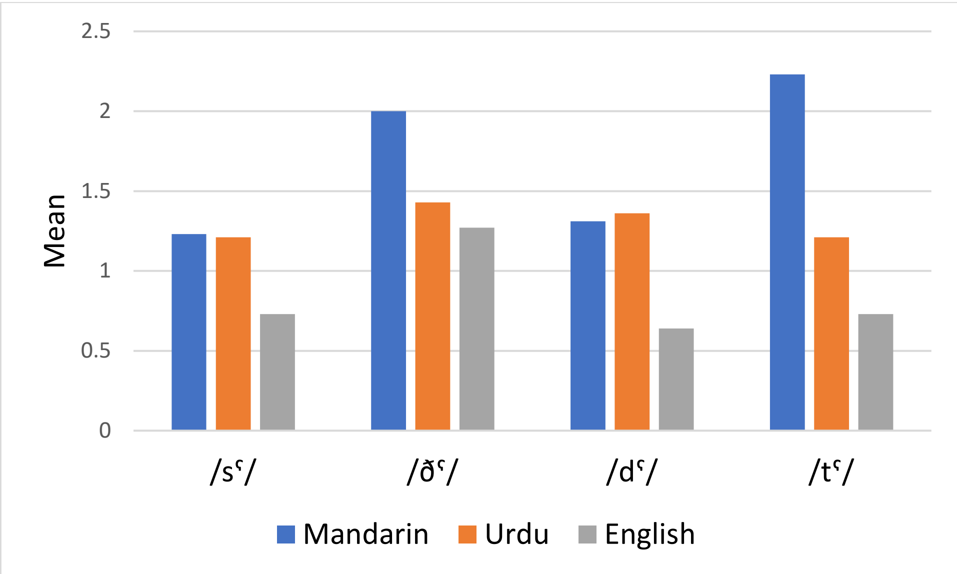


Figure 8.8: Mean error rate in perception of emphatics, by language group

8.4.2 Production Errors

The results of the production pre-test from the three language groups revealed that English speakers (25%) performed better than Urdu (36%) and Mandarin (39%) speakers. However, English speakers were less accurate than Mandarin and Urdu speakers in the production of the sound /sˤ/. The Kruskal Wallis test was conducted to reveal the differences in production errors between the three language groups (see Table 8.11).

Sounds	Mandarin speakers (N=13)			Urdu speakers (N=14)			English speakers (N=11)			Kruskal Wallis test		
	No. error	M	SD	No. error	M	SD	No. error	M	SD	df	Chi-square	*p*-value
/sˤ/	12	.92	.954	13	.93	.917	15	1.36	1.027	2	1.448	.485
/ðˤ/	18	1.38	1.121	21	1.50	.941	14	1.27	1.104	2	.340	.843
/dˤ/	23	1.77	1.092	12	.86	1.027	8	.73	.786	2	6.657	.036
/tˤ/	27	2.08	1.320	26	1.86	1.351	14	1.27	1.191	2	2.951	.229

The grey shading indicates significant results $p<0.05$

Table 8.11: Descriptive analysis in the production of emphatics from different L1 backgrounds in the pre-test

The results showed that the number of errors in the production of the sounds /sˤ/ (H (2) = 1.448, *p*=.485), /tˤ/ (H (2) = 2.951, *p*=.229) and /ðˤ/ (H (2) = .340, *p*=.843) from Mandarin, Urdu, and English was not significantly different. No language group was significantly better than the other groups in the pronunciation of these sounds. The only significant difference was found in the production of the emphatic /dˤ/ (H (2) = 6.657, *p*=.036).

The Mann-Whitney U test showed that Mandarin speakers produced significantly more errors than Urdu speakers (U=49.500; *p*=.037) and English speakers (U=33.000; *p*=.021) in pronouncing the sound /dˤ/. Urdu and English speakers did not differ significantly with the sound /dˤ/ (U=74.500; *p*=.883). The results suggested that Mandarin speakers found the sound /dˤ/ significantly difficult to pronounce more than Urdu and English speakers. Figure 8.9 pictures the differences between language groups in the production of emphatics.

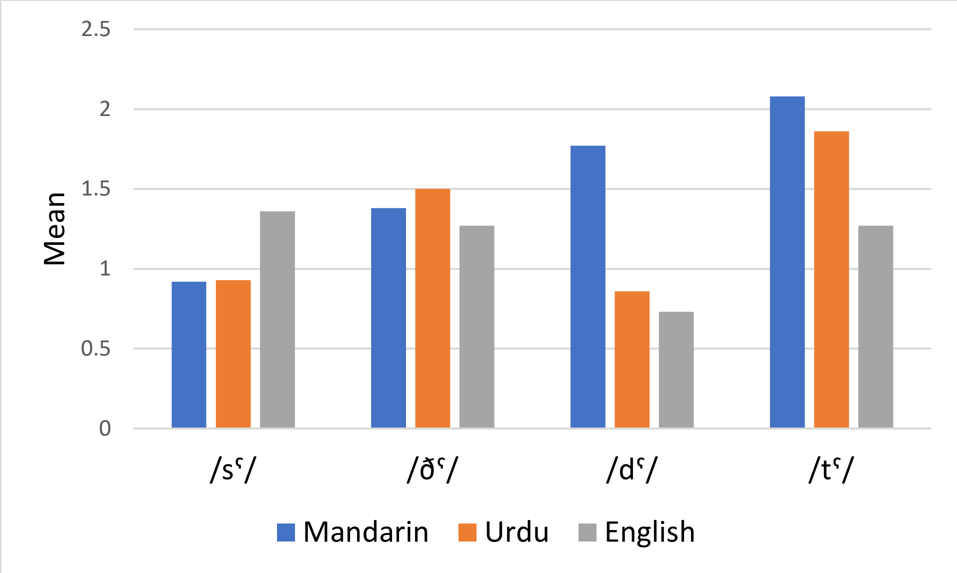


Figure 8.9: Mean error rate in production of emphatics, by language group

Similar to the analysis of proficiency levels, the significant differences appeared in production more than in perception. Particularly, Mandarin speakers differed significantly in the pronunciation of the sound /dˤ/, although the perception of the same sound between the three language groups was not significantly different.

8.5 Types of Errors in the Pre-test

After analysing the frequency of errors in the perception and production of the emphatics from the three proficiency levels, language groups and vowel contexts, specific types of errors were determined. The types of perception and production errors were analysed, based on the language backgrounds of the participants. The emphatics are presented in the three vowel contexts to reveal the vowel confusions for language groups. The types and number of errors are presented next.

Since the perception test was a forced choice identification task, the results obtained were either pharyngealised or non-pharyngealised consonants. This means that the types of errors in the perception test were only the non-emphatics (i.e., /s/, /ð/, /d/, and /t/).

The production errors, in general, showed a large degree of variance in phoneme replacement across the three groups. Table 8.12 presents learners' substitutions of emphatics in the three vowel contexts.

Participants production (Substitutions)	Vowel context	Mandarin speakers	Urdu speakers	English speakers
/sˤ/→[s]	[sˤɑ]	4	2	3
	[sˤʊ]	4	3	6
	[sˤɨ]	5	7	6
/dˤ/→[d]	[dˤɑ]	4	0	0
	[dˤʊ]	8	5	2
	[dˤɨ]	4	7	6
/dˤ/→[ðˤ]	[dˤɑ]	2	0	0
	[dˤʊ]	2	0	0
	[dˤɨ]	3	0	0
/ðˤ/→[ð]	[ðˤa]	4	4	4
	[ðˤʊ]	6	7	3
	[ðˤɨ]	8	7	7
/ðˤ/→[z]	[ðˤa]	0	0	0
	[ðˤʊ]	1	0	0
	[ðˤɨ]	1	1	0
/tˤ/ →[t]	[tˤɑ]	8	8	3
	[tˤʊ]	10	8	5
	[tˤɨ]	9	10	6

Table 8.12: Types and number of errors of emphatics from Mandarin, Urdu and English speakers in the pre-test

Figure 8.10 shows the patterns of errors in the production of emphatics among Mandarin, Urdu and English speakers.

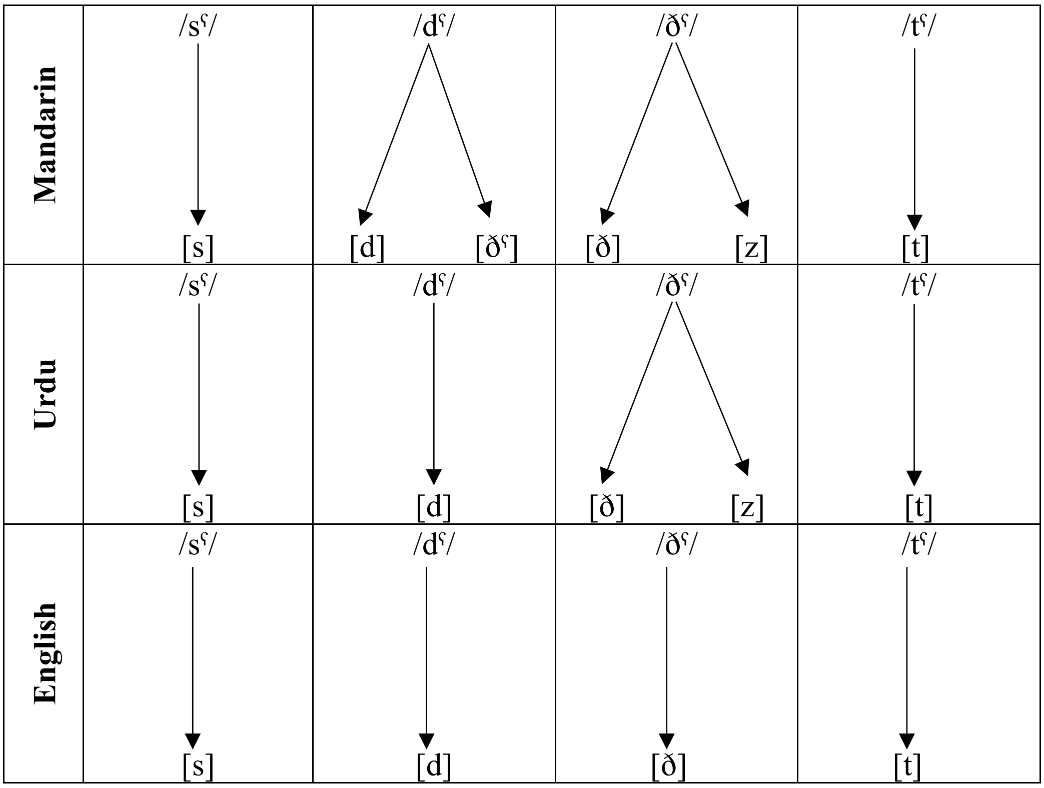


Figure 8.10: Production variants from Mandarin, Urdu and English speakers in the pre-test

The rate of errors for these particular confusions presented above was reduced systematically as visual and verbal phonetic instruction was provided, as is explained in the next section.

8.6 Technology-based Instruction and Traditional-based Instruction

This section presents the results and answers the third research question regarding the effect of the form-focused technology-based and the form-focused traditional-based instruction on L2 learners of Arabic on their ability to perceive and produce accurate pharyngealised consonants in different vowel contexts. The experiment included two groups of 19 participants each. Each group received four days' training in the perception and production of the four emphatic sounds.

The traditional group received training using explicit sounds instruction, reading aloud, repetition, and practicing minimal pairs. The technology group received training that included explicit sounds instruction but also explanations of the visual representations of sounds and practicing minimal pairs through Praat.

After collecting the perception and production pre- and post-tests, the Mann-Whitney U test was conducted to compare the two groups. Furthermore, the Wilcoxon signed-rank test was conducted to measure participants' performance before and after the form-focused phonetic instruction. The effect size (*r*) which detected the size of the impact of interest in the population for each test was measured to ensure the robustness of the analysis, as suggested by Field (2009) and to detect if an observed difference is not only statistically significant but also meaningful and important. It was one of the influencing factors that affects the power of the analysis. The formula used in calculating the effect size for the non-parametric Mann-Whitney U test and the Wilcoxon signed-rank test was taken from Rosenthal (1991). The standard values for *r* were decided, based on Cohen (1988), who interpreted the *r* values as: small effect ≥ .10, medium effect ≥ .30 and large effect ≥ .50.

8.6.1 Perception and Production Pre-tests Results

Prior to comparing participants' performance after receiving the phonetic instruction, their perception and production scores were tested. The aim of testing the performance of the two groups before training was to make sure that they were homogeneous with regard to their perception and production abilities of the target sounds. The results showed no significant difference between the traditional and the technology groups in perception and production. Table 8.13 and 8.14 reveal the descriptive statistics and the Mann-Whitney U test results for the perception and production pre-tests.

	Traditional group (N=19)			Technology group (N=19)			Mann-Whitney U test			
	No. errors	M	SD	No. errors	M	SD	U	z	*p*-value	Effect size *r*
/sˤ/	23	1.21	1.084	18	.95	.705	161.000	-.603	.547	.18
/ðˤ/	27	1.42	1.107	33	1.74	.733	154.000	-.808	.419	.13
/dˤ/	20	1.05	.911	23	1.21	1.032	168.000	-.384	.701	.15
/tˤ/	38	2.00	.882	34	1.79	.855	154.500	-.805	.421	.13

Table 8.13: Descriptive statistics and Mann-Whitney U test results for the perception pre-test

	Traditional group (N=19)			Technology group (N=19)			Mann-Whitney U test			
	No. errors	M	SD	No. errors	M	SD	U	z	*p*-value	Effect size *r*
/sˤ/	17	.89	.737	23	1.21	1.134	156.000	-.751	.453	.12
/ðˤ/	23	1.21	.976	30	1.58	1.071	143.500	-1.122	.262	.18
/dˤ/	23	1.21	1.084	20	1.05	1.079	165.000	-.473	.637	.16
/tˤ/	33	1.74	1.240	34	1.79	1.398	169.500	-.342	.732	.14

Table 8.14: Descriptive statistics and Mann-Whitney U test results for the production pre-test

According to Table 8.13 and 8.14, there was no significant difference for any of the emphatic sounds ($p > 0.05$). Therefore, it can be said that the two groups were homogeneous in perception and production of the target sounds.

8.6.2 Perception Post-test Results

For the purpose of detecting the difference in efficacy between the technology and traditional-based instruction, the perception performance of participants in the two groups was compared (see Table 8.15).

		Traditional group (N=19)			Technology group (N=19)			Mann-Whitney U test			
		No. errors	M	SD	No. errors	M	SD	U	z	*p*-value	Effect size *r*
/sˤ/	Pre	23	1.21	1.084	18	.95	.705	161.000	-.603	.547	.18
	Post	18	.95	.911	5	.26	.562	100.000	-2.651	.008	.43
/ðˤ/	Pre	27	1.42	1.107	33	1.74	.733	154.000	-.808	.419	.13
	Post	18	.95	.970	12	.63	.895	146.000	-1.092	.275	.17
/dˤ/	Pre	20	1.05	.911	23	1.21	1.032	168.000	-.384	.701	.15
	Post	15	.79	.918	16	.84	.898	173.000	-.235	.814	.13
/tˤ/	Pre	38	2.00	.882	34	1.79	.855	154.500	-.805	.421	.13
	Post	20	1.05	.970	20	1.05	.705	177.000	-.108	.941	.11

The grey shading indicates significant results p<0.05

Table 8.15: Descriptive statistics and Mann-Whitney U test results for the perception post-test

According to Table 8.15, the Mann-Whitney U test results showed no significant difference in the post-test between the technology group and the traditional group in the perception of the sounds /ðˤ/ (U=146.000; *p*= .275), /dˤ/ (U=173.000; *p*= .814) and /tˤ/ (U=177.000; *p*= .941). The only difference between the two groups was found in the perception of the sound /sˤ/ (U=100.000; *p*= .008, *r*=.43), illustrating that the technology group performed significantly better than the traditional group. According to the interpretation of *r* by (Coe, 2002), the medium *r* of 0.43 indicates a value of 66%, which means that the average individual in the technology group would score higher than 66% of the traditional group (See Figure 8.11).

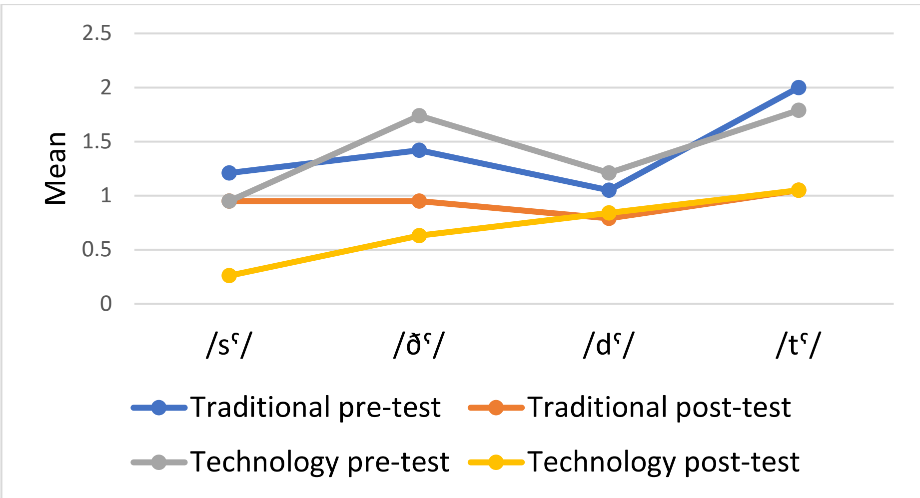


Figure 8.11: Mean error rate of learners' perception of emphatics in both groups

Participants in both groups demonstrated general improvement after phonetic instruction with respect to the perception of emphatics. To determine if such improvement was significant, the data were submitted to a Wilcoxon signed-rank test. Learners in the traditional group improved significantly in the perception of the sound /tˤ/ (Wilcoxon, Z =-3.082; *p* =.002, *r*=.70). No significant improvement was detected in the perception of the sounds /sˤ/ (Wilcoxon, Z =-.965; *p* =.334, *r*=.22), /ðˤ/ (Wilcoxon, Z =-1.340; *p* =.180, *r*=.30) and /dˤ/ (Wilcoxon, Z =-1.291; *p* =.197, *r*=.29).

On the other hand, a statistically significant reduction of errors was found for the learners in the technology group after taking the training course in the perception of the sounds /sˤ/ (Wilcoxon, Z =-2.586; *p* =.010, *r*=.59), /ðˤ/ (Wilcoxon, Z =-3.071; *p* =.002, *r*=70), /dˤ/ (Wilcoxon, Z =-2.111; *p* =.035, *r*=.48) and /tˤ/ (Wilcoxon, Z =-2.725; *p* =.006, *r*=.62). The differences in the perception of the emphatics after receiving the two phonetic training sessions are shown in Figure 8.12.

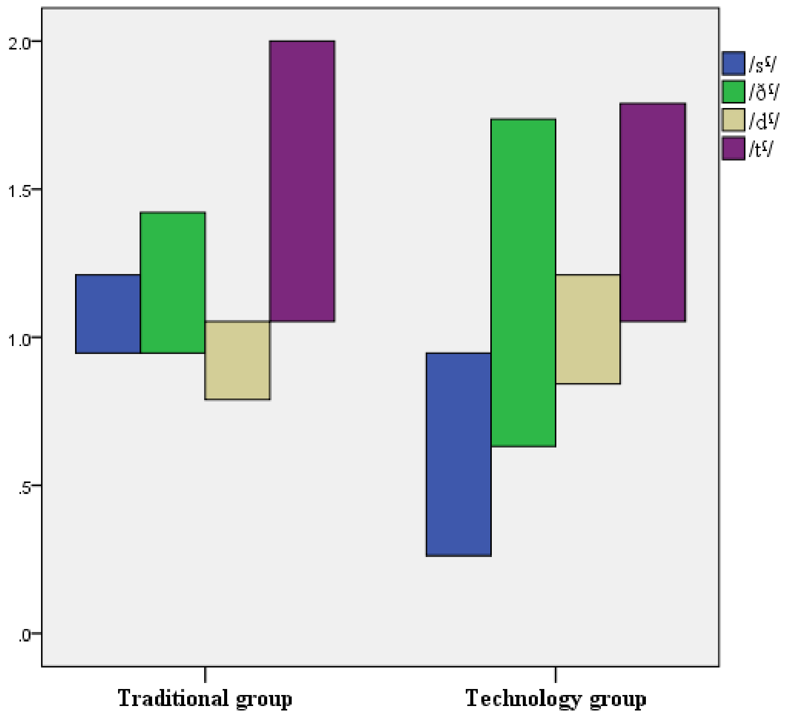


Figure 8.12: Perception pre- and post-tests errors from the technology and traditional group

Similar to the explanation in Figure 5.4 in the Results for Study 1, each vertical bar on this chart represents the mean of errors for each emphatic. The top of the bar represents the mean of errors in the pre-test, whereas the lower end of the bar represents the mean of errors in the post-test. The distance between the beginning and the end of each bar represents the learning gain.

Both groups produced fewer errors after the instruction as the mean of errors decreased. However, the sounds /ðˤ/and /sˤ/ had lower means in the technology group than the traditional group. Moreover, the difference in the learning gain between the two groups in the sound /sˤ/ was significant.

It can be seen from Figure 8.12 that the sound /sˤ/ received significantly fewer errors from the technology group. The results suggested that the technology teaching method enhanced learners' perception abilities of this particular sound more than the traditional method. This case did not apply to the rest of the emphatics, as they all received significantly fewer errors from the two groups after the instruction.

8.6.3 Production Post-test Results

The Mann-Whitney U test results showed no significant difference between the technology group and the traditional group. The descriptive analysis and the results of the Mann-Whitney U test between the two groups are summarised in Table 8.16.

		Traditional group (N=19)			Technology group (N=19)			Mann-Whitney U test			
		No. errors	M	SD	No. errors	M	SD	U	z	*p*-value	Effect size *r*
/sˤ/	Pre	17	.89	.737	23	1.21	1.134	156.000	-.751	.453	.12
	Post	7	.37	.684	8	.42	.769	178.000	-.095	.925	.14
/ðˤ/	Pre	23	1.21	.976	30	1.58	1.071	143.500	-1.122	.262	.18
	Post	13	.68	.885	9	.47	.841	152.500	-.938	.348	.15
/dˤ/	Pre	23	1.21	1.084	20	1.05	1.079	165.000	-.473	.637	.16
	Post	16	.84	.958	12	.63	.895	157.500	-.736	.462	.12
/tˤ/	Pre	33	1.74	1.240	34	1.79	1.398	169.500	-.342	.732	.14
	Post	17	.89	.937	25	1.32	1.157	144.000	-1.114	.265	.18

Table 8.16: Descriptive statistics and Mann-Whitney U test results for the production post-test

Table 8.16 showed that the mean of the sounds /ðˤ/ and /dˤ/ for the technology group was less than the traditional group, which suggested that the technology group performed better and produced fewer errors than the traditional group. Furthermore, the mean of the sounds /sˤ/ and /tˤ/ for the traditional group was less than the technology group, which means that they produced fewer errors and performed better than the technology group. However, the difference between the groups was not significant (see Figure 8.13).

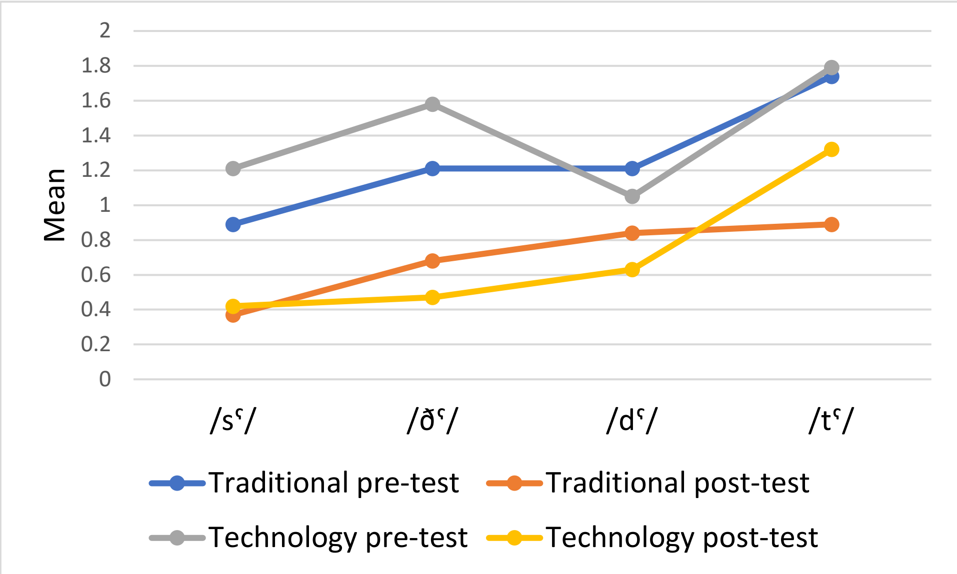


Figure 8.13: Mean error rate of learners' production of emphatics in both groups

Based on the results of the Wilcoxon signed-rank test, the traditional group improved significantly in the production of the sounds /sˤ/ (Wilcoxon, Z =-3.162; *p* =.002, *r*=.72), /ðˤ/ (Wilcoxon, Z =-2.673; *p* =.008, *r*=.61) and /tˤ/ (Wilcoxon, Z =-2.818; *p* =.005, *r*=.64). No significant improvement was found in the pronunciation of the sound /dˤ/ from the traditional group (Wilcoxon, Z =-1.604; *p* =.109, *r*=.36).

The technology group improved significantly in the production of the sounds /sˤ/ (Wilcoxon, Z =-2.950; *p* =.003, *r*=.67), /ðˤ/ (Wilcoxon, Z =-3.140; *p* =.002, *r*=.72) and /tˤ/ (Wilcoxon, Z =-2.165; *p* =.030, *r*=.49). The difference between the pre and post-test results of the sound /dˤ/ in the technology group was approaching significance (Wilcoxon, Z =-1.930; *p* =.054, *r*=.44) but was considered not significant (see Figure

8.14). However, the value of *r* indicated a medium effect similar to the effect of technology on the production of /tˤ/.

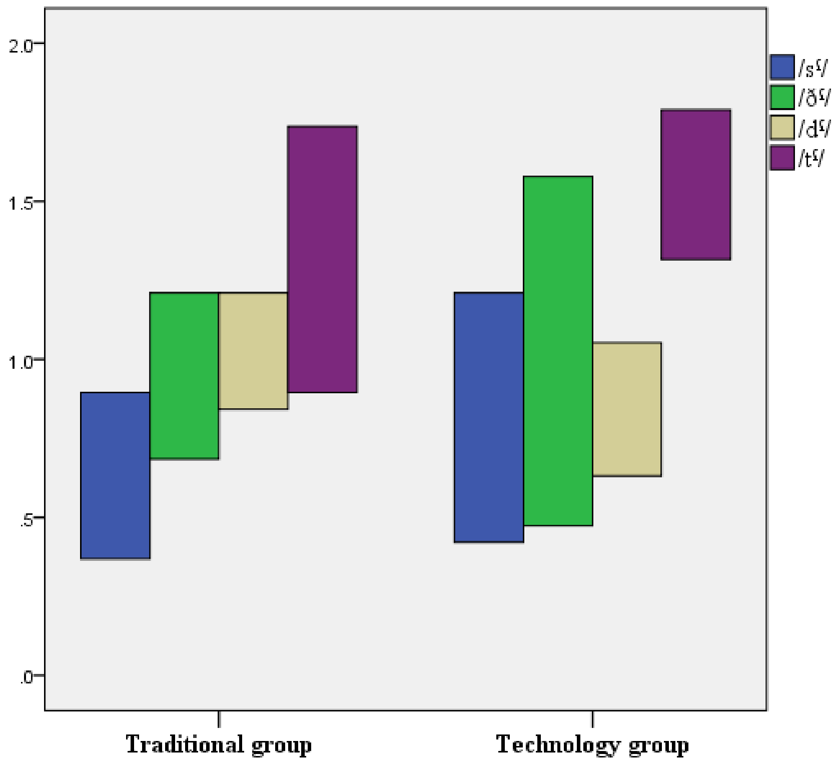


Figure 8.14: Production pre- and post-tests errors from the technology and traditional group

The commonalities between the two groups in their results after the instruction were that both groups had significantly fewer errors in perceiving the sound /tˤ/ and pronouncing the sounds /sˤ/, /ðˤ/ and /tˤ/. In addition, both groups did not significantly produce fewer errors in pronouncing the sound /dˤ/.

The difference between the two groups was that the technology group produced significantly fewer errors than the traditional group in perceiving the sounds /sˤ/, /ðˤ/ and /dˤ/. Compared to the traditional group, the perception abilities of participants in the technology group were more developed after the technology training than the traditional group, while both groups improved equally in their production abilities with regard to the target sounds.

8.6.4 Perception and Production Results of Emphatics Across Vowel Contexts

It was also important to investigate the effects of the two teaching methods on learners' perception and pronunciation of the emphatics across different vowel contexts. The objective was to reveal whether the form-focused phonetic instruction helped in improving learners' perception and production of these vowel contexts.

The errors were calculated for each vowel context for the pronunciation of the four emphatics. Each vowel context was pronounced 67 times by each teaching group. Table 8.17 shows the frequency of errors from each group for each vowel context.

Vowel contexts	Test	Traditional group		Technology group	
		perception	production	perception	production
[_ɑ]	pre	23	19	24	27
	post	12	6	10	7
[_ʊ]	pre	41	32	35	38
	post	21	16	17	17
[_ɨ]	pre	44	45	49	44
	post	38	31	26	30

Table 8.17: Vowel contexts error frequency between groups in the pre and post-tests

The Mann-Whitney U test results showed no significant difference between the technology group and the traditional group in the perception and production pre- and post-test for the three vowel contexts. The values of *r* were also small enough to be considered of practical importance. The results of the Mann-Whitney U tests in perception and production are presented in Table 8.18 and 8.19.

Test		Traditional group (N=19)		Technology group (N=19)		Mann-Whitney U test			
		M	SD	M	SD	U	z	*p*-value	Effect size *r*
[ɑ]	Pre	1.21	1.032	1.26	1.240	177.000	-.107	.915	.11
	Post	.63	.684	.53	.772	160.000	-.670	.503	.11
[ʊ]	Pre	2.16	1.068	1.84	1.119	160.500	-.609	.542	.18
	Post	1.11	1.100	.89	1.049	159.000	-.667	.505	.11
[ɨ]	Pre	2.32	1.204	2.58	1.170	156.500	-.723	.470	.12
	Post	2.00	1.374	1.37	1.116	136.000	-1.342	.180	.22

Table 8.18: Mann-Whitney U test results of the groups' perception of the vowel context in the pre and post-tests

Test		Traditional group (N=19)		Technology group (N=19)		Mann-Whitney U test			
		M	SD	M	SD	U	z	*p*-value	Effect size *r*
[ɑ]	Pre	1.00	.943	1.42	1.071	139.500	-1.249	.212	.21
	Post	.32	.820	.37	.684	164.500	-.656	.512	.11
[ʊ]	Pre	1.68	1.204	2.00	1.202	155.500	-.759	.448	.13
	Post	.84	.958	.89	1.049	177.500	-.094	.925	.14
[ɨ]	Pre	2.37	1.535	2.32	1.108	171.500	-.270	.787	.13
	Post	1.63	1.212	1.58	1.071	176.000	-.136	.892	.11

Table 8.19: Mann-Whitney U test results of the groups' production of the vowel context in the pre and post-tests

The perception post-test results indicated that the technology group had fewer errors than the traditional group. On the other hand, the production post-test results showed that the technology group produced more errors than the traditional group, except with the vowel [ɨ]. It can be speculated from these results that the technology teaching method enhanced learners' perception skill more than their production skill (see Figure 8.15).

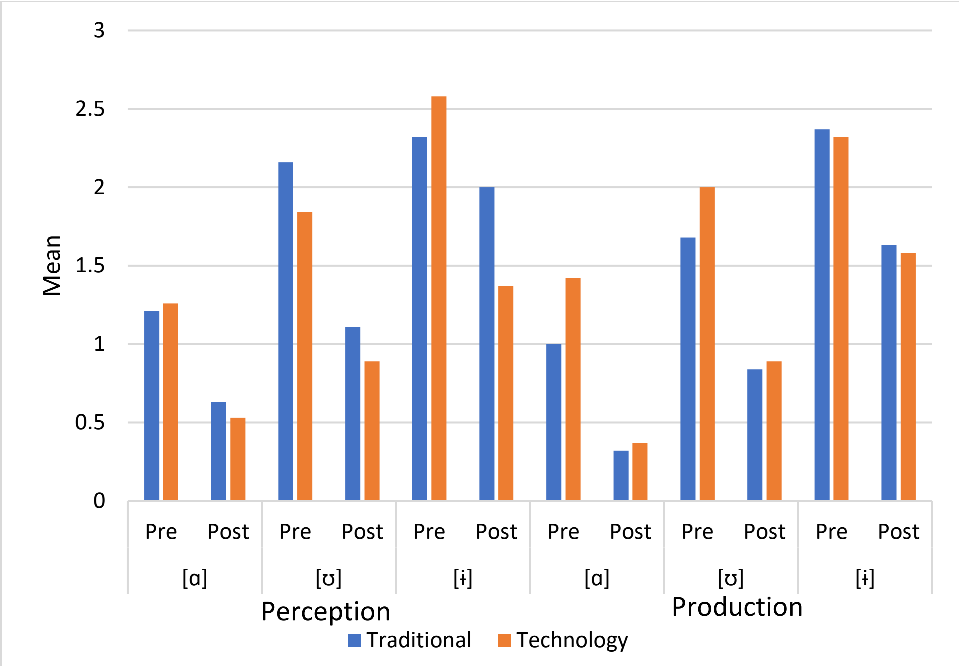


Figure 8.15: The perception and production of the vowel contexts from the two groups in the pre- and post-tests

Figure 8.15 presents the non-significant differences between the traditional and technology groups after receiving the two phonetic types of instruction. However, it is worth detecting which vowel context was significantly improved in perception and production after the training. Therefore, Wilcoxon signed-rank tests were conducted to compare the mean of the vowel contexts before and after the phonetic instruction in both perception and production.

The results showed that learners in the traditional group improved significantly after taking the traditional-based instruction in the perception of the vowels [ɑ] (Wilcoxon, Z =-2.054; *p* =.040, *r*=.47) and [ʊ] (Wilcoxon, Z =-2.848; *p* =.004, *r*=.65). No significant difference was found in the perception of the vowel [ɨ] (Wilcoxon, Z =-1.473; *p* =.141, *r*=.33). In addition, the same group improved significantly in the production of the vowels [ɑ] (Wilcoxon, Z =-2.919; *p* =.004, *r*=.66), [ʊ] (Wilcoxon, Z =-3.176; *p* =.001, *r*=.72) and [ɨ] (Wilcoxon, Z =-3.071; *p* =.002, *r*=.70).

Learners in the technology group, on the other hand, improved significantly after taking the technology-based instruction in the perception of the vowels [ɑ] (Wilcoxon, Z =-2.970; *p* =.003, *r*=.68), [ʊ] (Wilcoxon, Z =-2.616; *p* =.009, *r*=.60) and [ɨ] (Wilcoxon, Z =-2.816; *p* =.005, *r*=.64). Moreover, they improved significantly in the production of the vowels [ɑ] (Wilcoxon, Z =-3.126; *p* =.002, *r*=.71), [ʊ] (Wilcoxon, Z =-3.384; *p* =.001, *r*=.77) and [ɨ] (Wilcoxon, Z =-3.071; *p* =.002, *r*=.70). The only difference between the technology and traditional groups was found in the perception of the vowel [ɨ], which appeared to be significant in the technology group but not in the traditional group (see Figure 8.16).

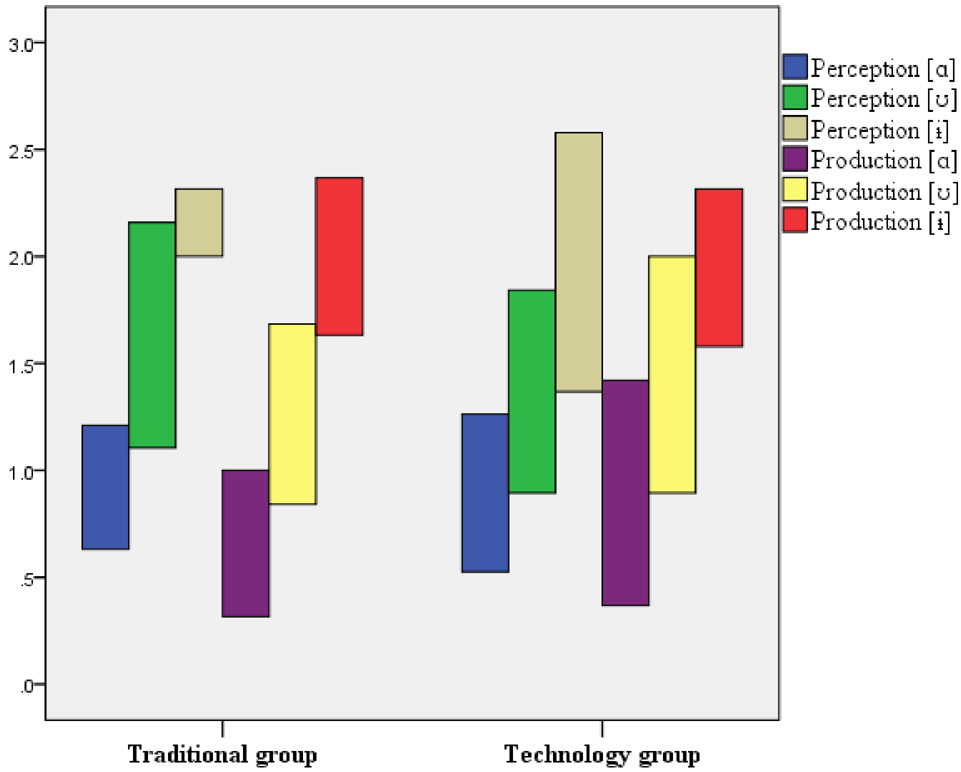
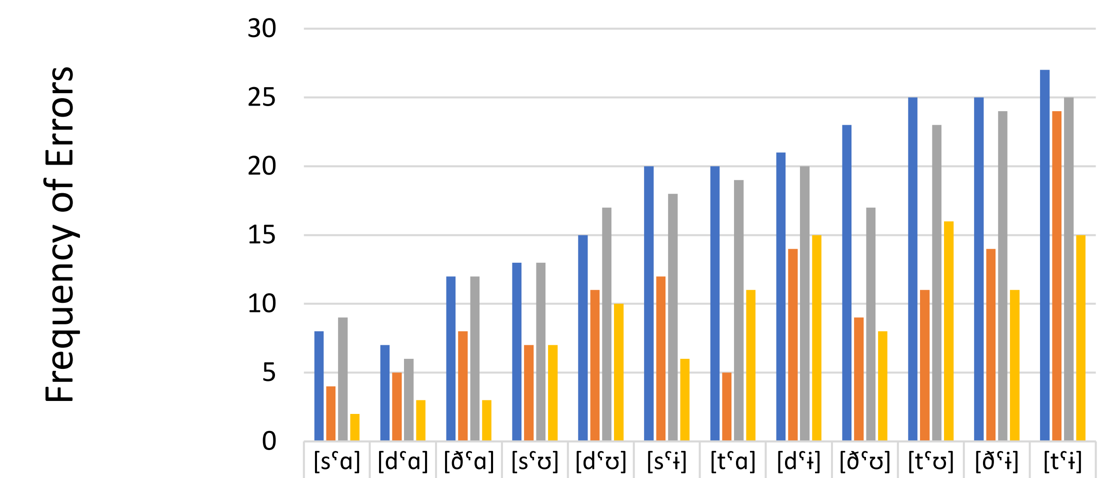


Figure 8.16: The improvements of learners' perception and production of vowel contexts in the two groups

After calculating the frequency of errors of each emphatic and vowel context after the pronunciation instruction, the results showed that the number of errors has reduced in almost all cases. Before the instruction, the two most difficult vowel contexts were [ðˤɨ] and [tˤɨ], followed by [tˤʊ] and [dˤɨ]. After the instruction, the difficult vowel contexts were [tˤʊ] and [dˤɨ] while the least difficult vowel context was [sˤɑ] and [dˤɑ]. Figure 8.17 shows the level of difficulty of each emphatic and vowel context in the pre- and post-test.



	[sˤɑ]	[dˤɑ]	[ðˤɑ]	[sˤʊ]	[dˤʊ]	[sˤɨ]	[tˤɑ]	[dˤɨ]	[ðˤʊ]	[tˤʊ]	[ðˤɨ]	[tˤɨ]
Perception pre-test	8	7	12	13	15	20	20	21	23	25	25	27
Perception post-test	4	5	8	7	11	12	5	14	9	11	14	24
Production pre-test	9	6	12	13	17	18	19	20	17	23	24	25
Production post-test	2	3	3	7	10	6	11	15	8	16	11	15

Figure 8.17: Error counts for each emphatic in each vowel context in the pre- and post-test (the vowel contexts were ordered from easy to difficult in the pre-tests)

8.6.5 Types of Errors After the Pronunciation Instruction

In Section 8.5, the types of errors taken from the production pre-test for each participant in each language background were calculated and presented. In this section, the types of production post-test errors were analysed, based on the language backgrounds of the participants. The emphatics are presented in the three vowel contexts to reveal the vowel confusions for language groups after the pronunciation instruction.

Unlike the types of errors in the production pre-test, the production post-test errors showed a small degree of variance in phoneme replacement across the three groups. Table 8.20 presents learners' substitutions of emphatics in the three vowel contexts after the instruction.

Participants production (Substitutions)	Vowel context	Mandarin speakers	Urdu speakers	English speakers
	[sˤɑ]	0	1	1
/sˤ/→[s]	[sˤʊ]	2	2	3
	[sˤɨ]	2	2	2
	[dˤɑ]	3	0	0
/dˤ/→[d]	[dˤʊ]	5	4	1
	[dˤɨ]	6	6	3
	[ðˤa]	2	1	0
/ðˤ/→[ð]	[ðˤʊ]	3	2	3
	[ðˤɨ]	4	3	4
	[tˤɑ]	6	3	2
/tˤ/ →[t]	[tˤʊ]	7	5	4
	[tˤɨ]	4	6	5

Table 8.20: Types of errors of emphatics from Mandarin, Urdu and English speakers in the post-test

Figure 8.18 shows the patterns of errors in the production of emphatics among Mandarin, Urdu and English speakers.

Mandarin	/sˤ/ → [s]	/dˤ/ → [d]	/ðˤ/ → [ð]	/tˤ/ → [t]
Urdu	/sˤ/ → [s]	/dˤ/ → [d]	/ðˤ/ → [ð]	/tˤ/ → [t]
English	/sˤ/ → [s]	/dˤ/ → [d]	/ðˤ/ → [ð]	/tˤ/ → [t]

Figure 8.18: Production variants from Mandarin, Urdu and English speakers in the post-test

The improvements from the three language groups were noticeable. What is more interesting was noticing a minimisation of the types of errors learners used to pronounce instead of pronouncing the emphatic sounds. Before the instruction, some Mandarin speakers pronounced /dˤ/ as [ðˤ] and /ðˤ/ as [z], while Urdu speakers pronounced /ðˤ/ as [z]. These types of errors did not appear after the instruction and the only substitutions were the four non-emphatics.

Since the difference between the technology and traditional group was not significant in the perception and production of pharyngealised consonants and in the three vowel contexts, the next section focuses on the effect of each teaching method on the perception and production of the target sounds in each language group and proficiency level. The reason for conducting this analysis was to closely explore the outcomes of using each teaching method and to show what each method could provide for the pronunciation of L2 learners of Arabic in different proficiency levels and language backgrounds.

8.7 The Effect of the Teaching Methods on Proficiency and Language Groups

This section looks at the effect of using form-focused technology-based instruction and form-focused traditional-based instruction in enhancing the perception and production of the emphatic sounds in each proficiency level and language group. The previous section indicated that the difference between the traditional and the technology groups was not significant but they both improved significantly after the phonetic instruction. Therefore, the focus here is to identify the extent to which each proficiency level and language group was influenced by these two teaching methods and to detect the amount of learning gain of each language group in each proficiency level.

The three language backgrounds that were investigated in this study were Mandarin (13), Urdu (14) and English (11). The three proficiency levels included beginners (9), intermediate (14) and advanced learners (15). Table 7.2 in the Methodology for Study 2 Chapter, Section 7.4.1 shows the learners' distribution in the two teaching groups.

As shown in section 8.3 and 8.4, in the pre-test, some participants in the three proficiency and language groups showed a low level of perception and production accuracy with certain pharyngealised sounds in certain contexts. This section shows how the three proficiency and language groups differed in their performance in perception and production in the post-test after taking the two kinds of form-focused instruction.

As mentioned in the Methodology for Study 2 Chapter, one of the main limitations of this study was that the number of participants was small with different variations among the sample. Grouping participants into technology and traditional groups with three language and proficiency groups made the interpretation of the results and the statistical analysis limited. However, an attempt was made to compare each language group and proficiency level in the technology condition with its corresponding group in the traditional condition to reveal differences in the learning gains between equivalent groups of participants receiving two different teaching methods, and to control for the effect of potential variations in learners' proficiency and language background. This was done by showing the number of errors and the mean of each group in tables, and the learning gain of each proficiency and language group in perception and production in graphs.

The Mann-Whitney U tests were conducted between technology and traditional groups who share the same proficiency level and language background in perception and production. The results revealed that no significant difference was found between the two groups, which suggested that neither the technology nor the traditional groups improved significantly more than the other (see Mann-Whitney U tests results in Appendix K). Table 8.21 and 8.22 show the number and mean of errors in the perception and production of the emphatics of the different language groups and proficiency levels independently in each teaching condition.

			/sˤ/			/ðˤ/			/dˤ/			/tˤ/		
		Test	No. error	M	SD	No. error	M	SD	No. error	M	SD	No. error	M	SD
Mandarin beginners	Traditional 2	Pre	4	2.0	1.4	5	2.5	.71	5	2.5	.71	5	2.5	.71
		Post	2	1.0	1.4	3	1.5	.71	5	2.5	.71	4	2.0	.00
	Technology 2	Pre	2	1.0	.42	4	2.0	.71	5	2.5	.71	5	2.5	.71
		Post	3	1.5	.71	5	2.5	.71	4	2.0	.00	3	1.5	.71
Mandarin intermediate	Traditional 2	Pre	1	.50	.71	5	2.5	.71	1	.50	.71	3	1.5	.71
		Post	1	.50	.71	0	.00	.00	1	.50	.71	1	.50	.71
	Technology 1	Pre	1	1.0	-	1	1.0	-	1	1.0	-	2	2.0	-
		Post	0	.00	-	0	.00	-	1	1.0	-	2	2.0	-
Mandarin advanced	Traditional 3	Pre	6	2.0	1.0	5	1.7	.57	3	1.0	1.0	7	2.3	1.2
		Post	3	1.0	1.0	2	.67	1.2	1	.33	.57	5	1.7	.57
	Technology 3	Pre	2	.67	1.2	6	2.0	1.0	2	.67	.57	7	2.3	.57
		Post	1	.33	.57	1	.33	.57	3	1.0	1.0	2	.67	.57
Urdu beginners	Traditional 2	Pre	3	1.5	.71	5	2.5	.71	3	1.5	.71	5	2.5	.71
		Post	4	2.0	.00	5	2.5	.71	3	1.5	.71	4	2.0	1.4
	Technology 2	Pre	4	2.0	.00	3	1.5	.71	5	2.5	.71	5	2.5	.71
		Post	0	.00	.00	1	.50	.71	4	2.5	1.4	3	1.5	.71
Urdu intermediate	Traditional 3	Pre	4	1.3	1.5	2	.67	1.2	4	1.3	.57	5	1.7	.57
		Post	4	1.3	1.5	4	1.3	.57	2	.67	1.2	1	.33	.57
	Technology 3	Pre	3	1.0	.00	6	2.0	.00	4	1.3	.57	7	2.3	.57
		Post	1	.33	.57	2	.67	1.2	3	1.0	.00	4	1.3	.57
Urdu advanced	Traditional 2	Pre	1	.50	.71	1	.50	.71	2	1.0	.00	3	1.5	.71
		Post	1	.50	.71	0	.00	.00	0	.00	.00	3	1.5	.71
	Technology 2	Pre	2	1.0	1.4	3	1.5	.71	1	.50	.71	1	.50	.71
		Post	0	.00	.00	0	.00	.00	0	.00	.00	1	.50	.71
English beginners	Traditional 0	Pre	-	-	-	-	-	-	-	-	-	-	-	-
		Post	-	-	-	-	-	-	-	-	-	-	-	-
	Technology 1	Pre	1	1.0	-	2	2.0	-	0	.00	-	1	1.0	-
		Post	0	.00	-	1	1.0	-	0	.00	-	1	1.0	-
English intermediate	Traditional 2	Pre	2	1.0	1.4	3	1.5	2.1	2	1.0	1.4	6	3.0	.00
		Post	1	.50	.71	3	1.5	.71	2	1.0	.00	2	1.0	1.4
	Technology 3	Pre	2	.67	.57	6	2.0	1.0	4	1.3	1.5	3	1.0	.00
		Post	0	.00	.00	1	.33	.57	1	.33	.57	4	1.3	.57
English advanced	Traditional 3	Pre	2	.67	1.2	1	.33	.57	0	.00	.00	4	1.3	1.2
		Post	2	.67	.57	1	.33	.57	1	.33	.57	0	.00	.00
	Technology 2	Pre	1	.50	.71	2	1.0	.00	1	.50	.71	3	1.5	.71
		Post	0	.00	.00	1	.50	.71	0	.00	.00	0	.00	.00

Table 8.21: Perception errors in traditional and technology groups in each language and proficiency group

			/sˤ/			/ðˤ/			/dˤ/			/tˤ/		
		Test	No. error	M	SD	No. error	M	SD	No. error	M	SD	No. error	M	SD
	Traditional	Pre	2	1.0	.00	6	3.0	.00	5	2.5	.71	6	3.0	.00
Mandarin	2	Post	0	.00	.00	5	2.5	.71	4	2.0	.14	5	2.5	.71
beginners	Technology	Pre	3	1.5	2.1	4	2.0	.00	5	2.5	.71	6	3.0	.00
	2	Post	2	1.0	1.4	2	1.0	1.4	4	2.0	1.4	6	3.0	.00
	Traditional	Pre	0	.00	.00	1	.50	.71	6	3.0	.00	5	2.5	.71
Mandarin	2	Post	0	.00	.00	1	.50	.71	2	1.0	1.4	1	.50	.71
intermediate	Technology	Pre	1	1.0	-	2	2.0	-	2	2.0	-	3	3.0	-
	1	Post	0	.00	-	0	.00	-	2	2.0	-	2	2.0	-
	Traditional	Pre	3	1.0	1.0	3	1.0	1.0	3	1.0	.0	4	1.3	1.5
Mandarin	3	Post	2	.67	1.2	1	.33	.57	0	.00	.0	2	.67	.57
advanced	Technology	Pre	3	1.0	1.0	2	.67	1.2	2	.67	1.2	3	1.0	1.7
	3	Post	0	.00	.00	0	.00	.00	2	.67	.57	1	.33	.57
	Traditional	Pre	2	1.0	.00	4	2.0	.00	3	1.5	.71	6	3.0	.00
Urdu	2	Post	0	.00	.00	3	1.5	.71	3	1.5	.71	4	2.0	.00
beginners	Technology	Pre	4	2.0	.00	5	2.5	.71	1	.50	.71	6	3.0	.00
	2	Post	1	.50	.71	2	1.0	.00	1	.50	.71	4	2.0	1.4
	Traditional	Pre	3	1.0	1.0	4	1.3	.57	3	1.0	1.0	7	2.3	.57
Urdu	3	Post	2	.67	.57	1	.33	.57	3	1.0	1.0	3	1.0	1.0
intermediate	Technology	Pre	2	.67	1.2	6	2.0	1.0	5	1.67	1.5	7	2.3	1.2
	3	Post	1	.33	.57	0	.00	.00	2	.67	1.2	3	1.0	1.0
	Traditional	Pre	2	1.0	1.4	1	.50	.71	0	.00	.00	0	.00	.00
Urdu	2	Post	1	.50	.71	0	.00	.00	1	.50	.71	0	.00	.00
advanced	Technology	Pre	0	.00	.00	1	.50	.71	0	.00	.00	0	.00	.00
	2	Post	0	.00	.00	0	.00	.00	0	.00	.00	0	.00	.00
	Traditional	Pre	-	-	-	-	-	-	-	-	-	-	-	-
English	0	Post	-	-	-	-	-	-	-	-	-	-	-	-
beginners	Technology	Pre	3	3.0	-	3	3.0	-	0	.00	-	3	3.0	-
	1	Post	2	2.0	-	1	1.0	-	0	.00	-	3	3.0	-
	Traditional	Pre	3	1.5	.71	2	1.0	.00	3	1.5	.71	4	2.0	.00
English	2	Post	2	1.0	1.4	2	1.0	.00	3	1.5	.71	1	.50	.71
intermediate	Technology	Pre	6	2.0	1.0	5	1.7	1.2	3	1.0	1.0	2	.67	1.2
	3	Post	2	.67	1.2	4	1.3	1.5	1	.33	.57	3	1.0	1.0
	Traditional	Pre	2	.67	.57	2	.67	1.2	0	.00	.00	1	.33	.57
English	3	Post	0	.00	.00	0	.00	.00	0	.00	.00	1	.33	.57
advanced	Technology	Pre	1	.50	.71	2	1.0	1.4	2	1.0	.00	4	2.0	1.4
	2	Post	0	.00	.00	0	.00	.00	0	.00	.00	3	1.5	.71

Table 8.22: Production errors in traditional and technology groups in each language and proficiency group

It should be noted that there were no beginner English participants in the traditional group and only one participant in the technology group. It can be seen from Tables 8.21 and 8.22 that both teaching methods had contributed to a decrease in the number of perception and production errors of most emphatics. There was no learning gain for some emphatics in some groups; for example, advanced Urdu learners did not improve in the perception of the sound /tˤ/ in the technology group and the sounds /tˤ/ and /sˤ/ in the traditional group. The learning gain measures the difference in a learner's pronunciation accuracy between the start and end of the teaching interventions. It was calculated by subtracting the number of errors in the post-test from the number of errors in the pre-test for each participant. Figures 8.19 and 8.20 present the learning gain of each group in perception and production.

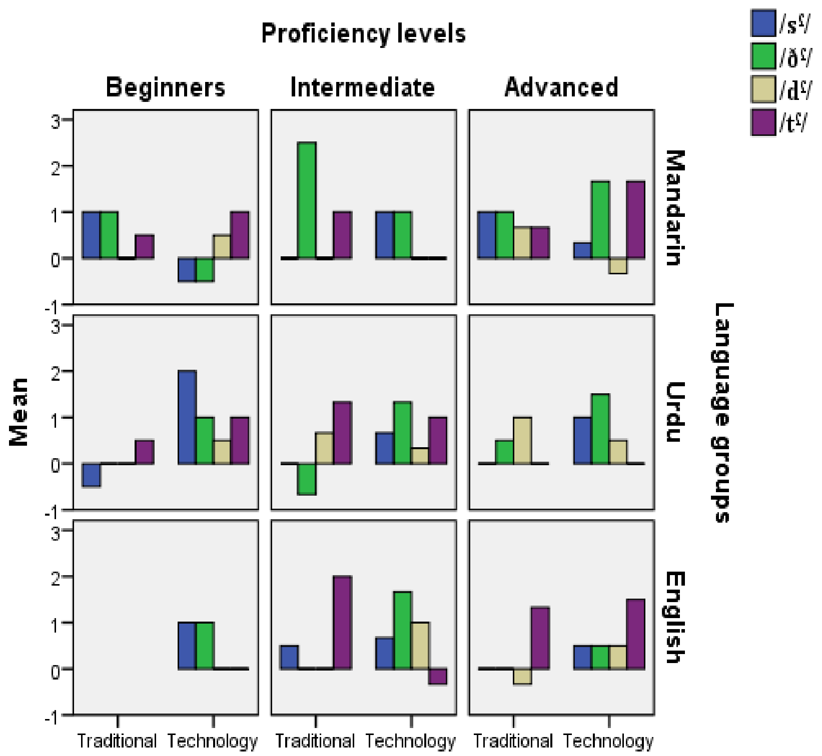


Figure 8.19: Mean error rate differential in perception pre- and post-tests in each group

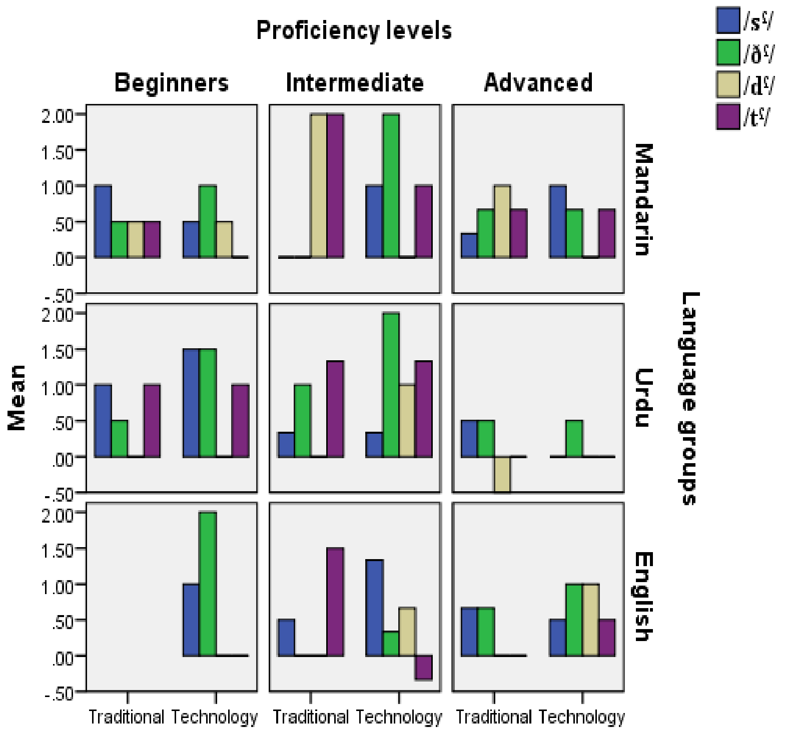


Figure 8.20: Mean error rate differential in production pre- and post-tests in each group

From the two graphs above, it was found that the sound that improved the least in both teaching methods was /dˤ/. This can also be seen in Figures 8.11 and 8.13 in sections 8.6.2 and 8.6.3. The sound /dˤ/ was significantly more difficult than others for Mandarin learners in the production pre-test according to results presented in Section 8.4.2. Mandarin learners had high learning gain in this sound in production, especially intermediate and advanced learners in the traditional group.

There were a few participants who misperceived and mispronounced the emphatics in the post-test but not in the pre-test, especially the sound /dˤ/ in perception by advanced Mandarin learners in the technology group, advanced English learners in the traditional group, and in production by intermediate Urdu learners in the traditional group. Those are represented in the graphs by scores below the mean 0.

Moreover, the sounds /ðˤ/ and /tˤ/ had higher learning gains among some groups in both teaching conditions. The learning gain in the production of these sounds was higher than in perception in some groups. However, identifying specific patterns of learning of each emphatic in each teaching group was difficult, which might be due to the limited data collected and the variations of the individual differences of the participants. These findings are discussed in the Discussion for Study 2 chapter, Section 9.7.2.

8.8 Summary of Findings

Since this chapter carried out a number of tests and deduced many results, it is necessary to summarise all the results in this section. First of all, the statistical tests used in this study were non-parametric, due to the data not having a normal distribution, as shown by carrying out The Kolmogorov-Smirnov and Shapiro-Wilk tests.

Second, the results showed that some learners in all three proficiency levels and language groups found difficulties in perceiving and producing the emphatics across the three vowel contexts, but patterns did emerge. Specifically, the emphatic /sˤ/ received the lowest number of errors and the emphatic /tˤ/ received the highest number of errors. Moreover, the emphatics preceding the vowel [ɑ] received the lowest number of errors, while the emphatics preceding the vowel [ɨ] received the highest number of errors. The results indicated that participants found more difficulties in perceiving and producing emphatics preceding the vowel [ɨ] than preceding the vowels [ʊ] and [ɑ].

Third, the results suggested that learners' language proficiency significantly affected their perception and production of most emphatics. Beginner learners showed significantly more errors than intermediate and advanced learners. The results also indicated that the three proficiency levels varied significantly in production more than perception, and especially with the sounds /ðˤ/, /dˤ/ and /tˤ/.

Fourth, no significant difference was found in the number of errors between Mandarin, Urdu and English speakers in perception and production, except for the pronunciation of the sound /dˤ/, which appeared to be significantly difficult for Mandarin speakers in comparison with the other groups.

Fifth, no significant difference was found between the efficacy of using speech analysis technology-based instruction and traditional-based instruction in enhancing learners' perception and production of emphatics, except in the perception of the sound /sˤ/, which improved significantly among participants in the technology group (p= .008). The results showed that the perception of all emphatics in the technology group improved significantly, while the traditional group improved only in the perception of the sound /tˤ/. Both groups improved significantly in the production of all emphatics except the emphatic stop /dˤ/. In addition, no significant difference was found between the two groups in perceiving and producing the emphatic sounds in the three vowel contexts. However, the perception of the emphatics preceding the vowel [ɨ] significantly improved in the technology group but not in the traditional group.

Sixth, the focus on the effect of pronunciation teaching between the technology and traditional groups of equivalent language and proficiency groups revealed no significant difference between groups who received technology and traditional pronunciation instruction. However, the small number of learners in the language and proficiency groups was not enough to make any claims about learning gain of each independent group after pronunciation instruction. This result needs further analysis with more data to accurately answer the third research question.

8.9 Summary of Chapter

This chapter presented the results of the main study that investigated the perception and production of the emphatics in the three vowel contexts from a group of L2 learners of Arabic. The beginning of this chapter offered a brief summary of the purpose of the study and presented the research questions.

After conducting the normality tests and choosing the non-parametric tests, the first question was answered by presenting the frequency of errors of each language group and proficiency level and in the three vowel contexts. The type of errors was then discussed and explained for each language group.

The second research question was answered next, by showing the differences in efficacy between using speech analysis technology-based instruction and traditional-based instruction in perception and production of emphatics across different vowel contexts. The third research question was answered by focusing on the effect of the two teaching methods on the performance of L2 learners of Arabic in different proficiency levels and language groups. The last section of this chapter summarised the main results of study 2. The next chapter discusses the findings of this study in the light of previous research in L2 pronunciation.

CHAPTER NINE

DISCUSSION FOR STUDY 2

9.1 Introduction

In this chapter, the three research questions of Study 2 are discussed in further detail. The first part of the chapter discusses the first research question, i.e., "What are the frequency and type of errors perceived and produced by L2 learners of Arabic in pronouncing Arabic pharyngealised sounds: (a) in different phonological environments, (b) in different proficiency levels and (c) from different language backgrounds?" The answer to this question provides thorough analysis about the effect of different factors on the difficulty of the perception and production of emphatics in different vowel contexts and with respect to learners' L1 backgrounds and proficiency levels.

The second part of the chapter discusses the second research question, i.e., "Do traditional form-focused instruction and technology-enhanced form-focused instruction have different effects on L2 learners' learning of Arabic emphatics across different vowel contexts?" Further analysis with respect to learners' proficiency levels and language backgrounds will be addressed to answer the third research question, i.e., "To what extent do traditional form-focused instruction and technology-enhanced form-focused instruction affect the perception and production of emphatics on L2 learners of Arabic in different language groups and proficiency levels?"

To conclude, a summary of the chapter will be provided.

9.2 The Difficulty of Emphatics in Light of Previous Research

For the first research question concerning the frequency and type of errors, the perception and production pre-test results have provided information about the errors perceived and produced by learners of Arabic from different proficiency levels and language backgrounds.

Overall, the results of the current study indicated that some learners of Arabic face pronunciation difficulty when it comes to dealing with Arabic emphatics in general and in certain vowel contexts. It was evident from the analysis of the results that the degree of difficulty and inaccuracy in the perception and production of emphatics by all learners was indeed high, ranging between 36% to 63% for perception and between 35% to 58.7% for production.

Prior to the analysis of perception and production errors of emphatics and vowel contexts, it is essential to discuss the difficulty of emphatics in general in light of previous literature. First of all, words with non-emphatics (i.e., /s/, /ð/, /d/, /t/) that were either produced or perceived during the tests were performed successfully by all participants. This result indicated that L2 learners from different proficiency levels and language backgrounds and regardless of their individual differences found Arabic non-emphatic sounds easy to perceive and produce.

Supporting the easiness of non-emphatic sounds, the current results agreed with the findings of Al Mahmoud (2013), which was described in the Literature Review Chapter in Section 2.4.5.2. Furthermore, Shehata (2015) demonstrated that the four non-emphatic sounds were rated by American learners of Arabic as easy to perceive and produce due to the existence of these sounds in English. The findings of these two studies were limited to native speakers of English while this current study confirmed the easiness of non-emphatics from speakers of English, Mandarin and Urdu.

The results for emphatic sounds, on the other hand, are broadly consistent with previous findings about the difficulty of these sounds encountered by L2 learners of Arabic in perception and production (Abdul-Kadir & Sudirman, 2011; Hayes-Harb & Durham, 2016; Shehata, 2015).

In perception, Al Mahmoud (2013) and Hong and Sarmah (2009) concluded that non-native speakers of Arabic find it difficult to discriminate among some of the Arabic phonemes, especially the emphatic sounds. The commonality between the current study and the studies of Al Mahmoud (2013) and Hong and Sarmah (2009) was that the subjects that were tested were experienced learners of Arabic.

What has been found interesting in Hong and Sarmah's (2009) study was that, in discriminating between the emphatics and the non-emphatics, Korean learners of Arabic in their study performed worse than the Korean speakers who had no experience of Arabic. Comparatively, in this current study, it was found in Section 8.3 that, in pronouncing the sound /dˤ/, intermediate learners (M=1.57) made few more errors than beginner learners (M=1.56). However, the difference between the two proficiency levels was not significant. Hong and Sarmah (2009) attributed the result of having lower experienced non-native listeners outperform more experienced non-native listeners to the loss of 'idiosyncrasy' of emphatic consonants by learner of Arabic, in which the more learners receive intensive and novel input, the more they get confused and, therefore, loss the ability to distinguish between sound contrasts. Although this explanation might be true, the discussion of it in Hong and Sarmah's study was perfunctory with no supporting evidence from previous research.

In this current study, the target sounds were added to a carrier phrase and, unlike Hong and Sarmah's study, were not presented in isolation. It was found in a previous study (Miyawaki et al., 1975) that it is easier to identify a sound outside of a linguistic context than within it by low experience non-native listeners, which may justify the performance of the naïve Korean speakers in correctly identifying the emphatic sounds. It was also found that, without practice, listeners or speakers may rely on familiar phonemic categories and show a high sensitivity to non-native sounds (Werker & Logan, 1985). This suggested that naïve non-native listeners may identify non-native sounds by focusing more on form than function (Swain, 1998). Once beginners build L2 phonetic knowledge and move to the intermediate level at a transitional position, they come more to focus on function and phonology and they have difficulties creating new phoneme categories. This current study does not provide absolute proof for these suggestions, but it attempts to bring to the light a plausible explanation for this finding.

Likewise, Alsulaiman et al.'s (2014) results are in line with the results of the current study. However, there are some paradoxical issues regarding the differences in the difficulty levels of each emphatic. The number of errors that were found in Alsulaiman et al. (2014) for each emphatic sound (i.e., /sˤ/ =69, /ðˤ/=52, /dˤ/=48, /tˤ/=13) indicated degrees of difficulties that were different from what has been found in the present study. Therefore, it might be speculated from those numbers of errors that the sound /sˤ/ was the most difficult to pronounce among emphatics and that the sound /tˤ/ was the easiest in pronunciation, which contradicts the results of the current study. Reasons for this are discussed below.

Compared to the methodology of the current study, the speech recorded by participants in the study of Alsulaiman et al. (2014) was different from one speaker to another, which means that the frequency of emphatics in participants' speech varied. Unfortunately, the numbers of each emphatic pronounced by each participant or language group in Alsulaiman et al. is unknown. In addition, the characteristics of participants and their backgrounds were also unknown. It has to be noted that the results of the current study were taken from experienced L2 learners of Arabic who had spent at least four months in an extensive Arabic course prior to their involvement in the study.

The findings of this current study presented in Section 8.2.3 showed that the sounds /sˤ/ were significantly easier in perception than the sound /ðˤ/ (p= .031), and /dˤ/ were significantly easier in perception than the sounds /ðˤ/ (p= .044) and /tˤ/ (p= .001). In addition, in production, /sˤ/ (p= .005) and /dˤ/ (p= .005) were significantly easier than the sound /tˤ/. The limited number of studies regarding the perception and production of Arabic phonemes made it difficult to discuss the expected frequencies of errors or patterns of acquisition from adults L2 learners of Arabic. Knowing the approximate patterns and frequencies of production or perception errors expected from L2 learners of Arabic helps in constructing effective and appropriate teaching materials. Therefore, it could be helpful to establish examples of expected pronunciation errors from learners of different proficiency levels and language backgrounds for L2 Arabic teachers in order to understand learners' needs and deficiencies in particular areas of Arabic phonetics and, therefore, focus more in classrooms on these weaknesses.

The studies mentioned above discussed generally the emphatic sounds and their difficulties in perception and production which are likely to hamper successful acquisition. One question that needs to be asked, however, is whether the four emphatic sounds and the three vowel contexts pose the same level of difficulty to L2 learners of

Arabic. This question has not been answered in previous research. A number of explanations have emerged in an attempt to justify the position of difficulty of each emphatic sound in the three vowel contexts in perception and production; these will be explained next.

9.3 The Influence of Vowel Contexts

It appears from the results in the current study that the difficulty that L2 learners experienced in perceiving and producing Arabic emphatics may relate to the effect of emphasis on the quality of following vowels and to learners' native language-specific perceptual systems. Generally, in the pronunciation of Arabic emphatics, the F2 of the preceding vowels is significantly lowered (Jongman et al., 2007; Jongman et al., 2011), which is discussed in the Literature Review Chapter in Section 2.3.4. It was found in previous studies that the effect of pharyngealisation was strongest throughout the vowel /a/, followed by /i/ and /u/ (Al-Ani, 1970; Jongman et al., 2007; Jongman et al., 2011). Furthermore, as discussed in the Literature Review Chapter in Section 2.3.4, Hayes-Harb and Durham (2016) found that the acoustic properties of the emphatic and plain contrast and the language background both govern learners' emphatic responses.

Due to the greatest effect of emphasis on the low front vowel [ɑ], which caused a stronger amount of F2 lowering than [ʊ] and [ɨ], emphatics that precede the vowel [ɑ] were perceived and produced more accurately than those coming before [ʊ] and [ɨ] from most participants with different language backgrounds. These results indicated that the quality of the following vowel may greatly influence the emphatics' perception and production accuracy by L2 learners of Arabic.

Learners' L1s have a great effect on their acquisition of L2 speech sounds (Benson, 2002; Major, 2008). This case can also be seen in the current study with Urdu speakers, who, similar to English speakers, found consonants in the context of the vowel [ɑ] easier than [ʊ] and [ɨ]. The vowel inventory of Urdu shows a low back vowel phoneme /ɑ/ that has similar quality to the pharyngealised allophone [ɑ]. Hence, it can be said that these results concur with the explanation of Hayes-Harb and Durham (2016) and Zaba (2007). However, the further investigation with Arabic learners other than English and Urdu native speakers emphasized the effect of the acoustic properties of emphatics in the various vowel contexts.

Unlike English and Urdu, the vowel inventory of Mandarin shows no similarities between the Mandarin vowel phonemes and Arabic pharyngealised allophones. However, the results of the current study showed that Mandarin speakers' responses were similar to Urdu and English speakers. Specifically, Mandarin speakers were able to more accurately perceive and produce emphatics that preceded the vowel [ɑ] than [ʊ] or [ɨ].

To illustrate this point, Figures 2.5, 2.6 and 2.7 presented in the Literature Review Chapter in Section 2.3.4 demonstrate the effect of the four emphatic sounds on the three adjacent vowels /a/, /u/ and /i/, which precede and follow the pharyngealised consonant in each case.

These figures show that the vowel [ɑ] has the strongest F2 lowering, followed by the vowel [ʊ], which, in turn, is stronger than the vowel [ɨ]. Therefore, besides the relationship between L1 and L2, the quality and realisation of pharyngealisation spread could also determine the quality of L2 perception and production.

The influence of the phonetic realisation of pharyngealisation spread could be a plausible explanation for the significant difference in the frequency of errors between the three vowel contexts due to finding similar identification patterns between the three language groups who have different vowel inventories. Moreover, the minimal phonetic difference between the two vowel phonemes [a] and [ɑ] could lead L2 learners to mispronounce or misperceive these sounds. Nevertheless, the data collected in this current study was not enough to confirm or fully support the results of Hayes-Harb and Durham (2016). Other studies on L2 learners of Arabic that follow a similar approach to Hayes-Harb and Durham (2016) are needed to determine the influence of the acoustic properties of the contrast and L2 learners' language backgrounds on the acquisition of Arabic emphatic and plain contrasts.

These results regarding the acquisition of Arabic pharyngealised sounds in the three vowel contexts from Arabic learners with different language groups have never been demonstrated and discussed by previous research. Further studies must be undertaken on different language groups that do not share the same vowel system to confirm the influence of pharyngealisation spread on learners' perceptive and productive skills.

9.4 The Effect of Learners' Arabic Proficiency

The effect of L2 proficiency on learning L2 speech sounds has not been the main factor investigated in most phonological research. However, extant studies of participants with different proficiency levels seem to suggest that learners' language proficiency may play a role in the development of speech sounds in the target language. The SLM claims that increasing the experience in perceiving and producing L2 may contribute to approximating native-like pronunciation (Best & Tyler, 2007; Derwing & Munro, 2013; Flege, 1995).

Perception and production pre-test results presented in Section 8.3 indicated that, although Arabic L2 learners at the advanced and intermediate levels of proficiency did not accurately perceive and produce all the target sounds, they outperformed beginners. Beginner learners perceived the sound /dˤ/ (p= .004) and produced the sounds /dˤ/ (p= .009), /ðˤ/ (p< .001) and /tˤ/ (p< .001) significantly less well than intermediate and advanced learners.

L2 experience has a substantial effect on the accurate perception and production of sounds (Flege, 1995). The results of this current study showed that, as experience in using Arabic increased, the establishment of Arabic sounds' categories was firmed up, which supported previous literature (Flege, 1987b; Munro & Derwing, 2008), emphasising the experience effects in the SLM.

While there is no doubt that learners' L2 acquisition goes through different stages and influences until reaching the ultimate attainment goals (Derwing, Munro, Thomson, & Rossiter, 2009; Major, 2008), researchers find it difficult to conduct a longitudinal study to provide an accurate and realistic representative sample (Munro & Derwing, 2008). This current short-term study did not show subtle changes over time and did not accurately measure learners' experience based on their first contact with Arabic but with their Arabic proficiency levels. The language experience written in the self-reported questionnaire were not taken as an accurate measure for learners' experience with Arabic. However, the findings agreed with many longitudinal studies that have been carried out on the effect of language experience and proficiency on learners' abilities to perceive and produce accurate L2 sounds (Flege & Liu, 2001;

Munro & Derwing, 2008). However, it remains uncertain whether or not proficient L2 learners of Arabic can completely develop target-like Arabic speech patterns.

9.5 The Role of L1 Transfer

The influence of the L1 background is considered one of the individual differences which could result in variations in perception and production among learners (Major, 2008). This section covers two aspects: the influence of L1 on learners' capacity to perceive and produce the emphatics accurately, and the difference between the three language groups in perceiving and producing emphatics in the current study.

It is likely that the frequency of errors found in the data resulted from the non-existence of these sounds in learners' native languages. Furthermore, the type of errors found in the data most likely resulted from other sounds in learners' L1s that are relatively similar in their phonological features to the target sounds.

Generally, it can be said that learners' L1s in this study are the 'stumbling stocks'– as described by Liu (2011) – that hamper their acquisition of emphatics. The results supported many studies that demonstrated the influence of learners' L1s on their acquisition of L2 (Alhawary, 2009; Börjesson, 2014; Brogan & Son, 2015; Seddighi, 2012; Trude & Tokowicz, 2011).

Analysis of the perception and production errors clearly showed an asymmetry between the three language groups in the ability to accurately perceive and produce sound contrasts that do not exist in learners' L1s. The question to be asked regarding the influence of learners' L1s is why certain emphatics were more difficult in perception and production, although learners' L1s lack all these emphatics. The interesting subject to discuss here is not what previous studies found and confirmed about the role of L1 transfer in L2 acquisition but why the acquisition was different between language learners and the target sounds. For example, in the current study in Section 8.4, Mandarin speakers performed less well than Urdu and English speakers, although all three groups lack the same sounds in their languages' phonemic inventories. Another example is that Mandarin speakers mispronounced the sounds /ðˤ/ and pronounced the sounds /ð/ instead, although sound /ð/ do not exist in Mandarin.

Investigating the type and frequency of L1 transfer of speech sounds requires a knowledge of the phonetic systems and phonological features of the learners' native languages and the target language. Therefore, CAH was needed to understand the rationale of L1 transfer.

The CAH elicits the differences and similarities between the native and target languages to identify the difficulties that are found in the acquisition of the target language (Alatis, 1968; Cai & Lee, 2015; James, 1980; Quinn, 2010). This method of phonetically contrasting learners' L1s with Arabic is used in this study to anticipate learners' responses with respect to the production of emphatics, and, as mentioned previously in this chapter, establishing examples of expected pronunciation errors to help teachers construct appropriate materials to eliminate such errors.

The CA that was presented in the Contrastive Analysis Chapter described the linguistic features of Mandarin, Urdu and English, as compared to Arabic. These features help in identifying the weakness points that Mandarin, Urdu and English speakers have in learning Arabic as L2. The CA of Mandarin, Urdu and English with Arabic succeeded to identify that the emphatic sounds would pose perception and production difficulty to those three language groups. Nevertheless, the present study did not attempt to examine the predictive power of CAH in L2 speech acquisition, but the data may provide some insight into the difficulty of emphatic consonants for learners of Arabic whose native speakers of Mandarin, Urdu and English.

As explained in the Literature Review Chapter, Section 2.6.2.2, this theory has been criticised for not being able to predict the degree of difficulty of L2 sounds (Khansir, 2012; Major, 1987; Sheldon & Strange, 1982). Therefore, when discussing the role of L1 transfer and the CAH in understanding speech errors, another hypothesis has to be mentioned as well, to remedy the deficiency of CAH. It was assumed that the MDH could also contribute in determining the type of speech errors that were derived indirectly from learners' L1s (Eckman, 1977; Major, 2008). Discussing the MDH in light of current findings is necessary to rationalise the existence of some speech errors.

9.5.1 Markedness Differential Hypothesis

The results obtained from the current study about the difficulty of emphatics were expected. Specifically, previous studies by (Al Mahmoud, 2013; Hong & Sarmah, 2009; Shehata, 2015) demonstrated the difficulty of emphatics and substantiated their findings, based on the theory of Markedness. In the present study, Mandarin, Urdu and English lack the feature of pharyngealisation in their phonological space, which made these L2 sounds marked and, therefore, hard to acquire.

What was not expected was finding a variation in the difficulty levels between emphatics and among the three language groups. The four emphatics are considered marked and the four non-emphatics are considered unmarked, although the fricative /ð/ does not exist in Urdu and Mandarin. To a limited degree, the theory of language transfer explains in general the reason for the difficulty encountered by L2 learners of

Arabic with the pronunciation and perception of emphatics. Markedness, on the other hand, may provide further explanation regarding perception and production responses from participants with different language backgrounds.

The data obtained from English speakers in Section 8.5 showed that they mistakenly produced non-emphatics instead of the emphatics. The four non-emphatic phonemes exist in the English phonemic inventory and are considered the closest to the Arabic emphatics in their place and manner of articulation (see Figure 2.8 in the Literature Review Chapter). They were also unmarked sounds, compared to the emphatics (Al Mahmoud, 2013). It can be concluded with regard to this group that the transfer from English to Arabic was clear and the existence of sounds that were similar to some extent to the Arabic target sounds has a major influence on determining the types of learners' pronunciation errors of emphatics.

Urdu speakers produced the non-emphatics /s/, /d/ and /t/ instead of the corresponding emphatics. Minor variation was found in the production of the sound /ðˤ/, due to the non-existence of its equivalent /ð/ sound in the Urdu phonemic inventory. Two explanations are behind the substitution of the sound /ðˤ/ with /z/ by only one Urdu speaker. First, /ðˤ/ is a voiced dental fricative emphatic phoneme and /z/ is a voiced alveolar fricative phoneme which exists in the Urdu phonemic inventory. The sound /z/ is the closest to the emphatic /ðˤ/ in its place and manner of articulation. Second, the variation of Arabic dialects – as discussed later in this chapter – could also influence the learner's response.

Interestingly, 19 Urdu speakers pronounced the sound /ð/, although this sound is not in the Urdu phonemic inventory. Two explanations can be proposed for this result. First, six Urdu speakers spoke English beside their native language and Arabic. This explanation supported previous findings about the existence of cross-linguistic influence in multilingual acquisition (Cenoz, 2001; Cenoz, Hufeisen, & Jessner, 2001) and the discussion of the influence of L2 on L3 acquisition in the Literature Review Chapter in Section 2.6.1.2. Second, although the sound /ð/ is considered rare in world languages (Wester et al., 2007), the theory of Markedness shows that the emphatic /ðˤ/ is more marked and more difficult to learn than the non-emphatic /ð/.

Mandarin speakers produced different types of errors in the emphatics /ðˤ/ and /dˤ/. The only two Arabic non-emphatic sounds that have counterparts in the Mandarin phonemic inventory are /s/ and /t/. This could be why Mandarin speakers produced the same alternative sounds in the production of the sounds /sˤ/ and /tˤ/. Similar to Urdu speakers, the sound /ðˤ/ was pronounced as /ð/ by 18 Mandarin speakers and as /z/ by two Mandarin speakers, although the sounds /ð/ and /z/ are not in Mandarins' sounds system. The role of Markedness in universally ordering the difficulty of sounds across world languages and Arabic dialectal variations, which is discussed later in this chapter, could be plausible explanations for these types of errors. Moreover, 18 Mandarin speakers pronounced /dˤ/ as /d/, while seven pronounced it as /ðˤ/. The first error is substantiated by the role of Markedness, which shows that the non-emphatic /d/ is unmarked and acquired easily. The second error can be interpreted by the confusion that the sounds /ðˤ/ and /dˤ/ pose to Arabic native speakers and L2 learners of Arabic as well (Al-Ani, 1970; Al-Raba'a, 2015; Ferrat & Guerti, 2013), which is discussed later in this chapter.

By looking at the types of errors among emphatics, the pharyngealisation feature was the obstacle learners of Arabic struggled to pronounce and perceive accurately. To the extent that this research is limited to learners of Arabic who speak Urdu, Mandarin or English, results of this study provide insight into the role of Markedness in the difficulty of identifying this novel sound feature. This linguistic investigation helped in enhancing the findings gained from CA and predict not only the difficult sounds, but the problems found in linguistically homogenous group of learners. This finding is significant from a pedagogical perspective because it helps teachers to establish a teaching method that focuses on explaining and emphasising the role of the adjacent vowels as cues rather than focusing on the place of articulation of emphatics.

Previous studies superficially mentioned MDH in learners' difficulties in the acquisition of Arabic sounds (Abdul-Kadir & Sudirman, 2011; Al Mahmoud, 2013; Alsulaiman et al., 2014; Hong & Sarmah, 2009), and they used this theory to justify why these sounds were difficult, in general, to learners of Arabic. This study combined CAH and MDH with actual data taken from learners of Arabic to present error frequency and divergence from three different language groups and illustrate which feature (i.e., place, manner, or voicing) was more challenging and more marked. However, previous studies demonstrated the role of Markedness regarding sounds' position within a word or in a single word and in a conversation (Major, 2008), this current research was mostly restricted to limited number of variables and the role of Markedness was only discussed regarding the feature of pharyngealisation in general. Other variables such as sounds' position within a word or syllables structure, which may have an influence on learners' ability to identify these sounds (Major, 2008), were not discussed in this current research.

9.6 Factors Affecting Learners' Perception and Production of Emphatics

The low degree of accuracy in producing and perceiving certain emphatic sounds might be, in general, indicative of one or several factors. There are a number of explanations that support some of the findings but contradict with other findings in the current study. The explanations that have emerged from the current findings concern functional load, orthographic representations of phonemes, Arabic dialectal variations and individual differences. These are discussed below.

9.6.1 The Functional Load of Emphatics

A likely explanation of the ease of acquisition of some emphatics compared to other emphatics among the participants in this study is the role of functional load in learning phonological contrasts, as discussed in the Literature Review Chapter in Section 2.3.7. This case can be seen with the sound /sˤ/, which was considered to be the easiest in production, and carries a heavier functional load than the other emphatics. Another correspondence with the theory of functional load is the sound /tˤ/, which has a low functional load, and was found to be the most difficult sound in production in the current study.

Lee and Hwang (2016) noted that sounds with high functional loads have high learnability. Therefore, it is likely that the high functional load of some emphatics caused L2 learners of Arabic to unconsciously acquire them earlier or focus more on pronouncing them accurately. However, this does not explain the situation with the other sounds in this study. Despite the mid functional load of the sound /ðˤ/, it posed more difficulty for the participants of this study than the sound /dˤ/, which carries a low functional load. This could be to do with the more marked dental fricative primary articulation of / ðˤ/, as discussed above, or the variations between Arabic dialects. It was possible for students to experience some Arabic pronunciation patterns taken from language teachers, although all Arabic teachers in the institution are supposed to speak to the students in MSA. Words pronounced in MSA with [dˤ] are realised in Najdi dialect as [ðˤ] (Ingham, 1994).

As mentioned in the Literature Review in section 2.3.7, the functional load of Arabic sounds was hypothesised based on their acquisition by child native speakers of Arabic. It would be beneficial to reorder the Arabic sounds' functional loads based on their frequencies in lexical items and minimally paired words, as suggested by Brown (1988), rather than relying on children native speakers' acquisition stages. Hellmuth (2014) stated that the order of Arabic sounds' functional load is subject to revision in view of future research because the order was supported by previous studies that concerned children who were native speakers of Arabic. Measuring the functional load of Arabic phonological contrasts by using suitable approaches provides valuable linguistic information on Arabic, that can be used in developing Arabic automatic speech recognition systems and constructing effective teaching materials that focused on the most used and important Arabic phonological contrasts.

As mentioned earlier, the explanations presented here agree with some results and contradict other results. This discrepancy can be seen when applying the concept of functional load on emphatics. However, other explanations, as presented next, may provide support to the argument and substantiate the differences in the difficulty levels between emphatics.

9.6.2 Orthographic Representations of Emphatics

There are Arabic graphemes that are orthographically similar to Arabic target phonemes which could cause confusion to L2 learners of Arabic. To explain this in light of the current findings, the voiceless emphatic stop /dˤ/ is represented by the

Arabic letter (ضـ) initially, (ـضـ) in the middle and (ـض) at the end of a word. Seven Mandarin speakers pronounced the sound /dˤ/ as /ðˤ/, which is represented by the Arabic letter (ظـ) initially, (ـظـ) in the middle and (ـظ) at the end of a word. What distinguishes the written /dˤ/ from /ðˤ/ in the initial or middle position in a word is the short vertical line above the sound /ðˤ/. Hence, substituting the sound /dˤ/ by /ðˤ/ could be the result of the orthographic similarities between the two Arabic letters.

The negative effect of the similarities in the orthographic representation of Arabic sounds was also supported by Al Mahmoud (2013), who found confusions in perception between the sounds /χ/ (خ), /ɣ/ (غ) and /ħ/ (ح). However, this conclusion in the current study and Al Mahmoud (2013) cannot propose that L2 learners of Arabic are severely hampered by the similarities in orthographic representations of Arabic sounds because the focus and the methodology in both studies did not concern the influence of L1-L2 orthographical representations of phonemes on the acquisition of L2 sounds.

It was found that the confusion in the current data between /dˤ/ and /ðˤ/ is supported by other studies on the Arabic language that have discussed great similarities between the two sounds in pronunciation and writing. These studies also demonstrated the same difficulty for native speakers of Arabic of distinguishing between these two sounds (Al-Raba'a, 2015). This is discussed in the next section.

9.6.3 Arabic Dialectal Variations

Speakers of an Arabic dialect have a set of underlying forms that are different from MSA. The differences in the realisation of Arabic emphatics can be seen in Shar and Ingram (2010), who investigated emphatics in Assiri Arabic, which is a dialect spoken in the south of Saudi Arabia, and Hassan (2012), who investigated emphatics in the Iraqi dialect. These two studies showed different acoustic values of F1 and F2 in the pronunciation of emphatics, which was discussed in the Literature Review Chapter in Section 2.3.5. Other differences between Arabic dialects are in the perseverance and directionality of the spread of pharyngealisation (Laufer & Baer, 1988).

Al-Raba'a (2015) examined the pronunciation of the sound /dˤ/ by Arabic native speakers and found that native speakers from Saudi Arabia pronounced the sound /dˤ/ as /ðˤ/. In the same vein, Al-Ani (1970) pointed out that Iraqi Christians tend to pronounce the emphatic /dˤ/ as /ðˤ/. Furthermore, speakers of Maghreb countries, including Morocco, Tunis and Algeria, merge the phonemes /dˤ/ and /ðˤ/in pronunciation (Ferrat & Guerti, 2013). Previous studies showed that the similarities in pronunciation and orthography between the sounds /dˤ/ and /ðˤ/ pose production problems to native speakers of Arabic.

This situation can be seen in the current study as regards the pronunciation of the alveolar fricative /z/ for the emphatic fricative /ðˤ/. Two Mandarin and one Urdu speakers pronounced the word /naðˤiːr/ 'equivalent' as /naziːr/ 'little', and /manðˤuːr/ (منظور) 'perspective' as /manzuːr/ 'little'. The two sounds /ðˤ/ and /z/ differ in the place of articulation and the feature of pharyngealisation. Hence, incorrect pronunciation could be the result of the variation in pronunciation between Arabic dialects and MSA. It is very likely that L2 learners of Arabic learn one of the Arabic dialects beside learning MSA to interact and communicate with local residents because MSA is mainly used in education and some form of media (Haddad, 2006). Therefore, the unusual types of errors such as pronouncing the fricative /z/ instead of the non-emphatic /ðˤ/ could be a result from a confusion between the two phonological rules. Unfortunately, the learners' background history of learning Arabic dialects other than MSA was unknown, and so it is not possible to confirm or refute the possible effects of knowing other Arabic dialects.

9.7 Teaching Pronunciation

This section focuses on the second part of the main study that investigates the use of traditional and technological techniques (Praat) in enhancing learners' perception and production of the emphatics. It provides answers to the second and third research questions and gives an idea about what to expect from learners with different language backgrounds and proficiency levels when using speech analysis technology to support learning Arabic pronunciation.

This section is divided into two subsections. The first subsection links the results obtained from the technology and traditional groups with previous research that had significant results after receiving phonetic instruction through traditional methods and Praat. The second subsection discusses the effect of the two teaching methods on learners with different language groups and proficiency levels.

Participants' failure to produce and perceive accurate emphatic sounds may be related to the type of instruction they received. The results showed that both teaching approaches contributed in developing L2 learners' pronunciation of sounds. As shown in the Results for Study 2 Chapter, Section 8.6.2 and 8.6.3, the errors in the traditional group declined 34.3% in perception and 23.2% in production in comparison with their pre-test scores, while the errors in the technology group declined 50.9% in perception and 49.5% in production.

The objective of the training courses was to aid Arabic learners to produce intelligible and accurate speech sounds, which will lead them to pronounce correct words and convey a comprehensible meaning (Burns & Claire, 2003; Morley, 1991). This current study followed Sajavaara and Dufva's (2001) suggestion in assessing learners' speech based on the intelligibility of sounds and not on achieving native-like pronunciation.

The idea of using pronunciation instruction with different teaching techniques in enhancing learners' understanding and production of speech sounds was demonstrated in previous research (e.g. Bajuniemi, 2013; Ghorbani et al., 2016; Gordon et al., 2012; Kissling, 2013; Lipińska, 2013; MacDonald et al., 1994; Saito, 2007; Saito, 2011a). The central components of the pronunciation instruction in the current study included a picture of the vocal tract, explicit interpretation of the phonetic features of emphatic and non-emphatic consonants, practicing minimal pairs, reading passages aloud, repeating words and receiving feedback.

These techniques were chosen carefully, as each one has proven its efficacy in teaching pronunciation in previous research (Arai, 2007; Gordon et al., 2012; Lee & Lyster, 2016b; Saito & Lyster, 2012a; Trofimovich & Gatbonton, 2006). The application of these techniques was different, depending on the method used with each group (i.e., technology or traditional). However, it cannot be confirmed whether the two groups were affected similarly by each technique, which raised the question about the most effective technique that led to this significant improvement.

Generally, the only focus in the classroom was on the sound features. This type of instruction is categorised as form-focused instruction (Saito & Lyster, 2012a). According to previous studies that demonstrated the effectiveness of form-focused instruction, this specific approach helped learners to notice the common and distinctive features of the target sounds by obtaining learners' engagement and attention (Ellis, 2002b; Lyster, 2004b; Saito, 2013b; Spada, 2011). The role of form-focused pronunciation instruction was not under investigation here and cannot be demonstrated without assigning a control group to confirm the positive outcomes of this teaching approach compared to other approaches.

Evidence of perception and production development in the current study can be seen in the types of errors after receiving the two types of pronunciation instruction, which were presented in Results for Study 2 Chapter in Section 8.6.5. The errors before the instruction included sounds that were different in the manner and place of articulation from the emphatic sounds, such as /dˤ/→[ðˤ] and /ðˤ/→[z]. These errors did not appear in participants output after the instruction. These results seem to corroborate the Noticing Hypothesis (Schmidt, 1990) and the benefit of the pedagogical sequence of form-focused instruction with the three stages of interlanguage development (Lyster, 2004a, 2004b, 2007). The main objective of using the stages of interlanguage development in the current study was to build learners' declarative knowledge of the distinctive features of emphatics.

According to the pedagogical sequence of form-focused instruction, discussed in the Literature Review Chapter, Section 2.4.4, the picture of the vocal tract and the explicit phonetic instruction were used in this study to promote learners' noticing of the pharyngealisation feature in Arabic (1- noticing stage). Engaging learners to further analyse the pharyngealisation feature came next, with some degree of elaboration including visual representation of sound features for the technology group, and explaining the differences between minimal pairs in the traditional group (2- awareness stage). Finally, after learners have demonstrated they can successfully understand the phonetic and gestural features of emphatics, they were ready to practice pronouncing the target sounds. This was achieved by recording and imitating native speakers in the technology group based on acoustic displays of the target sounds in speech, and repeating after the instructor and reading passages aloud for the traditional group (3-practice stage). This study was the first one to attempt at testing Lyster's form-focused interlanguage development stages in the area of Arabic pronunciation teaching.

9.7.1 Traditional and Technology Teaching Approaches

In answering the second research question, as can be seen from the Results for Study 2 Chapter, in Section 8.6.2 and 8.6.3, no significant difference was found in the perception and the production of emphatics between the technology and traditional groups after receiving the two types of instruction, except in the perception of the emphatic /sˤ/ (p=.008). The technology group made fewer errors in perceiving and pronouncing the emphatics than the traditional group. Moreover, in Section 8.6.4, the results also showed that, unlike the technology group, the traditional group did not improve significantly in the perception of the emphatics preceding the vowel [ɨ] after the phonetic instruction (traditional group (p =.141), technology group (p =.005)).

Overall, both teaching approaches contributed significantly in developing L2 learners' pronunciation of sounds. The techniques used in both courses helped to enhance learners' knowledge and understanding of Arabic sounds. The lack of statistical significance in the comparison of the two groups could be due to the fact that the same teaching techniques were applied to learners, such as corrective feedback and explicit description of sound features. The results of this study provide support for literature about both traditional (Gómez Lacabex & García Lecumberri, 2010;

Tergujeff, 2012) and modern technology-assisted teaching approaches (Offerman & Olson, 2016; Olson, 2014).

Based on the results of this experiment, it can be concluded that some traditional methods that are used in teaching pronunciation can be beneficial in developing the ability to produce intelligible and comprehensible speech and good perception ability. Other modern methods, such as using Praat with L2 learners, can also be helpful in developing their understanding of sound features visually. The greatest contribution of the present study is its demonstration that the use of Praat in teaching Arabic emphatics was just as effective for improving learners' perception and production as the traditional methods that are commonly and frequently used in L2 classrooms.

The two groups received the training sessions for four days (90 minutes/day), when each day was dedicated to one emphatic sound. Indeed, this amount of time spent in receiving pronunciation instruction was brief, but on par with the amount of time devoted to teaching phonetics in previous research, which yielded significant and positive results, for example, two training sessions in Liu, Massaro, Chen, Chan, and Perfetti (2007), 25 minutes for nine days in Gordon et al. (2012), one hour two times a week for two weeks in Saito and Lyster (2012a), one hour and 30 minutes in Muranoi (2000), one hour in Ellis, Loewen, and Erlam (2006), 90 minutes in Sheen (2007) and two hours in Yang and Lyster (2010). Gordon et al. (2012) noted that "[e]ven adding only a relatively time-limited explicit pronunciation component in a primarily communicative classroom can lead to beneficial results in production for learners" (p. 112). This was also found beneficial for learners learning for religious purposes in the current study.

The results of this study support many previous studies that attributed their positive results to using speech analysis technology as a main tool in phonetic teaching (Gorjian et al., 2013; Le & Brook, 2011; Offerman & Olson, 2016; Olson, 2014). However, the difference between previous studies and this study is that this study found no significant difference between traditional and modern teaching approaches, as both groups improved significantly after taking one of the training courses. As explained previously, and unlike previous research that demonstrated the effectiveness of using Praat in comparison with traditional methods, the techniques used with the traditional group were similar to those used with the technology group, which may have affected the results of the traditional group. The explicit information component used in this study needs to be controlled in order to see better if using speech analysis in learning Arabic sounds would be significantly better than the traditional method. It appeared that explicit information and feedback were possible confounding variables that were not taken into consideration, eliminating the possibility to conclusively determine if the use of Praat actually helped Arabic learners or whether the explicit instruction and feedback improved learners' perception and production. Future research could eliminate this limitation and control these variables.

9.7.2 The Effect of Instruction on Different Proficiency and Language Groups

To answer the third research question, the present study addressed the issue of proficiency and language background as factors that affect developing the perception and production of speech sounds in traditional and technology pronunciation instruction. The majority of researchers who investigated the L2 production features and the effect of explicit instruction employed advanced L2 learners (Bongaerts, Mennen, & Slik, 2000; de Castro Gomes & Lúcia, 2012; González-Bueno, 1997; Lord, 2005; Smit & Dalton, 2000; Towell, Hawkins, & Bazergui, 1996). These studies addressed the need to carry out similar research on L2 learners with low L2 experience. The current study included L2 learners enrolled in three proficiency levels: beginner, intermediate and advanced.

The results showed that most of the learners in the three proficiency levels and language groups improved after the two types of phonetic trainings as shown in Section 8.7. The development can be clearly seen in Figures 8.19 and 8.20 in the beginner learners, which leads to the assumption that the different techniques used in this study, along with Praat, can help in perception and production not only for learners with high language experience but also for those with low language experience, which supports the results of Olson (2014) in the possibility for beginner L2 learners to benefit from using modern learning techniques .

The results presented in Section 8.7 did not show similarities or differences in the pattern of learning gain among participants between the two groups, which suggested that no definite outcomes were found that can judge the effectiveness of the two teaching methods on learners in different levels of proficiency and language backgrounds for different reasons. Several influences on pronunciation learning have been proposed by theorists and researchers such as, age, learning styles, personality, language experience, aptitude, cognitive abilities, etc. These factors/ variables affect learners' productive and perceptive abilities in different ways (Derwing & Munro, 2015; Dörnyei, 2014; Dörnyei & Skehan, 2003). Furthermore, learners have different characteristics and behave differently in instructional interventions and tests and their behaviour cannot be controlled and measured in a short period of time with limited resources (Colantoni, Steele, & Escudero, 2015). These influences might explain the inconsistent behaviour among participants after receiving pronunciation instruction. Moreover, the small number of participants and data collected from each participant might have contributed to not finding common patterns of acquisition.

Therefore, the third research question cannot be accurately answered. Nevertheless, this investigation gives an idea to other researchers who are interested in examining the learning gain of learners in learning emphatic sounds through pronunciation teaching, which can be investigated again intensively through obtaining more data from a larger number of participants with controlled individual variations and from different L1 language backgrounds and different proficiency levels, and also with a more prolonged period of pronunciation teaching.

As mentioned above, this was an attempt to find which method was better for learners from certain L1 language backgrounds or proficiency levels. However, finding commonalities between equivalent language or proficiency groups was difficult in this study due to the low number of participants and groups. Therefore, it can be said that this attempt has failed to detect similar patterns of learning gain between groups, which suggested further investigations in this topic with more participants and data to gain accurate and informative results.

9.8 Limitations of the Study

Although the methodology and purposes of this study responded to calls in previous studies for further investigation (Offerman & Olson, 2016; Olson, 2014; Saito & Lyster, 2012a), there are several limitations, which may limit the generalisability of the findings.

9.8.1 Research Framework

This research aimed at quantifying perception and production errors from a group of L2 learners of Arabic. Thus, the research framework for this study was quantitative and did not focus on the behaviour and responses of specific individuals. Study 1 and 2 carried out an experimental design that focuses on learners' performance before and after certain conditions. Unfortunately, this study did not examine other variables, such as learners' feedback and attitudes towards the use of speech analysis.

Furthermore, the experimental design was conducted solely in order to facilitate the acquisition of Arabic fricatives and emphatics. Applying the same method to teaching other sounds may yield different results. The quasi-experimental design that was chosen in both studies has threatened their internal and external validity, as discussed in the Methodology for the Study 1 Chapter.

9.8.2 Participants

The first study involved a sample of 46 Arabic learners and native speakers of Urdu, Mandarin and Tagalog. The second study involved 38 Arabic learners and native speakers of Mandarin, Urdu and English. The learners in both groups were attending the Arabic Linguistic Institute at Princess Nourah University in Saudi Arabia at the time of the data collection (April 2015 for Study 1 and April 2016 for Study 2). The sample size was small, with large variations among samples. The results cannot be generalised to make inferences about a population of all learners of Arabic. The CA results are delimited to Arabic learners whose native speakers of Mandarin, Urdu and English. Furthermore, the majority of the participants were from intermediate and advanced levels of proficiency. The participants in both studies varied in their age, and age was not taken as a variable in this study.

The biggest potential concern was the tests used in the institute as indicators of learners' language proficiency. Learners were assigned to proficiency levels based on a non-standardised test that was set by individual examiners. The proficiency placement tests were not systematic and were the result of examiners' choices. Unfortunately, access to those tests was restricted. The pedagogical methods and techniques used in the institution to teach pronunciation were subject to instructors' choices. Hence, it was difficult to access a consistent pronunciation curriculum to detect learners' knowledge of such techniques. Furthermore, due to the limited time given to collect the data, it was not possible to detect learners' previous knowledge about Arabic phonemes and phonology, other than performing a pre-test.

9.8.3 Selection and Grouping of Participants

The current study was drawn from intact groups, rather than from randomised participants, which possibly threatens the internal and external validity (Hatch & Lazaraton, 1991). The only randomisation of the population was due to the students' self-selection into the classes. The circumstances involved in the selection of the sample prevented the use of a randomised design (i.e., specific language backgrounds). Participants' characteristics, such as their age and their experience with technology, were not taken into account in the group selection, which may have raised the individual variations among the sample.

9.8.4 Perception and Production Tests

For Study 1, the data was collected through recordings of 13 single words containing the fricatives in random vowel contexts, which may not have been sufficient to judge the learners' ability to produce the sounds. For Study 2, the tokens used in both perception and production were words in a carrier phrase. For perception, each word was repeated twice: one with an emphatic and one with a non-emphatic. Furthermore, each emphatic and non-emphatic was repeated three times in different vowel contexts.

As mentioned earlier in section 9.7.2, it was difficult to say with certainty how much the technology teaching technique contributed to the learning gain as compared to the traditional technique in each language group and proficiency level because of the small data and the individual differences that cannot be controlled. As mentioned before, a plan was designed prior to collecting the data, which contained interviewing the participants and collecting recordings from participants reading the Quran. Unfortunately, the time given from the institution to conduct the study was limited, forcing the researcher to be very brief when training learners and collecting the data in order to finish testing all the participants in the short period of time allowed, and to give more time to the teaching sessions.

The data was obtained through two small tests and not through natural conversations or carried phrases. The words used in measuring learners' developments of speech sounds were limited. Using more words and phrases may yield different and more reliable results. It should be noted that participants were given an unlimited time to perform the tests, which may not be comparable to real-life situations. The reaction time of learners' responses was not measured; hence, it was not known how fast the learners mentally processed L2 tokens.

Furthermore, the perception test was carried out by means of a computer, where participants listened to the phrases and chose the right words. Participants were not offered a second chance to listen to the words again or retake the test under any circumstances, although one participant claimed that she hit a wrong button by mistake. The use of a computer requires a competence that may have been lacking in some participants. Therefore, it is possible that taking the perception test through other means may produce more genuine results.

The results here cannot be directly linked with studies that have applied other sorts of tests, and the accuracy of participants should not be inferred with regard to their pronouncing similar sounds in spontaneous speech. The tokens used in the tests were controlled by using known words. However, it is possible that not all participants knew all the words, which may have created variations in the responses between participants.

9.8.5 Procedure and Teaching Materials

I was involved as a teacher in giving the instructions for the experimental group, which may raise the matter of the 'Pygmalion effect'. Maclachlan (1993) defined the 'Pygmalion effect' as "the likelihood that a teacher's expectations of a pupil's performance will shape the pupil's behaviour to coincide with the teacher's expectations" (p. 167).

The experiment was conducted in both classroom and laboratory settings. The results from using L2 classroom could be influenced by the learning environments.

Furthermore, the materials used in the teaching courses were only piloted once on a very small number of participants (six in total) and the techniques used were limited. In the training sessions, beginners were treated equally as advanced learners, which may have affected the understanding of any beginner student.

Due to the limited time given in collecting the data, the teaching materials focused only on the pharyngealised vowels that followed the emphatics. Other studies should look at both directions as the pharyngealisation spread affects the proceeding vowels as well (Al Khatib, 2008; Watson, 1999). Moreover, this study did not take into account the influence of suprasegmental features such as stress or pitch, which may contribute to distinguishing between sounds similarly as phonemic differences.

9.8.6 Rating Reliability

To reduce any potential bias, I did not judge participants' performances in the pre- and post-tests for Study 1 and 2. Eleven external raters were used to rate learners' speech. However, the use of listeners' judgments in assessing L2 speech have some degree of subjectivity, in which may be influenced by many factors such as language experience in specific accent or bias against certain accents or voices (Derwing & Munro, 1997; Derwing et al., 1998).

9.8.7 Course Duration and Delayed Post-test

Due to time constraints, it was not possible to conduct a longitudinal study to elicit more accurate and in-depth information about participates' performances over time. The duration of the teaching courses was very short, just four days, six teaching hours in total. It would be valuable to extend the duration of the training to allow more improvements and to see if the errors continue to decrease.

The time of collecting the data was during April in 2015 and 2016 at the end of term. It was not possible to perform a delayed post-test. Participants in the advanced proficiency level have graduated right after the end of the training course and they went back to their home countries. Some participants have ended their scholarships and travelled to their countries as well. Reaching those participants and performing a delayed post-test was impossible. However, this is considered one of the greatest limitations to the study, which leave us with little knowledge about how long-lasting the learning gains were.

9.8.8 Computer Skills and the Use of Praat

The participants' self-evaluated data showed that they ranged from poor to excellent in their computer proficiency, which may result in variances across participants in the use of Praat and in the tests results. It is may be better to assign a group of participants that have the same level of competence to control such variable.

In terms of Praat, the pronunciation training cannot be done without instruction and feedback from the teacher, and the time taken for training on Praat was only one and a half hours. The study was limited to the examination of the effects of Praat on pronouncing certain sounds. The use of other technological tools or the use of Praat in teaching sounds other than the Arabic emphatics and fricatives may result in different outcomes. The use of Praat in this study was based on the strategy of Olson (2014) and Offerman and Olson (2016). Using a methodology based on other studies that integrate Praat in teaching pronunciation following different approaches, such as Wilson (2008) who suggested integrating Praat with Moodle and Delrue (2013) who constructed a training approach at sentence level and English prosody, may not deliver similar results.

9.9 Summary of Chapter

This chapter has discussed the findings in relation to the research questions. In the first part, the focus was on learners' perception and production of emphatics and the influence of the three vowel contexts on the realisation of these sounds.

The second part presented a discussion that emerged from comparing the technology and the traditional methods and their contribution to enhancing learners' perception and production of emphatics. It also included a discussion about the effect of these teaching methods on learners in different proficiency levels and from different language backgrounds.

CHAPTER TEN

CONCLUSION

10.1 Introduction

This concluding chapter summarises the major findings of Study 1 and 2 and draws conclusions about the necessity of teaching Arabic phonemes and integrating speech analysis technology in teaching those phonemes. In addition, it suggests recommendations for future research.

10.2 Summary of Major Findings

The following outlines the major findings that have arisen from the analyses of the research questions in Study 1 and 2.

- The data provided support for the notion that L2 learners of Arabic find some Arabic phonemes difficult to learn, especially /χ/, /ɣ/, /ð/, /θ/, /ħ/, /ʕ/, /sˤ/, /ðˤ/, /dˤ/ and /tˤ/. The low accuracy in perceiving and producing these sounds may partially result from the major variances between the phonetic systems of learners' native languages and Arabic. L2 learners' inability to perceptually and phonetically categorise novel Arabic sounds to fit in their L1 phonological space causes them to treat these unfamiliar sounds identically as L1 sounds. The difficulty of these sounds made them ideal candidates for instruction.

- The use of traditional teaching techniques is not more beneficial than the use of speech analysis technology (Praat) in explaining and understanding the characteristics of sounds. The improvements exhibited by the technology group in Study 1 and 2 suggest supporting the use of visual representations of sound features as an assistive tool in teaching Arabic phonemes along with traditional techniques. The results suggest the idea that the use of speech analysis, specifically in visualising the features of fricatives and emphatics, in L2 Arabic classrooms can serve as an approach in interpreting the distinctive features of sounds that cannot be recognised in natural conversation.

10.3 Conclusions

This study aimed at investigating L2 learners of Arabic in their ability to perceive and produce emphatic sounds accurately and whether technology and traditional teaching approaches significantly enhanced learners' perception and production skills. It was demonstrated that some L2 learners encountered difficulty in the perception and production of emphatics in certain vowel contexts. The role of the L1 adds confusion to the learners, as the learners L1s' phonological space plays a great role in the perception and production of sounds.

This study has shed light on the possibilities of integrating the technology teaching approach, specifically, the speech analysis technique, into the Arabic pronunciation curriculum, in order to enhance learners' pronunciation of difficult L2 sounds. Affirmative information about places of articulation of L2 sounds cannot be derived directly from the visual representation of sounds without the help of aural input and visual cues of articulation. Adding the visual technology component to the whole traditional teaching pronunciation process in this current study helped learners to see small phonetic features that cannot be clearly explained through traditional techniques. The use of the three components (i.e., visual analysis of speech, form-focused instruction, auditory input) in this current study improved learners significantly despite the short course.

Results from this current study showed no significant difference between technology and traditional approaches, although the learners in the technology group improved more than the learners in the traditional group. Similar strategies were used with both groups including explicit explanations of sound features, practicing minimal pairs and listening and repeating. These techniques may have contributed to learners' developments in the traditional group, as well as in the technology group. The speech analysis method used with the technology group may have added more clarification of some sound features, but did not greatly enhance learners' understanding of sounds in general. One of the reasons could be that this technology was beyond some learners' abilities and understanding. Some low experienced learners may not be capable of decoding visual speech, especially when the differences between two spectrograms are very small, supporting the opinion of Setter and Jenkins (2005) about the inappropriateness of Praat to be a didactic tool because it requires high level of understanding and training, which language teachers and learners may lack. In addition, it could also be the case that some sound contrasts are very similar in their F1 and F2 frequencies, as in the sounds /tˤ/ and /t/ (explained in Appendix L), which made identifying and distinguishing these two sounds visually through spectrograms difficult and requires effort, time and experience. It is, however, noteworthy that most participants in both groups in this current study succeeded to some degree in learning the rather complex and unfamiliar Arabic sounds.

The primary contribution of the current study is to show how the learning of Arabic emphatic and fricative sounds can be equally well facilitated through two methods: pronunciation teaching which includes presenting visual acoustic representations of novel sounds; and traditional pronunciation teaching techniques. The technology method is beneficial to L2 learners of Arabic in different proficiency levels and language groups. It is hoped that this research will benefit Arabic language instructors and researchers in embedding this modern tool in the teaching of Arabic sounds, which can be used inside or outside of classroom settings.

10.4 Pedagogical Implications

This research can help teachers of Arabic as L2 to set goals to improve learners' speech intelligibility and comprehensibility of sound features in some areas of Arabic pronunciation.

First, these results support pronunciation teaching to Arabic L2 pronunciation development and, therefore, recommend the incorporation of pedagogy into Arabic pronunciation curricula. The focus in the research of Arabic teaching and learning as L2 has mostly been on constructing pedagogical materials on grammar, reading and writing. Some learners in this study showed weaknesses in pronouncing some difficult and unfamiliar Arabic sounds, which demonstrates the need for designing effective pedagogical approaches to develop learners' perception and production skills of speech sounds, especially for teaching Arabic for religious purposes.

The current study showed that the effect of learners' native languages on their perceptual organisation of Arabic phonetic contrasts can be mitigated with training. One of the purposes of this research was to find out whether training using speech analysis and visual representation of sound features is as effective as traditional instruction. Since the speech analysis training was effective for acquiring correct Arabic emphatic and fricative sounds, it should be adopted to teach intelligible pronunciation, alongside traditional techniques and other technologies that provide aural input and articulatory cues. Having the learners actively engaged in an activity that includes different techniques such as repetition, feedback and description of sound features is pedagogically desirable.

It is known that the time spent on pronunciation teaching and learning is limited in the regular language classroom. By using Praat as an out-of-class activity, after giving focused training on its functionality, time in the regular classroom can be used more efficiently for activities that can be done only in the classroom. Although some of the factors affecting pronunciation learning in this study could not be manipulated, the use of speech analysis in enhancing learners' perception and production was used effectively and yielded noteworthy results. This method is suitable for learners in groups of differing proficiency.

The idea of integrating this technology in an Arabic L2 classroom is based on enhancing learners' ability to notice features that cannot be recognised in natural speech. As Derwing and Munro (2015) noted, teachers can help learners with "noticing what they are doing" (p. 387). Noticing is an important element for L2 learners to start recognising their errors and correct them accordingly (Schmidt, 1990).

Olson (2014) pointed out that listening and repeating in the classroom are the most common methods that teachers use regularly. Learners may not notice specific and important sound features that cannot be implicitly learned. As such, the efficiency of the speech analysis technology may lie in its ability to make learners notice the variances between their own pronunciation and those of a native speaker. Visual representation of sound features could offer a second modality to enable learners to notice those features visually, which is mostly relevant for situations in which auditory perception is limited. It must be noted that teachers need to receive training, which includes downloading Praat, recording new sounds and interpreting the waveforms and spectrograms, which could be a limitation for its applicability in classroom settings.

This research calls for enriching learners' pronunciation skill through integrating technological tools and specifically visual forms of speech in Arabic L2 classrooms. Pronunciation instruction, including visual representation of sounds, should be part of the curriculum in Arabic institutions in Saudi Arabia. The importance of pronunciation is similar to that of other subjects such as grammar and writing.

The teaching techniques that were used in this study over a period of only four days helped learners significantly in perceiving and producing accurate Arabic phonemes in different vowel contexts. Indeed, spending more time practicing these techniques would help learners greatly in mastering Arabic phonemes more accurately, as well as expanding their knowledge to learn other sound features and new Arabic vocabularies through repetition and practicing minimal pairs.

The motivation of students who come to Saudi Arabia to learn the Arabic language is to know more about Islam and to have the ability to read the Holy Quran correctly. Some of the students in this study wanted to become Arabic teachers in their home countries. Therefore, it is very important to teach accurate Arabic pronunciation to those future Arabic teachers.

10.5 Limitations and Recommendations for Future Research

There were some significant limitations in this study in terms of the study design and the technology employed. Several limitations in terms of the study design were discussed previously in Study 1 and 2, which may affect the results and limit the generalisability of the findings to other contexts and student populations. First, the learning context of the participants was limited to teaching Arabic for religious purposes in an immersion programme. Other studies that apply the same method on learners in different learning contexts may not yield similar results. Second, the sample was small in both studies with large variations among participants, such as their age, duration of Arabic learning and computer abilities, which could influence learners' performance in the results. These factors were difficult to control for in the current study due to the lack of large enough groups of participants who share similar L1s. Third, the data is missing a lot of important information about individual learners including their fluency and reading abilities. Moreover, this study did not carry out a test to measure learners' reading ability prior to conducting the study. Fourth, the perception and production tests were limited to only one token per target sound pronounced once for each participant, which were not enough to make generalisable claims about learning gain. Furthermore, participant heard one token per target sound, which increased the possibility of the participants choosing the correct answer by chance. Fifth, there was no control group to test whether the explicit instruction is the significant factor for increasing students' learning gains and the role of form-focused pronunciation instruction in this study cannot be demonstrated.

In terms of the technology employed, instructor's assistance is needed, which includes giving explicit instruction about the functions of Praat and explanations of the spectrograms and providing sound files of native speakers. Learners' cannot work on Praat alone without providing sufficient instructions and sound files of a native speaker. The benefit of Praat was demonstrated in this study when learning only the Arabic fricative and emphatic sounds following the approach of Olson (2014) and Offerman and Olson (2016). This program may not work on moderating the perception and production of other sounds.

Although there were many limitations in this study, this research opens avenues to explore issues related to the influence of learners' L1s and the benefits of testing different pronunciation teaching approaches for learners of Arabic. Importantly, more studies need to be focused on the acquisition of Arabic sounds among L2 learners of Arabic with different levels, genders and language backgrounds inside and outside of Saudi Arabia. More data needs to be collected and analysed from a larger group of participants with small variations among them. There is also a need to control for as many factors as possible to receive accurate and generalisable results. Furthermore, investigating the efficacy of different pronunciation techniques on L2 learners of Arabic is necessary to find the most suitable and effective methods that help Arabic teachers and develop their teaching performances.

Praat needs to be tested on other sounds rather than fricatives and emphatics and the training course should last longer with different types of evaluations, such as spontaneous speech and reading passages. Other didactic technological tools have to be tested on learners of Arabic to increase the number of pronunciation programs that could help with Arabic teaching and learning and to facilitate pronunciation learning among L2 learners of Arabic. There is also a need to make an experiment on the efficacy of Praat again in a large sample of participants with small variations across sample. Furthermore, knowing to what extent L2 learners rely on these visual cues to identify phonetic features is important to create teaching materials and activities and to assess learners' understanding of specific features. Therefore, there is a need to conduct a study that tests participants' understanding of visual analysis of speech and how they identify certain sounds based on their visual cues.

There is also a need to conduct acoustical analysis studies to assess learners' pronunciation of Arabic sounds and describe their production compared to native speakers of Arabic. A small amount of acoustic analysis is presented in Appendix (L) as a sample of the kind of research which could be done in this subject.

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APPENDICES

Appendix A: Approval Letter from University of Reading's Research Ethics Committee

University of Reading

Memo

School of Literature and Languages
Department of English Language and Applied Linguistics

Please reply to: Dr. Jon Clenton (j.clenton@reading.ac.uk)

To Prof. Jane Setter

From Dr. Jon Clenton

Copy ~~Hajar Binasfour~~
Anne Whitbread (file)

Date 12th December 2014

Your application for Ethical Approval

Your project entitled **'Using TEL to support the acquisition of voiced and voiceless fricative sounds in L2 Arabic learners'** has been considered by the School Ethics Committee, and we are pleased to report that the Committee has raised no ethical objections, and subject to your undertaking to store the consent forms in the Department Office in the normal way, it has accordingly given permission for the project to proceed under the exceptions procedure as outlined in paragraph 6 of the *University's Ethics Guidance to Schools.*

Signed J. Clenton

Dr. Jon Clenton

On behalf of the School Ethics Committee,
Prof. Catherine Leglu, School Director of Research.
Prof. Alison Donnell, Head of School.

Appendix B: Approval Letter from Princess Nourah University to Conduct Study 1

KINGDOM OF SAUDI ARABIA
Ministry Of Higher Education
Princess Nora Bint Abdul Rahman University

جامعة الأميرة نورة بنت عبد الرحمن
Princess Nora Bint Abdul Rahman University

المملكة العربية السعودية
وزارة التعليم العالي
جامعة الأميرة نورة بنت عبد الرحمن
(٠٤٨)
وكالة الجامعة للدراسات العليا والبحث العلمي
عمادة البحث العلمي

الموضوع: بشــأن تسهيل مهمة الباحثة / هاجر بن عصفور

تعميـــم

سعادة مديرة معهد تعليم اللغة العربية لغير الناطقات بها　　　　حفظها الله.

السلام عليكم ورحمة الله وبركاته، وبعد.

إشارة إلى خطاب الملحق الثقافي بسفارة المملكة العربية السعودية بلندن (مرفق١)، الذي يفيد بأن الباحثة/ هاجر بن سلمان محمد بن عصفور، وهي مبتعثة من جامعة الملك سعود لدراسة الدكتوراه بجامعة University of reading في مجال Applied linguistics ويتطلب بحثها دراسة مناهج مختلفة في تدريس النطق باللغة العربية.

عليه نأمل من سعادتكم التكرم بتسهيل مهمتها لتطبيق هذا البرنامج على طالبات المعهد كما هو موضح بخطابها (مرفق٢).

ولمزيد من التواصل مع الباحثة على الإيميل التالي: hbinasfour@ksu.edu.sa

شاكرين ومقدرين حسن تعاونكم .

عميدة البحث العلمي.

د. أريج بنت عبد الكريم الخلف.

افنان الخراشي

الرقم ١٦٢٨٧/٤/ع ب ع　　التاريخ: ٢٣/٤/١٤٣٦هـ　　المشفوعات ....٥........

English Translation of the Approval Letter from Princess Nourah University to Conduct Study 1

To the director of Arabic Linguistic Institute.

peace, mercy and blessings be on you,

According to the letter from Saudi Cultural Mission in London, UK, which indicated that Hajar Binasfour is a PhD student who has a scholarship from King Saud University to study at University of Reading, and her research requires investigating different Arabic pronunciation teaching approaches.

We hope from you that you facilitate her mission to apply her study on learners in the Arabic Linguistic Institute.

For more information please contact the researcher: hbinasfour@ksu.edu.sa

Thank you and we appreciate your cooperation

The dean of scientific research

Dr. Areej bint Abdul Kareem Al Khalaf

Appendix C: A Confirmation Letter from Princess Nourah University After Collecting Data for Study 1

KINGDOM OF SAUDI ARABIA
Ministry Of Higher Education
Princess Nora Bint Abdul Rahman University

المَملَكة العَربيَّة السَّعُوديَّة
وِزَارَة التَعلِيم العَالِي
جامعة الأميرة نورة بنت عبد الرحمن
وكالة الدراسات العليا والبحث العلمي
عمادة البحث العلمي

جامعة الأميرة نورة بنت عبد الرحمن
Princess Nora Bint Abdul Rahman University

إفـــــــادة٢

بناء على خطاب سعادة عميدة البحث العلمي رقم ٣٤ب٤/١٦٢٨٧ وتاريخ ١٤٣٦/٤/٢٣هـ
بشأن تسهيل مهمة الباحث/ة هاجر سليمان بن عصفور ، نفيدكم بأنه
تم توزيع الاستبانة/إجراء المقابلة على العينة المطلوبة في يوم الأربعاء وتاريخ
١٤٣٦/٦/١٤هـ
وهذا للإحاطة .

وتقبلوا خالص تحياتنا.

اسم الجهة : معهد تعليم اللغة العربية للناطقات بغيرها جامعة الأميرة نورة.
اسم الرئيس المباشر للجهة : عنها حياة علي الشهري
التوقيع :
١٤٣٦/٧/١٠هـ

المملكة العربية السعودية
وزارة التعليم العالي
جامعة الأميرة نورة بنت عبد الرحمن
معهد تعليم اللغة العربية للناطقات بغيرها
رئيسة قسم الإعداد اللغوي

✍ أفنان الخراشي

الرقم : .... التاريخ : .../.../١٤هـ المشفوعات : ....

English Translation of The Confirmation Letter from Princess Nourah University After Collecting Data for Study 1

Statement

According to the letter from the Dean of Scientific Research number ع ب ع/16287 in 12/02/2015 about facilitating the mission of the researcher/ Hajar Binasfour, we inform you that the researcher has finished collecting the data, and she received this information on Wednesday 15/04/2015.

Accept my sincere regards

Department name: Arabic linguistics institute at Princess Nourah University

Head of Department: Salehah Al shehri

Appendix D: Consent Form

أعزائي المشاركين:

اسمي هاجر بن عصفور, طالبة دكتوراه في قسم علم اللغة التطبيقي في جامعة ريدنج في المملكة المتحدة. أعمل حالياً على بحث كجزء من متطلبات الحصول على درجة الدكتوراه. الغرض من هذا البحث هو لدراسة مناهج مختلفة في تدريس النطق باللغة العربية.

مشاركتك في هذه الدراسة تطوعيّ وتم اختيارك عشوائياً. سوف تنضم إلى مجموعة من الطلاب لدورة تدريبية عن نطق الأصوات العربية. هذه الدورة التعليمية ستكون عبارة عن ساعتين يوميا لمدة أسبوع واحد. وجمع البيانات سيكون بواسطة اختبارين, اختبار في أول الدورة التعليمية واختبار في ختامها. في هذا الاختبار, سوف تقوم بقراءة مجموعة من الكلمات والجمل وسيتم تسجيل صوتك. جميع التسجيلات سوف تبقى سريّة, وسيتم حفظها في جهاز حاسوب مؤمن بكلمة سر, وسيتم استخدام التسجيلات لغرض الدراسة فقط. الباحثة والمشرف على البحث فقط لهما الحق في الاطلاع على هذه التسجيلات. يمكنك الانسحاب من هذه الدراسة في أي وقت متى رغبت في ذلك.

بعد الانتهاء من هذه الدراسة, سيقوم الباحث بحذف جميع البيانات المتعلقة بالمشاركين. التسجيلات وورقة البيانات الشخصية سيتم ترميزها برموز مثل "س1, ص1, وهكذا."

تم إخضاع هذه الدراسة للمراجعة من قبل لجنة الأخلاقيات والبحث, وتمت الموافقة على المضي في هذه الدراسة تحت البند المذكور في فقرة رقم 6 في دليل اخلاقيات البحث العلمي في جامعة ريدنج.

إذا كان لديك أي تساؤل أو ترغب في توضيح أي نقطه تتعلق بهذه الدراسة, أرجو التواصل مع مشرف الباحث على العنوان المذكور أعلاه أو عن طريق البريد الالكتروني j.e.setter@reading.ac.uk

أتفهم الغرض من هذه الدراسة, وأعرف ما يتوجب علي القيام به. لقد قرأت وفهمت المعلومات الموجودة في الورقة المتعلقة بهذه الدراسة والتي تم شرحها لي بواسطة **هاجر بن عصفور**. أوافق على الترتيبات الموصوفة في ورقة المعلومات.

أتفهم أن مشاركتي في هذا الدراسة هو تطوع مني وأن لدي القدرة على الانسحاب من هذا المشروع في أي وقت أريد.

الاسم:

التوقيع:

التاريخ:

English Translation of the Consent Form

Dear participant,

My name is Hajar Binasfour, and I am a PhD student in the Applied Linguistics Department at University of Reading UK. I am conducting a research as part of my thesis requirement. The purpose of my study is to investigate different approaches in teaching Arabic language.

Your Participation in this study is VOLUNTARY and you have been selected randomly. You are going to join a group of students and take an Arabic language course. This course will take only two hours a day for one week. The data will be collected through two tests at the beginning and the end of the course. You will be asked to read several words two times then your voice will be recorded. All the recordings will be kept confidential on a password-protected computer within reasonable limits. Only the researcher and her supervisor will have access to the recordings. All steps necessary to keep your confidentiality will be taken. Your name will not appear in the research at all. You may withdraw from participating in this study at any stage if you so wish.

Upon completion of the tasks, subjects' involvement in the study will be completed. The researcher, at the end of the study will destroy any information which identifies the subjects with their data. Recordings and demographic information will be connected only by a simple code "S1, A1, etc."

This project has been subject to ethical review by the School Ethics and Research Committee, and has been allowed to proceed under the exceptions procedure as outlined in paragraph 6 of the University's *Notes for Guidance* on research ethics.

If you have any queries or wish to clarify anything about the study, please feel free to contact my supervisor by email at j.e.setter@reading.ac.uk

I understand the purpose of this research and understand what is required of me; I have read and understood the Information Sheet relating to this project, which has been explained to me by **Hajar Binasfour**. I agree to the arrangements described in the Information Sheet in so far as they relate to my participation.

I understand that my participation is entirely voluntary and that I have the right to withdraw from the project at any time.

I have received a copy of this Consent Form and of the accompanying Information Sheet.

Name:

Signed:

Date:

Appendix E: Questionnaire

أعزائي المشاركين,

أُقدِّر لكم مشاركتكم في هذه الدراسة. هذا لايعدُّ اختباراً وليس تقييما لقدراتكم. سوف تُستخدم المعلومات الشخصيّة فقط لأغراض علميّة في الدراسة.

سيُطلب مِنك تقديم معلومات شخصيّة, ومن ثمَّ الاستماع و قراءة بعض الكلمات والجُمل باللغة العربية. أُقدِّر حقاً تعاونكم ومشاركتكم في هذه الدراسة ولكم جَزيلُ الشُكر والعرفان.

الاسم:-- المستوى:------------------------------

أرجو الإجابة على الاسئلة التالية:

1- ماهو جنسك؟ ذكر ☐ أنثى ☐

2- كم عمرك؟--

3- ماهي لغتك الأم؟ --

4- ماهي اللغات الأخرى التي تتحدث بها (بجانب اللغة العربية ولغتك الأصلية)؟---------------------

----

5- منذ متى وأنت تتعلم اللغة العربية (عدد السنوات)؟--

6- منذ متى وأنت في المملكة العربية السعودية (عدد السنوات)؟-------------------------------------

7- ماهي اللغة الأكثر استخداما في حياتك اليومية، اللغة العربية أم لغتك الأصلية؟ ----------------------

----

8- ماهو السبب الأساسي في دراستك للغة العربية؟ ---

9- كيف هي قدراتك في استخدام الحاسب الآلي؟ ممتازة ☐ متوسطة ☐ ضعيفة ☐

English Translation of the Questionnaire

Dear participant, I appreciate your generous cooperation in participating in my study. This work is NOT a test or any other kind of evaluation of your Arabic. The data will be mainly used as background information for my study. You will be expected to provide demographic information and read aloud and record a list of Arabic words. I sincerely appreciate your participation and help.

Your first name: .... Level:..............................

1- What is your gender? Male ☐ Female ☐
2- What is your age? --
3- What is your native language? ----------------------------------
4- What other language (s) do you speak? -----------------------------
5- How long have you been studying Arabic? ---------------------------
6- How long have you been in Saudi Arabia? ---------------------------
7- Which language do you mostly use on a daily basis since you came to Saudi Arabia, Arabic or your native language? -------------------------------------
   ----
8- What is your primary reason for taking Arabic course? ---------------------
   ----

9- Rate your ability in using computer.
   Poor ☐ Good ☐ Excellent ☐

Appendix F: Approval Letter from Princess Nourah University to Conduct Study 2

KINGDOM OF SAUDI ARABIA
Ministry Of Education
Princess Nourah bint Abdulrahman University
(048)
Graduate Studies and Scientific Research Vice-Rectorate
Deanship of Scientific Research

المملكة العربية السعودية
وزارة التعليم
جامعة الأميرة نورة بنت عبد الرحمن
(٠٤٨)
وكالة الجامعة للدراسات العليا والبحث العلمي
عمادة البحث العلمي

جامعة الأميرة نورة بنت عبد الرحمن
Princess Nourah bint Abdulrahman University

الموضوع: إفادة بالموافقة على مهمة الباحثة/هاجر بن عصفور.

إلى من يهمه الأمر

السلام عليكم ورحمة الله وبركاته، وبعد.

بناء على طلب الباحثة/ هاجر بن سلمان بن عصفور، المبتعثة بجامعة (Reading)بالمملكة المتحدة بإجراء دراسة علمية في جامعة الأميرة نورة بنت عبد الرحمن بعنوان: (استخدام التكنولوجيا لدعم اكتساب الأصوات الاحتكاكية لمتعلمي اللغة العربية كلغة ثانية) حيث تشتمل على منهج تطبيقي جديد لتعليم الأصوات المشددة في اللغة العربية (ض، ظ، ط، ص).

فإنه بعد اطلاع لجنة أخلاقيات البحث العلمي والموافقة على محتوى المنهج ،لا مانع لدينا من إجراء دراستها العلمية، خلال ثلاث أشهر من منتصف فبراير الموافق ٢٠١٦/٢/٢١، وحتى منتصف مايو الموافق ٢٠١٦/٥/١٢، وتقديم هذا الخطاب لمن يهمه الأمر.

وتقبلوا خالص تحياتنا.

عميدة البحث العلمي.

٤/١٤

د. أريج بنت عبد الكريم الخلف.

المملكة العربية السعودية
وزارة التعليم
جامعة الأميرة نورة بنت عبدالرحمن
عمادة البحث العلمي

٤/١٤

الرقم: .... التاريخ: .../.../...١٤هـ المشفوعات: ....

English Translation of the Approval Letter from Princess Nourah University to Conduct Study 2

To Whom It May Concern,

peace, mercy and blessings be on you,

We received a request from the researcher/ Hajar Salman Binasfour, who studies at University of Reading, to conduct a study at Princess Nourah University entitled: Using technology to enhance the acquisition of Arabic sounds. This study includes applying a new teaching approach to teach the emphatic sounds in Arabic (/sˤ/, /ðˤ/, /dˤ/, and /tˤ/).

After examining her request by the ethics committee, we approved her request to conduct the study in this university for three months starting from mid-February 21/2/2016 until Mid-May 12/5/2016.

Accept my sincere regards

The dean of scientific research

Dr. Areej bint Abdul Kareem Al Khalaf

Appendix G: A Confirmation Letter from Princess Nourah University After Collecting Data for Study 2

جامعة الأميرة نورة بنت عبد الرحمن
وكالة الدراسات العليا والبحث العلمي
(عمادة البحث العلمي)

نماذج عمادة البحث العلمي

جامعة الأميرة نورة بنت عبد الرحمن
Princess Nora Bint Abdul Rahman University

نموذج إنتهاء مهمة باحث

بناء على خطاب سعادة عميدة البحث العلمي	
رقم	١٦٢٨٧/ع ب ع.
وتاريخ	١٤٣٦/٤/٢٣هـ
ولذلك لتسهيل مهمة الباحث/ة	هاجر بنت سلمان بن عصفور- المبتعثة بجامعة (Reading) ببريطانيا. لإجراء دراستها العلمية (استخدام التكنولوجيا لدعم اكتساب الأصوات الاحتكاكية لمتعلمي اللغة العربية كلغة ثانية).

نفيدكم بأنه تم توزيع الاستبانة/إجراء المقابلة على العينة المطلوبة خلال الفترة	
من	الخميس ٢٠١٦/٣/٢٤.
حتى	الإثنين ٢٠١٦/٤/١٨.
في	معهد تعليم اللغة العربية للناطقات بغيرها بجامعة الأميرة نورة بنت عبد الرحمن.

وهذا للإحاطة .

وتقبلوا خالص تحياتنا.

عميدة البحث العلمي

١٤٣٧/٨/١٨

أ.د. أريج بنت عبد الكريم الخلف

المملكة العربية السعودية
وزارة التعليم
جامعة الأميرة نورة بنت عبدالرحمن
عمادة البحث العلمي

English Translation of the Confirmation Letter from Princess Nourah University After Collecting Data for Study 2

Princess Nourah University

The Department of Post-Graduate and Scientific Research

According to the letter from the Dean of the Scientific Research, number: ع ب ع /16287, in 12/02/2015 for facilitating the mission of the researcher Hajar Salman Binasfour, who studies at the University of Reading, to conduct a study entitled: Using technology to enhance the acquisition of Arabic sounds.

We would like to let you know that the researcher has finished collecting the data during the period from Thursday 24/3/2016 to Monday 18/4/2016 in the Arabic linguistic institute at Princess Nourah University.

Accept our sincere regards

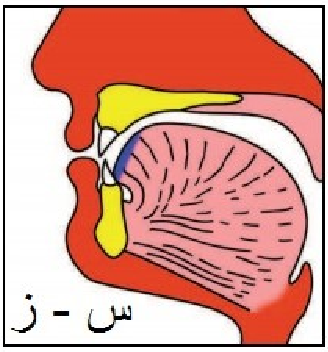
The dean of scientific research

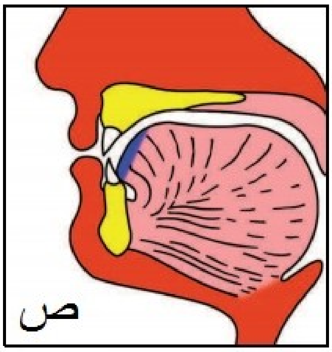
Dr. Areej bint Abdul Kareem Al Khalaf

Appendix H: Study 2 Teaching Materials for the Traditional Group (Example)

حرف الصاد (ص)

مخرج الحرف: رأسُ اللسانِ مع ما بين الأسنانِ العُليا والسُفلى، مع وجود فرجةٍ قليلة بين اللسان والأسنان.



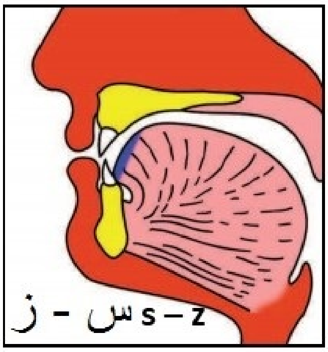


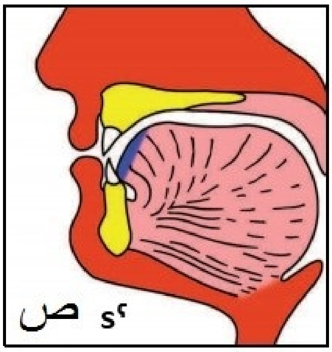
جُمل:
ذهبت مع صديقي إلى السوق.
صاحبي مسافر.
أصبح الجو معتدلاً.
كلمات متشابهة: صفير – سفير/ بصل – بسل/ صفر– سفر/ عصير- عسير/ صُحُب –سُحُب.
قطعة:
سافر صاحبي صالحٌ إلى الصين. أوصاني قبل ذهابه بأن أعتنيَ بطيرِه الصَّغير. ظللت أُطعمه وأهتمُّ به صُبح مساء حتى عاد صالحٌ من السَّفر. شكرني على اهتمامي بطيرِه وأهداني تُحفَةً جميلةً صفراءَ أحضرها خصيصاً لي من الصين عِرفاناً لما فعلتُه مع طيره.

English Translation of the Study 2 Teaching Materials for the Traditional Group (Example)

sˤ

Place of articulation: the top of the tongue, and between the upper and lower teeth, with a little gap between the tongue and teeth



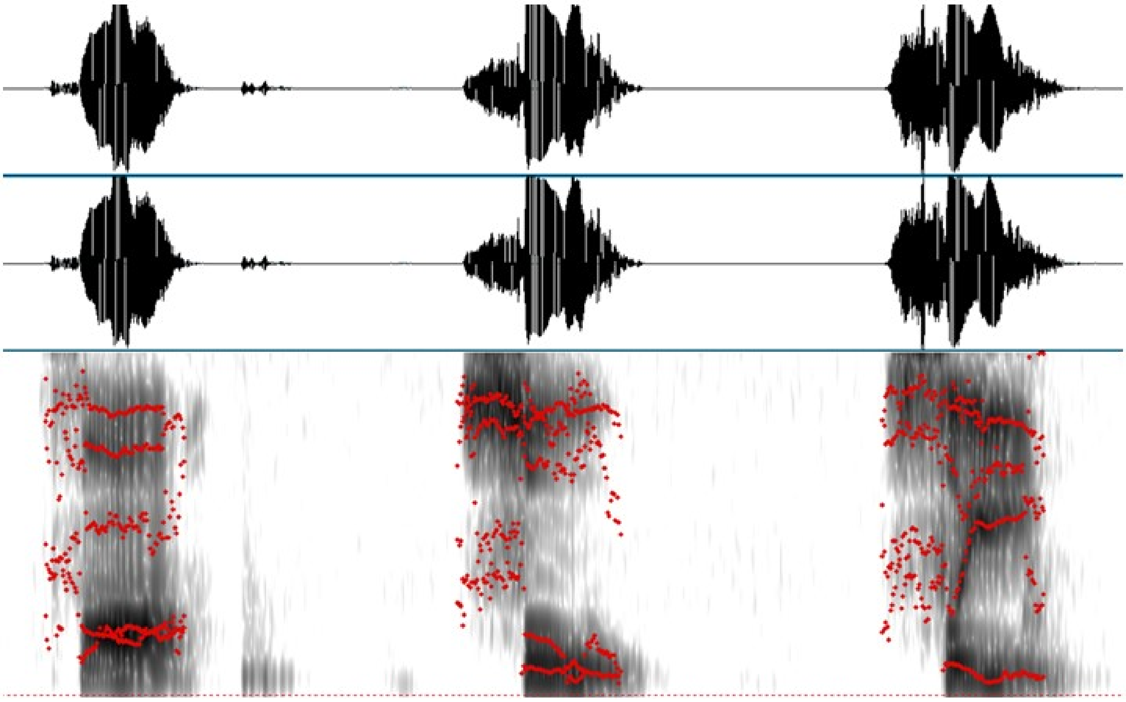


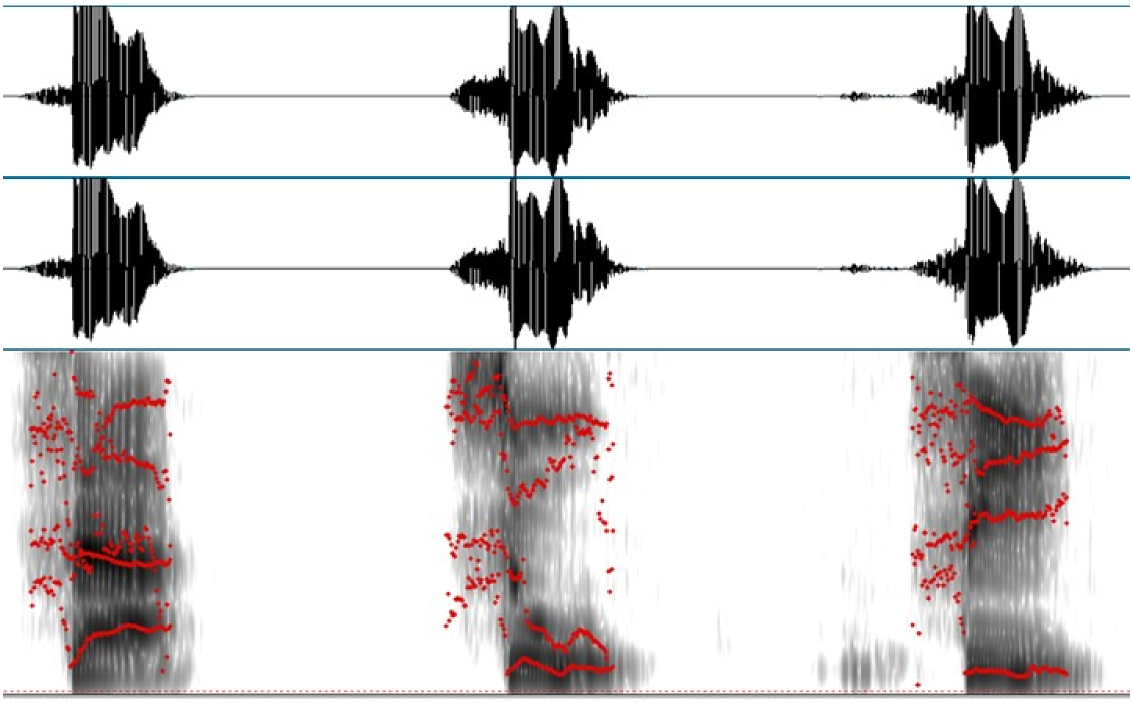
Sentences:
I went with my friend to the mall.
My friend travelled.
The weather became moderate.

Minimal pairs:
Whistling – ambassador/ onion- strong/ safar (Arabic month) – travel/ juice- difficult/ friends – clouds.

Reading passage:
My friend Saleh travelled to china. He asked me to take care of his little bird. I kept taking care of it and feed it in the morning and night until Saleh came back from China. He thanked me for taking care of the little bird and gave me a yellow beautiful masterpiece for what I did for his bird.

Appendix I: The Training Course Teaching Materials for The Technology Group (Example)





Appendix J: DMDX Scripts for The Perception and Production Tests

Perception test:

<ep> <azk> <n 30> <s 15> <fd 1000> <d 10> <t 3000> <req> <rcot> <dbc 255255255> <vm desktop> <nfb> <id #Keyboard> <mnr +#42> <mpr +#54> <mr +#56> <eop>

$00 <ln -6> “**التعليمات لاختبار الاستماع**.”,

<ln -4> “ستستمع إلى جمل باللغة العربية.

ستظهر لك كلمتين واحدة على اليمين والأخرى على اليسار

والمطلوب منك اختيار الجملة التي تعتقد أنّها صحيحة.”,

<ln -3> “اضغط على المفتاحين الموضحين في لوحة المفاتيح.

لاختيار الكلمة اليمنى (اللون الأحمر) أو اليسرى (اللون الأصفر)

واضغط مفتاح المسافة للاستماع للجملة التالية ”,

<ln 2> “إذا كنت مستعدا لبدء الاختبار اضغط مسافة الآن.”; $

+101 <wav 2> "نهب" / "*نهب --- نحب" ;

+102 <wav 2> "دال" / "*ضال --- دال" ;

+103 <wav 2> "مسير" / "*مسير --- مصير" ;

+104 <wav 2> "تب" / "*طُب --- تُب" ;

+105 <wav 2> "نادل" / "*نادل --- ناضل" ;

+106 <wav 2> "حذر" / "* حَظَرَ --- حذَرَ" ;

+107 <wav 2> "كبير" / "*كبير --- خبير" ;

+108 <wav 2> "سار" / "*صَار --- سار" ;

+109 <wav 2> "تين" / "*تين --- طين" ;

+110 <wav 2> "ضال" / "*دال --- ضال" ;

+111 <wav 2> "أين" / "*عين --- أين" ;

+112 <wav 2> "تاب" / "*تاب --- طاب" ;

+113 <wav 2> "منذور" / "*منظور --- منذور" ;

+114 <wav 2> "مصير" / "*مصير --- مسير" ;

+115 <wav 2> "خبير" / "*كبير --- خبير" ;

+116 <wav 2> "نذير" / "*نذير --- نظير" ;

+117 <wav 2> "صار" / "*سَار --- صار" ;

+118 <wav 2> "طب" / "*تُب --- طُب" ;

+119 <wav 2> "ناضل" / "*ناضِل --- نادِل" ;

+120 <wav 2> "منظور" / "*منذور --- "منظور ;

+121 <wav 2> "طاب" / "*طاب --- "تاب ;

+122 <wav 2> "موضوع" / "*موضوع --- "مودوع ;

+123 <wav 2> "حظر" / "*حذَر --- "حظَر ;

+124 <wav 2> "طين" / "*تين --- "طين ;

+125 <wav 2> "صورة" / "*صورة --- "سورة ;

+126 <wav 2> "نظير" / "*نذير --- "نظير ;

+127 <wav 2> "عين" / "*عين --- "أين ;

+128 <wav 2> "مودوع" / "*موضوع --- "مودوع ;

+129 <wav 2> "نحب" / "*نحب --- "نهب ;

+130 <wav 2> "سورة" / "*صورة --- "سورة ;

$0 "إنتهى اختبار الاستماع. شكرا لك على المشاركة."; $

Production test:

<ep> <azk> <n 30> <s 15> <fd 1000> <d 10> <t 3000> <req> <rcot> <dbc 255255255> <vm desktop> <nfb> <id #Keyboard> <mnr +#30> <mpr +#40><eop>

$00 <ln -6> "**التعليمات لاختبار النطق**.",

<ln -4> "ستظهر جمل باللغة العربية ومطلوب منك قرائتها بصوت واضح وسيتم تسجيل صوتك.",

<ln -3> "إقرأ كل جملة ثلاث مرات ثم اضغط مسافة للانتقال للجملة التالية*",

<ln 2> "إذا كنت مستعدا لبدء الاختبار اضغط مسافة الآن."; $

+101 * "الكلمة هي نَهَبَ";

+102 * "الكلمة هي دال";

+103 * "الكلمة هي مَسِير";

+104 * "الكلمة هي طُب";

+105 * "الكلمة هي نادِل";

+106 * "الكلمة هي حَظَر";

+107 * "الكلمة هي كبير";

+108 * "الكلمة هي صار";

+109 * "الكلمة هي تِين";

+110 * "الكلمة هي ضَّال";

+111 * "الكلمة هي عَيْن";

+112 * "الكلمة هي طاب";

+113 * “الكلمة هي مَنْظُور”;

+114 * “الكلمة هي مَصِير”;

+115 * “الكلمة هي خَبِير”;

+116 * “الكلمة هي نَذِير”;

+117 * “الكلمة هي سَار”;

+118 * “الكلمة هي تُبْ”;

+119 * “الكلمة هي ناضِل”;

+120 * “الكلمة هي مَنْذُور”;

+121 * “الكلمة هي تَاب”;

+122 * “الكلمة هي مَوضُوع”;

+123 * “الكلمة هي حَذَر”;

+124 * “الكلمة هي طِيْن”;

+125 * “الكلمة هي صُورَة”;

+126 * “الكلمة هي نَظِير”;

+127 * “الكلمة هي أيْن”;

+128 * “الكلمة هي مَودُوع”;

+129 * “الكلمة هي نَحَبَ”;

+130 * “الكلمة هي سُورَة”;

$0 “إنتهى اختبار النطق. شكرا لك على المشاركة.”; $

Appendix K: Statistical Results

Study 1 SPSS results

Normality tests (Methodology for Study 1 Chapter, Section 4.11)

	Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Pre-test	Traditional group	.206	23	.013	.876	23	.008
	Technology group	.150	23	.194	.911	23	.044
Post-test	Traditional group	.301	23	.000	.804	23	.000
	Technology group	.331	23	.000	.734	23	.000

Wilcoxon signed-rank test results of fricatives in determining the degree of difficulty of each fricative sound (Results for Study 1 Chapter, Section 5.2.1)

	χ - ɣ	χ - ð	χ - θ	χ - ħ	χ - ʕ	χ - sˤ	χ - ðˤ	ð - ɣ	θ - ɣ
Z	-.378[b]	-1.732[b]	-1.807[b]	-2.828[b]	-3.500[b]	-4.811[b]	-5.014[b]	-1.890[b]	-1.897[b]
Asymp. Sig. (2-tailed)	.705	.083	.071	.005	.000	.000	.000	.059	.058

ʕ - ɣ	sˤ - ɣ	ð - ɣ	θ - ð	ħ - ð	ʕ - ð	sˤ - ð	ðˤ - ð	ħ - θ	ʕ - θ
-3.357[b]	-4.899[b]	-4.747[b]	-.302[b]	-1.604[b]	-2.138[b]	-4.146[b]	-4.041[b]	-1.387[b]	-2.111[b]
.001	.000	.000	.763	.109	.033	.000	.000	.166	.035

sˤ - θ	ðˤ - θ	ʕ - ħ	sˤ - ħ	ðˤ - ħ	sˤ - ʕ	ðˤ - ʕ	ðˤ - sˤ	ħ - ɣ
-4.243[b]	-3.922[b]	-.577[b]	-3.153[b]	-3.638[b]	-3.051[b]	-3.153[b]	-.632[b]	-2.840[b]
.000	.000	.564	.002	.000	.002	.002	.527	.005

Kruskal Wallis test results in the production of fricatives from three language groups (Results for Study 1 Chapter, Section 5.2.2)

	χ	ɣ	ð	θ	ħ	ʕ	sˤ	ðˤ
Chi-Square	5.571	2.422	.643	2.934	2.275	1.230	1.753	.124
df	2	2	2	2	2	2	2	2
Asymp. Sig.	.062	.298	.725	.231	.321	.541	.416	.940

Kruskal Wallis test results in the production of fricatives from three proficiency levels (Results for Study 1 Chapter, Section 5.2.4)

	χ	ɣ	ð	θ	ħ	ʕ	sˤ	ðˤ
Chi-Square	.451	1.519	5.803	6.419	8.882	5.378	4.482	4.171
df	2	2	2	2	2	2	2	2
Asymp. Sig.	.798	.468	.055	.040	.012	.068	.106	.124

Mann-Whitney U test results of fricatives between traditional and technology groups before and after pronunciation instruction (Results for Study 1 Chapter, Section 5.3)

	χ pre	χ post	ɣ pre	ɣ post	ð pre	ð post	θ pre	θ post
Mann-Whitney U	264.500	253.000	253.000	253.000	264.500	264.500	253.000	253.000
Wilcoxon W	540.500	529.000	529.000	529.000	540.500	540.500	529.000	529.000
Z	.000	-1.000	-.469	-1.000	.000	.000	-.342	-.469
Asymp. Sig. (2-tailed)	1.000	.317	.639	.317	1.000	1.000	.732	.639

	ħ pre	ħ post	ʕ pre	ʕ post	sˤ pre	sˤ post	ðˤ pre	ðˤ post
Mann-Whitney U	241.500	241.500	264.500	230.000	253.000	230.000	253.000	230.000
Wilcoxon W	517.500	517.500	540.500	506.000	529.000	506.000	529.000	506.000
Z	-.612	-.866	.000	-1.026	-.302	-1.218	-.311	-1.103
Asymp. Sig. (2-tailed)	.540	.386	1.000	.305	.763	.223	.756	.270

Wilcoxon signed-rank test results in the production of fricatives by the traditional group (Results for Study 1 Chapter, Section 5.3.1.1)

	χ pre – χ post	ɣ pre - ɣ post	ð pre – ð post	θ pre – θ post	ħ pre - ħ post	ʕ pre - ʕ post	sˤ pre - sˤ post	ðˤ pre - ðˤ post
Z	-1.000^b	-1.000^b	-2.000^b	-1.414^b	-1.732^b	-1.000^b	-3.162^b	-3.000^b
Asymp. Sig. (2-tailed)	.317	.317	.046	.157	.083	.317	.002	.003

Wilcoxon signed-rank test results in the production of fricatives by the technology group (Results for Study 1 Chapter, Section 5.3.1.2)

	χ pre – χ post	ɣ pre - ɣ post	ð pre – ð post	θ pre – θ post	ħ pre - ħ post	ʕ pre - ʕ post	sˤ pre - sˤ post	ðˤ pre - ðˤ post
Z	-1.414^b	-1.732^b	-2.000^b	-2.000^b	-2.646^b	-2.236^b	-3.464^b	-3.357^b
Asymp. Sig. (2-tailed)	.157	.083	.046	.046	.008	.025	.001	.001

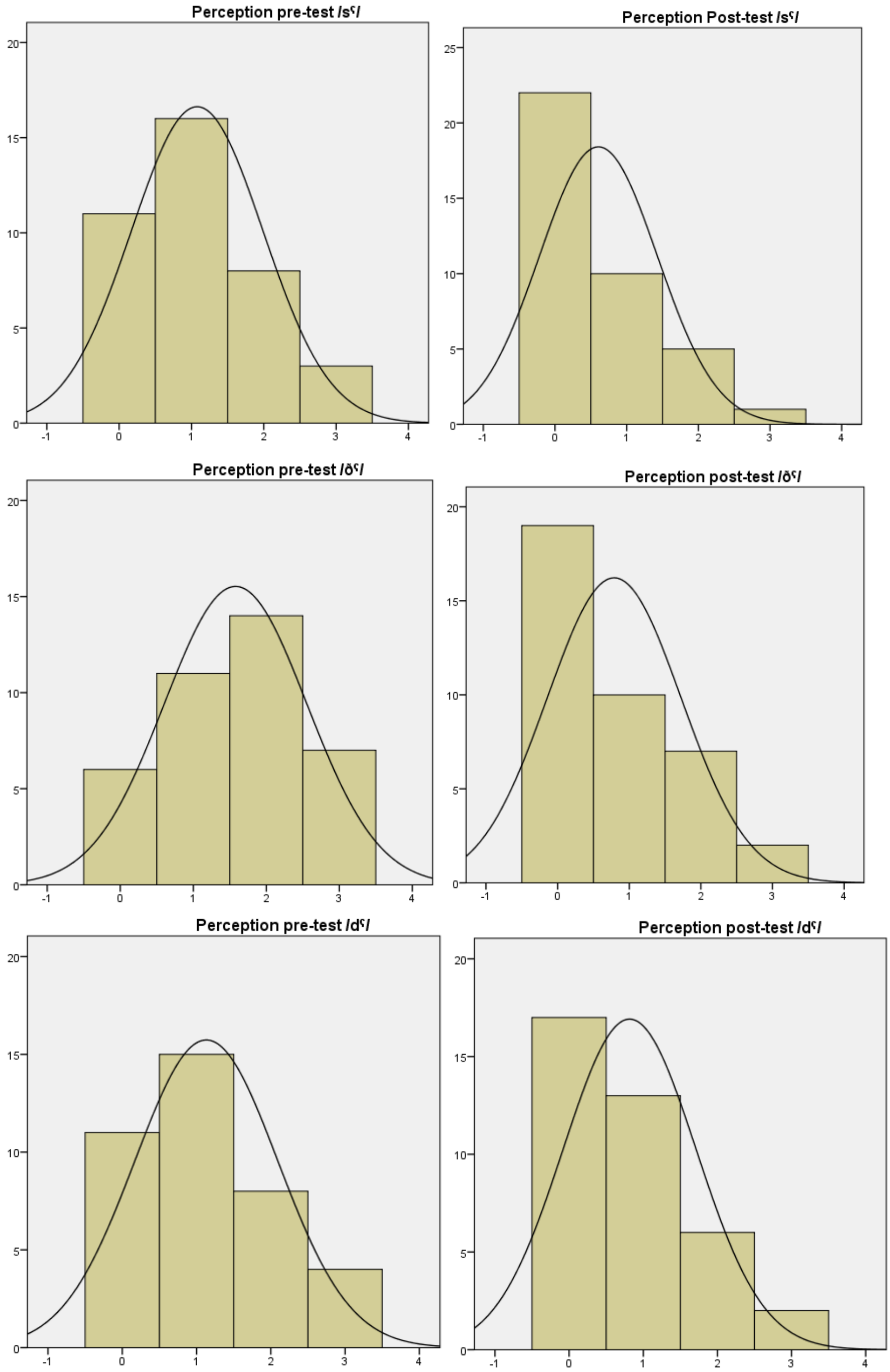
Study 2 statistical results

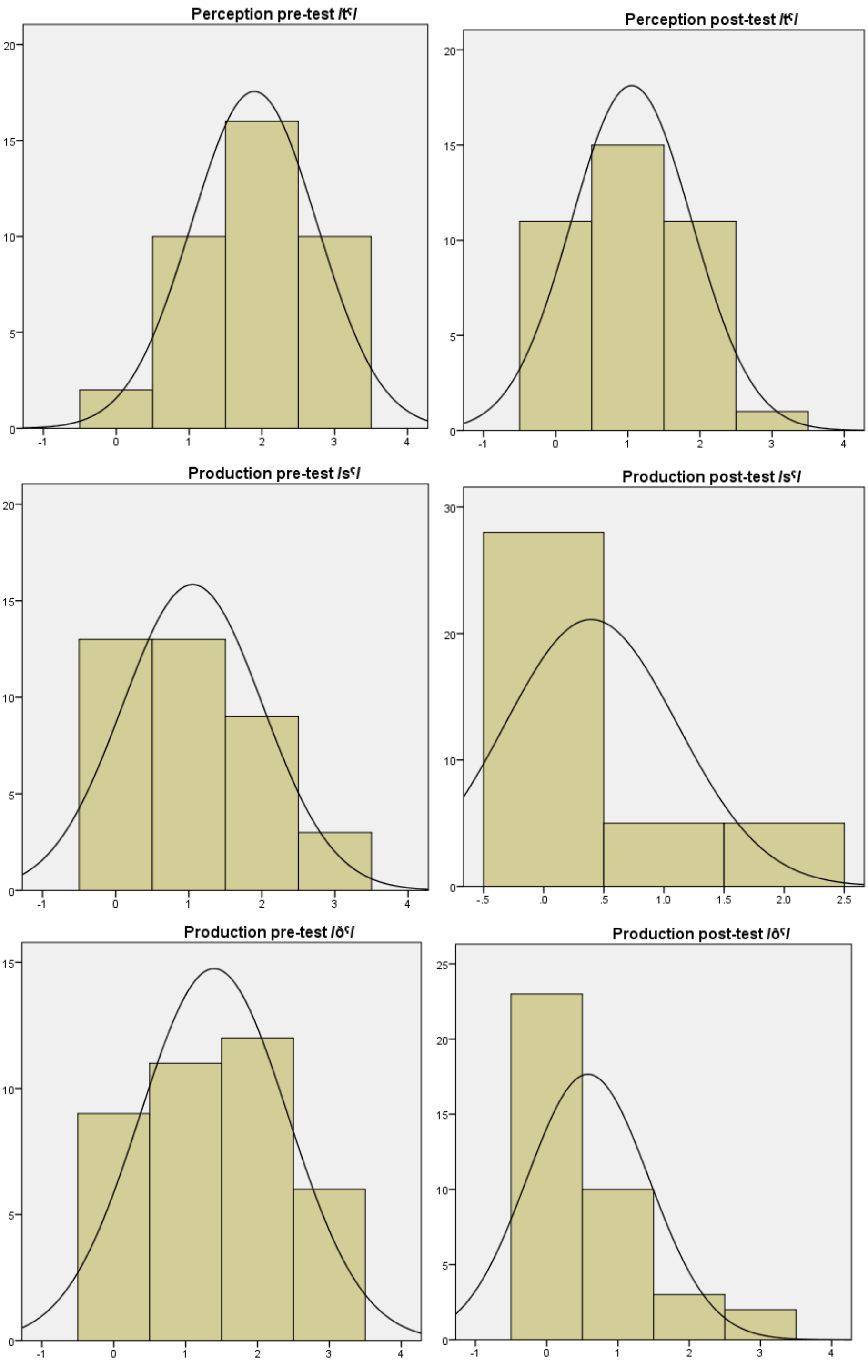
Normality tests (Methodology for Study 2 Chapter, Section 7.10)

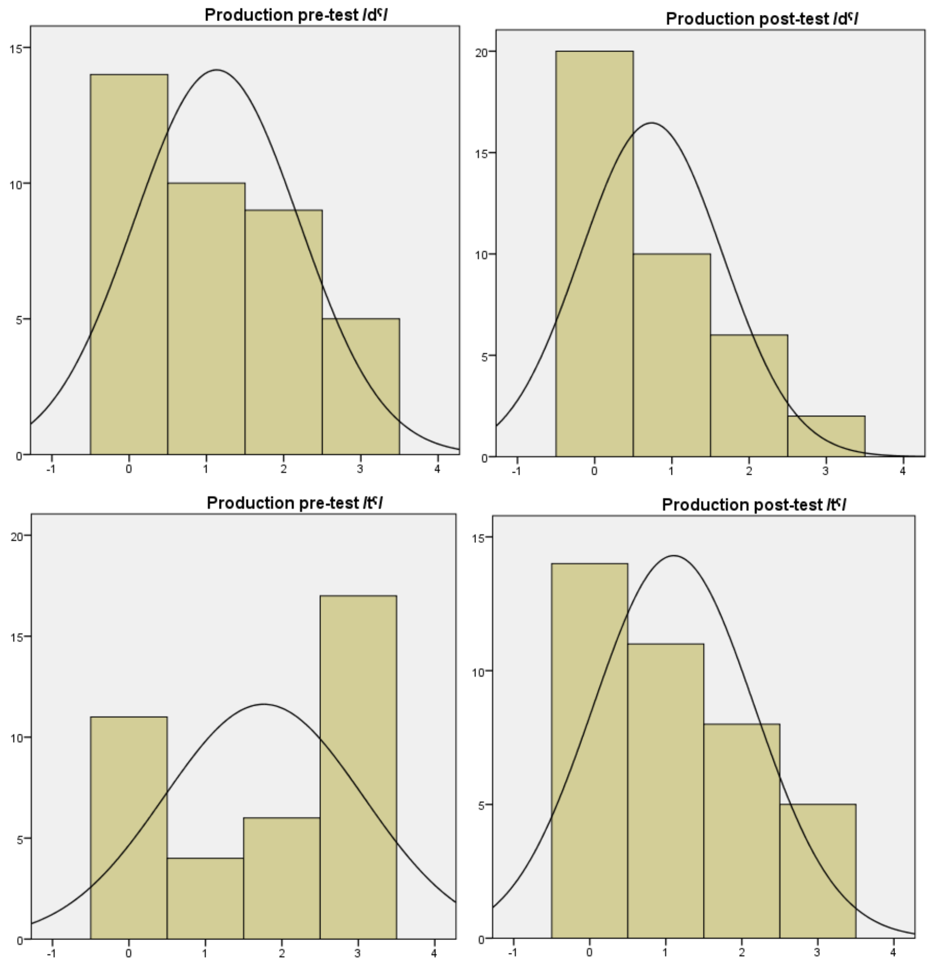
	Group	Kolmogorov-Smirnov[a]					
		Statistic	df	Sig.	Statistic	df	Sig.
PER pre sˁ	Traditional group	.209	19	.029	.861	19	.010
	Technology group	.267	19	.001	.812	19	.002
PER post sˁ	Traditional group	.219	19	.017	.848	19	.006
	Technology group	.470	19	.000	.536	19	.000
PER pre ðˁ	Traditional group	.216	19	.020	.846	19	.006
	Technology group	.263	19	.001	.793	19	.001
PER post ðˁ	Traditional group	.257	19	.002	.830	19	.003
	Technology group	.339	19	.000	.733	19	.000
PER pre dˁ	Traditional group	.207	19	.031	.865	19	.012
	Technology group	.265	19	.001	.855	19	.008
PER post dˁ	Traditional group	.279	19	.000	.803	19	.001
	Technology group	.247	19	.003	.823	19	.003
PER pre tˁ	Traditional group	.237	19	.006	.859	19	.009
	Technology group	.229	19	.010	.877	19	.019
PER post tˁ	Traditional group	.229	19	.010	.844	19	.005
	Technology group	.267	19	.001	.812	19	.002
PRO pre sˁ	Traditional group	.241	19	.005	.814	19	.002
	Technology group	.225	19	.012	.844	19	.005
PRO post sˁ	Traditional group	.442	19	.000	.593	19	.000
	Technology group	.445	19	.000	.583	19	.000
PRO pre ðˁ	Traditional group	.217	19	.019	.880	19	.021
	Technology group	.232	19	.008	.873	19	.016
PRO post ðˁ	Traditional group	.307	19	.000	.764	19	.000
	Technology group	.398	19	.000	.634	19	.000
PRO pre dˁ	Traditional group	.209	19	.029	.861	19	.010
	Technology group	.256	19	.002	.829	19	.003
PRO post dˁ	Traditional group	.284	19	.000	.807	19	.001
	Technology group	.339	19	.000	.733	19	.000
PRO pre tˁ	Traditional group	.216	19	.020	.808	19	.002
	Technology group	.333	19	.000	.714	19	.000
PRO post tˁ	Traditional group	.251	19	.003	.831	19	.003
	Technology group	.188	19	.076	.853	19	.007

PER= perception, PRO= production, Pre= pre-test, Post= post-test

Histograms for the normality results of each pharyngealised sound in perception and production and in the pre-and post-tests.




Perception pre-test /tˤ/
Perception post-test /tˤ/
Production pre-test /sˤ/
Production post-test /sˤ/
Production pre-test /ðˤ/
Production post-test /ðˤ/



Wilcoxon signed-rank test results in the perception and production of the pharyngealised consonants in determining the degree of difficulty of each pharyngealised sound (Results for Study 2 Chapter, Section 8.2.3)

	ðˤ - sˤ	dˤ - sˤ	tˤ - sˤ	dˤ - ðˤ	tˤ - ðˤ	tˤ - dˤ
Z	-2.160[b]	-.214[b]	-3.216[b]	-2.017[c]	-1.728[b]	-3.434[b]
Asymp. Sig. (2-tailed)	.031	.831	.001	.044	.084	.001

ðˤ - sˤ	dˤ - sˤ	tˤ - sˤ	dˤ - ðˤ	tˤ - ðˤ	tˤ - dˤ
-1.695[b]	-.248[b]	-2.787[b]	-1.171[c]	-1.923[b]	-2.822[b]
.090	.804	.005	.242	.055	.005

Wilcoxon signed-rank test results in the perception and production of the vowel contexts in determining the degree of difficulty of each vowel context (Results for Study 2 Chapter, Section 8.2.5)

	Perception ɑ - ʊ	Perception i - ɑ	Perception i - ʊ	Production ʊ - ɑ	Production i - ɑ	Production i - ʊ
Z	-3.781[b]	-3.650[b]	-2.124[b]	-3.328[b]	-4.265[b]	-2.782[b]
Asymp. Sig. (2-tailed)	.000	.000	.034	.001	.000	.005

Kruskal Wallis test results in the perception and production of emphatics from three proficiency levels (Results for Study 2 Chapter, Section 8.3)

	PER pre sˤ	PER pre ðˤ	PER pre dˤ	PER pre tˤ	PRO pre sˤ	PRO pre ðˤ	PRO pre dˤ	PRO pre tˤ
Chi-Square	3.786	5.209	11.068	3.211	3.763	15.504	9.440	16.373
df	2	2	2	2	2	2	2	2
Asymp. Sig.	.151	.074	.004	.201	.152	.000	.009	.000

Kruskal Wallis test results in the perception and production of emphatics from three language backgrounds (Results for Study 2 Chapter, Section 8.4)

	PER pre sˤ	PER pre ðˤ	PER pre dˤ	PER pre tˤ	PRO pre sˤ	PRO pre ðˤ	PRO pre dˤ	PRO pre tˤ
Chi-Square	2.206	3.561	5.315	3.738	1.448	.340	6.657	2.951
df	2	2	2	2	2	2	2	2
Asymp. Sig.	.332	.169	.070	.154	.485	.843	.036	.229

Mann-Whitney U test results of emphatics between traditional and technology groups before and after pronunciation instruction (Results for Study 2 Chapter, Section 8.6)

	PER pre sˤ	PER post sˤ	PER pre ðˤ	PER post ðˤ	PER pre dˤ	PER post dˤ	PER pre tˤ	PER post tˤ
Mann-Whitney U	161.000	100.000	154.000	146.000	168.000	173.000	154.500	177.000
Wilcoxon W	351.000	290.000	344.000	336.000	358.000	363.000	344.500	367.000
Z	-.603	-2.651	-.808	-1.092	-.384	-.235	-.805	-.108
Asymp. Sig. (2-tailed)	.547	.008	.419	.275	.701	.814	.421	.914
Exact Sig. [2*(1-tailed Sig.)]	.583[b]	.018[b]	.452[b]	.325[b]	.729[b]	.840[b]	.452[b]	.931[b]

	PRO pre sˤ	PRO post sˤ	PRO pre ðˤ	PRO post ðˤ	PRO pre dˤ	PRO post dˤ	PRO pre tˤ	PRO post tˤ
Mann-Whitney U	156.000	178.000	143.500	152.500	165.000	157.500	169.500	144.000
Wilcoxon W	346.000	368.000	333.500	342.500	355.000	347.500	359.500	334.000
Z	-.751	-.095	-1.122	-.938	-.473	-.736	-.342	-1.114
Asymp. Sig. (2-tailed)	.453	.925	.262	.348	.637	.462	.732	.265
Exact Sig. [2*(1-tailed Sig.)]	.488[b]	.954[b]	.284[b]	.418[b]	.665[b]	.506[b]	.751[b]	.297[b]

Mann-Whitney U test results of vowel contexts between traditional and technology groups before and after pronunciation instruction (Results for Study 2 Chapter, Section 8.6.4)

	PER pre ɑ	PER post ɑ	PER pre ʊ	PER post ʊ	PER pre ɨ	PER post ɨ
Mann-Whitney U	177.000	160.000	160.500	159.000	156.500	136.000
Wilcoxon W	367.000	350.000	350.500	349.000	346.500	326.000
Z	-.107	-.670	-.609	-.667	-.723	-1.342
Asymp. Sig. (2-tailed)	.915	.503	.542	.505	.470	.180
Exact Sig. [2*(1-tailed Sig.)]	.931[b]	.563[b]	.563[b]	.544[b]	.488[b]	.201[b]

	PRO pre ɑ	PRO post ɑ	PRO pre ʊ	PRO post ʊ	PRO pre ɨ	PRO post ɨ
Mann-Whitney U	139.500	164.500	155.500	177.500	171.500	176.000
Wilcoxon W	329.500	354.500	345.500	367.500	361.500	366.000
Z	-1.249	-.656	-.759	-.094	-.270	-.136
Asymp. Sig. (2-tailed)	.212	.512	.448	.925	.787	.892
Exact Sig. [2*(1-tailed Sig.)]	.234[b]	.644[b]	.470[b]	.931[b]	.795[b]	.908[b]

Mann-Whitney U test results between traditional and technology groups in each language and proficiency group (Results for Study 2 Chapter, Section 8.7).

Mandarin beginners

	PER pre sˤ	PER post sˤ	PER pre ðˤ	PER post ðˤ	PER pre dˤ	PER post dˤ	PER pre tˤ	PER post tˤ
Mann-Whitney U	1.000	1.500	1.500	.500	2.000	1.000	2.000	1.000
Wilcoxon W	4.000	4.500	4.500	3.500	5.000	4.000	5.000	4.000
Z	-1.000	-.408	-.408	-1.225	.000	-1.000	.000	-1.000
Asymp. Sig. (2-tailed)	.317	.683	.683	.221	1.000	.317	1.000	.317
Exact Sig. [2*(1-tailed Sig.)]	.667[b]	.667[b]	.667[b]	.333[b]	1.000[b]	.667[b]	1.000[b]	.667[b]

	PRO pre sˤ	PRO post sˤ	PRO pre ðˤ	PRO post ðˤ	PRO pre dˤ	PRO post dˤ	PRO pre tˤ	PRO post tˤ
Mann-Whitney U	2.000	1.000	.000	.500	2.000	2.000	2.000	1.000
Wilcoxon W	5.000	4.000	3.000	3.500	5.000	5.000	5.000	4.000
Z	.000	-1.000	-1.732	-1.225	.000	.000	.000	-1.000
Asymp. Sig. (2-tailed)	1.000	.317	.083	.221	1.000	1.000	1.000	.317
Exact Sig. [2*(1-tailed Sig.)]	1.000b	.667b	.333b	.333b	1.000b	1.000b	1.000b	.667b

Mandarin intermediate

	PER pre sˤ	PER post sˤ	PER pre ðˤ	PER post ðˤ	PER pre dˤ	PER post dˤ	PER pre tˤ	PER post tˤ
Mann-Whitney U	.500	.500	.000	1.000	.500	.500	.500	.000
Wilcoxon W	3.500	1.500	1.000	2.000	3.500	3.500	3.500	3.000
Z	-.707	-.707	-1.225	.000	-.707	-.707	-.707	-1.225
Asymp. Sig. (2-tailed)	.480	.480	.221	1.000	.480	.480	.480	.221
Exact Sig. [2*(1-tailed Sig.)]	.667[b]	.667[b]	.667[b]	1.000[b]	.667[b]	.667[b]	.667[b]	.667[b]

	PRO pre sˤ	PRO post sˤ	PRO pre ðˤ	PRO post ðˤ	PRO pre dˤ	PRO post dˤ	PRO pre tˤ	PRO post tˤ
Mann-Whitney U	.000	1.000	.000	.500	.000	.500	.500	.000
Wilcoxon W	3.000	2.000	3.000	1.500	1.000	3.500	3.500	3.000
Z	-1.414	.000	-1.225	-.707	-1.414	-.707	-.707	-1.225
Asymp. Sig. (2-tailed)	.157	1.000	.221	.480	.157	.480	.480	.221
Exact Sig. [2*(1-tailed Sig.)]	.667[b]	1.000[b]	.667[b]	.667[b]	.667[b]	.667[b]	.667[b]	.667[b]

Mandarin advanced

	PER pre sˤ	PER post sˤ	PER pre ðˤ	PER post ðˤ	PER pre dˤ	PER post dˤ	PER pre tˤ	PER post tˤ
Mann-Whitney U	1.500	2.500	3.500	4.000	3.500	2.500	4.000	1.000
Wilcoxon W	7.500	8.500	9.500	10.000	9.500	8.500	10.000	7.000
Z	-1.348	-.943	-.471	-.258	-.471	-.943	-.236	-1.650
Asymp. Sig. (2-tailed)	.178	.346	.637	.796	.637	.346	.814	.099
Exact Sig. [2*(1-tailed Sig.)]	.200[b]	.400[b]	.700[b]	1.000[b]	.700[b]	.400[b]	1.000[b]	.200[b]

	PRO pre sˤ	PRO post sˤ	PRO pre ðˤ	PRO post ðˤ	PRO pre dˤ	PRO post dˤ	PRO pre tˤ	PRO post tˤ
Mann-Whitney U	4.500	3.000	3.500	3.000	3.000	1.500	3.500	3.000
Wilcoxon W	10.500	9.000	9.500	9.000	9.000	7.500	9.500	9.000
Z	.000	-1.000	-.471	-1.000	-.707	-1.581	-.471	-.745
Asymp. Sig. (2-tailed)	1.000	.317	.637	.317	.480	.114	.637	.456
Exact Sig. [2*(1-tailed Sig.)]	1.000[b]	.700[b]	.700[b]	.700[b]	.700[b]	.200[b]	.700[b]	.700[b]

Urdu beginners

	PER pre sˤ	PER post sˤ	PER pre ðˤ	PER post ðˤ	PER pre dˤ	PER post dˤ	PER pre tˤ	PER post tˤ
Mann-Whitney U	1.000	.000	.500	.000	.500	1.500	2.000	1.500
Wilcoxon W	4.000	3.000	3.500	3.000	3.500	4.500	5.000	4.500
Z	-1.000	-1.732	-1.225	-1.549	-1.225	-.408	.000	-.408
Asymp. Sig. (2-tailed)	.317	.083	.221	.121	.221	.683	1.000	.683
Exact Sig. [2*(1-tailed Sig.)]	.667[b]	.333[b]	.333[b]	.333[b]	.333[b]	.667[b]	1.000[b]	.667[b]

	PRO pre sˤ	PRO post sˤ	PRO pre ðˤ	PRO post ðˤ	PRO pre dˤ	PRO post dˤ	PRO pre tˤ	PRO post tˤ
Mann-Whitney U	.000	1.000	1.000	1.000	.500	.500	2.000	2.000
Wilcoxon W	3.000	4.000	4.000	4.000	3.500	3.500	5.000	5.000
Z	-1.732	-1.000	-1.000	-1.000	-1.225	-1.225	.000	.000
Asymp. Sig. (2-tailed)	.083	.317	.317	.317	.221	.221	1.000	1.000
Exact Sig. [2*(1-tailed Sig.)]	.333[b]	.667[b]	.667[b]	.667[b]	.333[b]	.333[b]	1.000[b]	1.000[b]

Urdu intermediate

	PER pre sˤ	**PER post sˤ**	**PER pre ðˤ**	**PER post ðˤ**	**PER pre dˤ**	**PER post dˤ**	**PER pre tˤ**	**PER post tˤ**
Mann-Whitney U	4.500	2.500	1.500	2.500	4.500	3.000	2.000	1.000
Wilcoxon W	10.500	8.500	7.500	8.500	10.500	9.000	8.000	7.000
Z	.000	-.943	-1.581	-.913	.000	-.707	-1.291	-1.650
Asymp. Sig. (2-tailed)	1.000	.346	.114	.361	1.000	.480	.197	.099
Exact Sig. [2*(1-tailed Sig.)]	1.000[b]	.400[b]	.200[b]	.400[b]	1.000[b]	.700[b]	.400[b]	.200[b]
	PRO pre sˤ	**PRO post sˤ**	**PRO pre ðˤ**	**PRO post ðˤ**	**PRO pre dˤ**	**PRO post dˤ**	**PRO pre tˤ**	**PRO post tˤ**
Mann-Whitney U	3.500	3.000	2.500	3.000	3.000	3.500	4.000	4.500
Wilcoxon W	9.500	9.000	8.500	9.000	9.000	9.500	10.000	10.500
Z	-.471	-.745	-.943	-1.000	-.674	-.471	-.236	.000
Asymp. Sig. (2-tailed)	.637	.456	.346	.317	.500	.637	.814	1.000
Exact Sig. [2*(1-tailed Sig.)]	.700[b]	.700[b]	.400[b]	.700[b]	.700[b]	.700[b]	1.000[b]	1.000[b]

Urdu advanced

	PER pre sˤ	**PER post sˤ**	**PER pre ðˤ**	**PER post ðˤ**	**PER pre dˤ**	**PER post dˤ**	**PER pre tˤ**	**PER post tˤ**
Mann-Whitney U	1.500	1.000	.500	2.000	1.000	2.000	.500	.500
Wilcoxon W	4.500	4.000	3.500	5.000	4.000	5.000	3.500	3.500
Z	-.408	-1.000	-1.225	.000	-1.000	.000	-1.225	-1.225
Asymp. Sig. (2-tailed)	.683	.317	.221	1.000	.317	1.000	.221	.221
Exact Sig. [2*(1-tailed Sig.)]	.667[b]	.667[b]	.333[b]	1.000[b]	.667[b]	1.000[b]	.333[b]	.333[b]
	PRO pre sˤ	**PRO post sˤ**	**PRO pre ðˤ**	**PRO post ðˤ**	**PRO pre dˤ**	**PRO post dˤ**	**PRO pre tˤ**	**PRO post tˤ**
Mann-Whitney U	1.000	1.000	2.000	2.000	2.000	1.000	2.000	2.000
Wilcoxon W	4.000	4.000	5.000	5.000	5.000	4.000	5.000	5.000
Z	-1.000	-1.000	.000	.000	.000	-1.000	.000	.000
Asymp. Sig. (2-tailed)	.317	.317	1.000	1.000	1.000	.317	1.000	1.000
Exact Sig. [2*(1-tailed Sig.)]	.667[b]	.667[b]	1.000[b]	1.000[b]	1.000[b]	.667[b]	1.000[b]	1.000[b]

English intermediate

	PER pre sˤ	**PER post sˤ**	**PER pre ðˤ**	**PER post ðˤ**	**PER pre dˤ**	**PER post dˤ**	**PER pre tˤ**	**PER post tˤ**
Mann-Whitney U	2.500	1.500	2.500	.500	2.500	1.000	.000	2.500
Wilcoxon W	8.500	7.500	5.500	6.500	5.500	7.000	6.000	5.500
Z	-.304	-1.225	-.296	-1.521	-.296	-1.333	-2.000	-.304
Asymp. Sig. (2-tailed)	.761	.221	.767	.128	.767	.182	.046	.761
Exact Sig. [2*(1-tailed Sig.)]	.800[b]	.400[b]	.800[b]	.200[b]	.800[b]	.400[b]	.200[b]	.800[b]
	PRO pre sˤ	**PRO post sˤ**	**PRO pre ðˤ**	**PRO post ðˤ**	**PRO pre dˤ**	**PRO post dˤ**	**PRO pre tˤ**	**PRO post tˤ**
Mann-Whitney U	2.000	2.500	2.000	3.000	2.000	.500	1.000	2.000
Wilcoxon W	5.000	8.500	5.000	9.000	8.000	6.500	7.000	5.000
Z	-.609	-.333	-.816	.000	-.609	-1.521	-1.333	-.609
Asymp. Sig. (2-tailed)	.543	.739	.414	1.000	.543	.128	.182	.543
Exact Sig. [2*(1-tailed Sig.)]	.800[b]	.800[b]	.800[b]	1.000[b]	.800[b]	.200[b]	.400[b]	.800[b]

English advanced

	PER pre sˤ	**PER post sˤ**	**PER pre ðˤ**	**PER post ðˤ**	**PER pre dˤ**	**PER post dˤ**	**PER pre tˤ**	**PER post tˤ**
Mann-Whitney U	3.000	1.000	1.000	2.500	1.500	2.000	3.000	3.000
Wilcoxon W	6.000	4.000	7.000	8.500	7.500	5.000	6.000	6.000
Z	.000	-1.333	-1.333	-.333	-1.225	-.816	.000	.000
Asymp. Sig. (2-tailed)	1.000	.182	.182	.739	.221	.414	1.000	1.000
Exact Sig. [2*(1-tailed Sig.)]	1.000[b]	.400[b]	.400[b]	.800[b]	.400[b]	.800[b]	1.000[b]	1.000[b]
	PRO pre sˤ	**PRO post sˤ**	**PRO pre ðˤ**	**PRO post ðˤ**	**PRO pre dˤ**	**PRO post dˤ**	**PRO pre tˤ**	**PRO post tˤ**
Mann-Whitney U	2.500	3.000	2.500	3.000	.000	3.000	.500	.500
Wilcoxon W	5.500	6.000	8.500	6.000	6.000	6.000	6.500	6.500
Z	-.333	.000	-.333	.000	-2.000	.000	-1.521	-1.521
Asymp. Sig. (2-tailed)	.739	1.000	.739	1.000	.046	1.000	.128	.128
Exact Sig. [2*(1-tailed Sig.)]	.800[b]	1.000[b]	.800[b]	1.000[b]	.200[b]	1.000[b]	.200[b]	.200[b]

Appendix L: Instrumental Analysis

This section describes similarities and differences in the spectrograms between a random sample of some learners of Arabic recruited in this current study and Arabic native speakers. It compares samples of learners' recordings in the production test with the recordings of the Arabic native speaker that were used in the perception test. The rating of the test results used in this current study was based on the judgment of a number of raters who relied solely on their hearing to mark learners' production accuracy. The raters were not given visual acoustic details concerning sound features such as intensity or the degree of F2 lowering of the vowels following the emphatics; their main focus was only on the correct and incorrect pronunciation based on their perspective and experience of the pronunciation of MSA sounds. This current study followed the same approach used in language institutions, which rely only on teachers' auditory judgments of pronunciation. However, it remains interesting to conduct some sample spectrographic comparisons to reveal whether the visual representations of sound feature that reflect learners' articulation conformed with the visual representation of the Arabic sounds produced by a native speaker, and whether these specific visual patterns of sounds (i.e., intensity and F2 lowering) conformed to Arabic native raters' judgments.

Each sound has its distinctive features, which is formed based on different aspects, such as individual's dialect and personality. Therefore, the patterns in the spectrograms of the sounds produced by learners of Arabic could slightly deviate from Arabic native speakers, which is normal to some extent. The degree of deviation in the visual representation of sounds between learners and Arabic native speakers does not necessarily reflect incorrect or unintelligible production.

One sample was taken randomly from each language group (i.e., Mandarin, Urdu, English) without looking at the accuracy of the articulation of the emphatics. The recordings of the Arabic speaker that were used in the perception test are used again in this comparison. It should be noted that not all Arabic speakers have the same form of spectrograms in emphatics' production, but their pronunciation varies according to their origins, gender, and other aspects (Al-Raba'a, 2015; Huneety & Mashaqba, 2016; Israel et al., 2012; Kahn, 1975; Shoul, 2008).

Teaching groups were not taken into account here because the aim was only to show how much the acoustic cues of the emphatics are presented in the speech of Arabic learners and how these cues are different between each language group. The cues that we will be looking at in these comparisons are the intensity of the emphatics and the F2 lowering of the following vowels.

Since the purpose of this additional section is to show briefly the differences of the visual acoustic cues, the comparison will be limited to showing the visual representation of the fricative emphatic /sˤ/ and the stop emphatic /tˤ/ in the vowel context /_a/, which clearly represents the F2 lowering more that the vowels /u/ and /i/. In future research, it would be interesting to look more deeply into this approach in analysing emphatics to construct hypotheses or teaching methods that are based on the similarities and differences in the visual cues of emphatics between Arabic speakers and L2 learners from different proficiency levels and language groups.

Example 1

The first example is the pronunciation of the word /sˤar/ 'became' from an Arabic speaker compared to one speaker in each language group. The frequency of the vowel /a/ following the emphatic in the Arabic speaker's articulation was F1= 728.87 and F2= 1219.616. The frequencies of the same vowel from the speakers of English (F1=1241.96, F2= 1962.00), Urdu (F1=620.30, F2= 992.80) and Mandarin (F1=1009.17, F2= 1579.60) were different. The closest one to the Arabic speaker's articulation in the vowel's frequencies was the Urdu speaker, and the raters marked her articulation as correct, while English and Mandarin speakers' articulations were marked as incorrect. Figure 1 shows the four spectrograms and illustrates the position of F1 and F2 and the intensity of the emphatic /sˤ/.

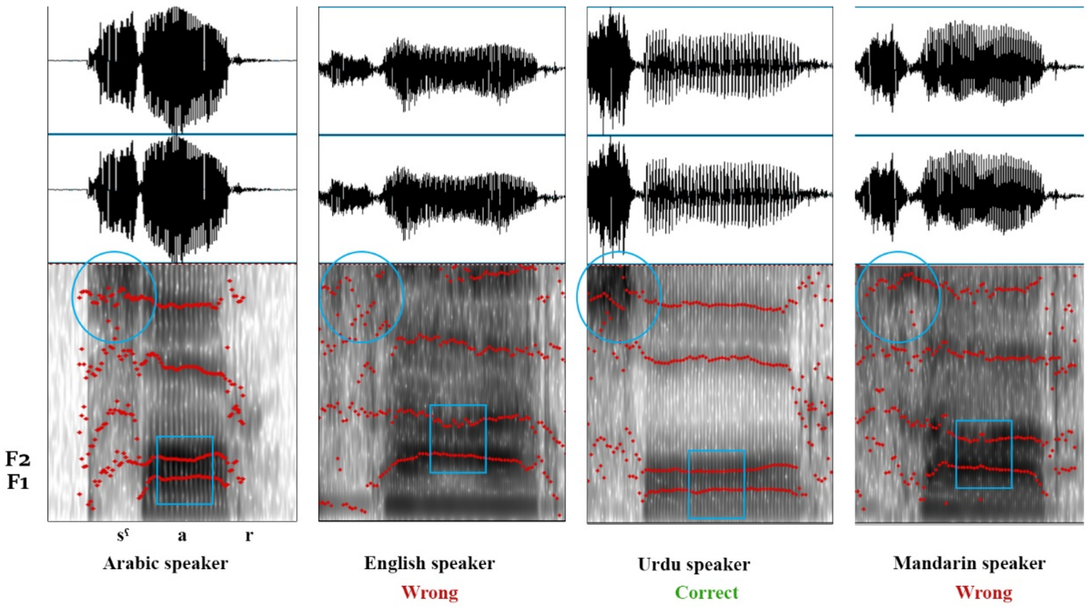


Figure 1: Spectrogram screenshots of the articulation of the word /sˤar/ 'became'

The blue circle in Figure 1 points at the intensity of the emphatic, while the blue square points at F1 and F2. As seen Figure 1, the intensity of the emphatic /sˤ/ in the Arabic speaker's spectrogram was relatively similar to the Urdu speaker. Furthermore, the F1 and F2 in the Arabic and Urdu speakers were very close. The intensity in the pronunciation of the emphatic /sˤ/ from English and Mandarin speakers were less than Urdu and Arabic speakers, which let us assume that they pronounced the sound /s/ instead of /sˤ/. In addition, F1 and F2 in the spectrograms of English and Mandarin speakers were higher than Arabic and Urdu speakers, which let us assume that they pronounced the mid-front vowel /a/ instead of the pharyngealised allophone [ɑ]. The raters' judgments conformed to the shape of spectrograms, which concluded that the Urdu speaker correctly pronounced the word /sˤar/ 'became' while English and Mandarin speakers pronounced the word /sar/ 'walk' instead. It can be said that the raters may have mainly used both the emphatic intensity and vowels' lowering as cues to distinguish correct and incorrect pronunciation of the emphatic /sˤ/.

Example 2

The second example is the pronunciation of the word /tˤab/ 'recovered' from an Arabic speaker compared to one speaker in each language group. The frequency of the vowel /a/ following the emphatic /tˤ/ in the Arabic speaker's articulation was F1= 735.50 and F2= 1242.31. The frequencies of the same vowel from the speakers of English (F1= 958.72, F2= 1736.72), Urdu (F1=953.72, F2= 1421.90) and Mandarin (F1=716.60, F2= 1190.54) were different. The closest one to the Arabic speaker's vowel frequencies was the English speaker, and the raters marked his articulation as correct, while Urdu and Mandarin speakers' articulations were judged incorrect. Figure 2 shows the four spectrograms and illustrates the position of F1 and F2 and the shape of the emphatic /tˤ/.

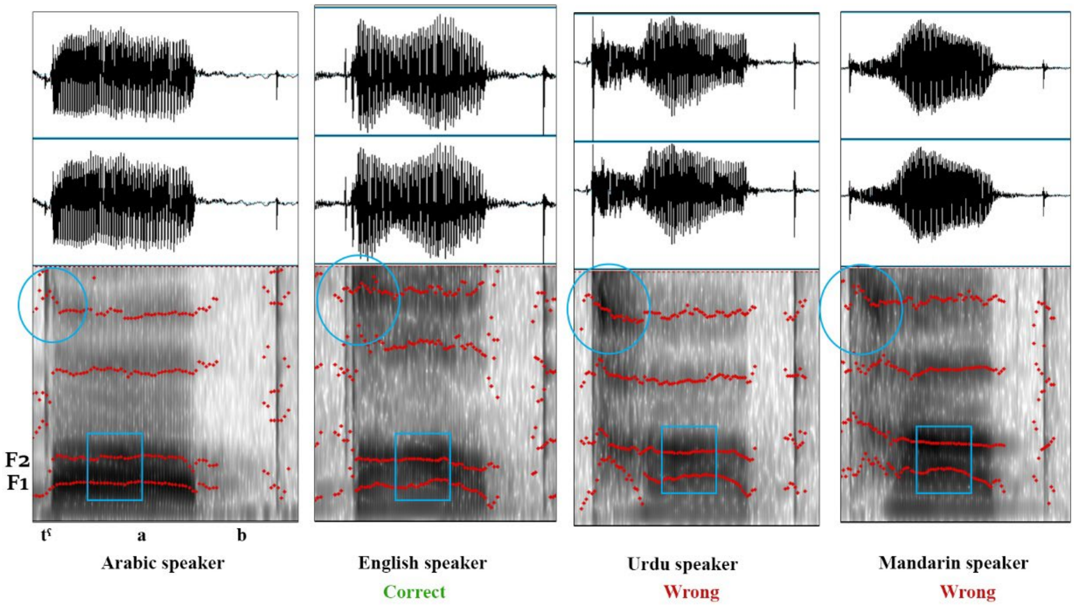


Figure 2: Spectrogram screenshots of the articulation of the word /tˤab/ 'recovered'

Figure 2 shows that, unlike the fricative /sˤ/, the F1 frequencies of the vowel following the stop /tˤ/ in English, Mandarin and Urdu were relatively close to the Arabic speaker's F1 frequency. Furthermore, the F2 frequencies in the four spectrograms did not greatly differ like the emphatic /sˤ/. The vowels' F1 and F2 in the two incorrect articulations slightly differed from the correct one but this different may not be distinguished in natural conversations. What was found different between the correct and incorrect pronunciation in the shape of spectrogram was the aspiration of the stop, which was apparent in the incorrect pronunciation more than the correct pronunciation of the emphatic /tˤ/. The blue circle in Figure 2 points at the aspiration position. It can be said that the raters may have used the aspiration as a cue to distinguish correct and incorrect pronunciation of the emphatic /tˤ/. If the raters heard the aspiration they would consider the sound /t/ instead of /tˤ/. This result was based on only one sample taken from each language group. More analyses are needed to confirm this finding in future research.

Conclusion

The results showed that it is clearly possible to distinguish accurate and inaccurate pronunciation by comparing the acoustic outputs of the Arabic speaker and the three language speakers. The two examples revealed that Arabic language teachers may unconsciously rely on certain acoustic cues to identify accurate or inaccurate articulation. In terms of the emphatic fricative /$s^ʕ$/, the analysis in example 1 showed that Arabic language teachers may identify this sound based on the following vowel and the degree of intensity of the emphatic. In terms of the emphatic stop /$t^ʕ$/, the analysis in example 2 showed that Arabic language teachers may identify this sound based only on the degree of emphatics' aspiration. A closer look at the effect of intensity, F1-F2 lowering and aspiration in identifying emphatics are needed in order to identify prominent acoustic cues that can help language teachers recognise emphatics and facilitate their features to L2 learners.