Chapter 1

Introduction

1.1 Aims of the dissertation

Vowel-to-Vowel (V-to-V) coarticulation refers to the coarticulatory impacts of one vowel on another across one or more intervening consonants. V-to-V coarticulation has been well investigated in many languages: Bantu languages such as Ndebele, Shona and Sotho (Manuel, 1987, 1990), German (Butcher and Weiher, 1976), Chinese languages (Mok, 2007, 2009, 2010, 2011, 2012; Han, 2007; Kondo and Arai 1998), Arabic (Hussein, 1990), Turkish (Beddor and Yavuz, 1995), Swedish, Russian, English, Bulgarian, Polish, Swahili, Shona, and Modern Greek (Öhman, 1966; Choi and Keating, 1991; Manuel and Krakow, 1984; Okalidou and Koenig, 1999; Beddor, Harnsberger and Lindemann, 2002, Purcell, 1979; Hawkins and Slater, 1994; Magen, 1997), Catalan and Spanish (Recasens, 1987). The aforementioned studies have shown that there are differences between languages in how VCV coarticulation takes place in a given language.

The factors that impact on V-to-V coarticulation have also been investigated in many languages. For example, there are studies that examined the effects of vowel space density (Manuel, 1990, 1999; Mok, 2007), coarticulatory resistance (Fowler, and Brancazio, 2000) coarticulatory direction (Recasens, 2002), extent of coarticulation (Recasens, 1989; Magen, 1997), syllable structure (Mok, 2007a, 2010; Modarresi; Sussman, Lindblom, and Burlingame, 2004), prosody (Cho, 2004), vowel harmony (Boyce, 1990; Beddor and Yavuz, 1995; Przedzbiecki, 2005), and stress (Fowler, 1981). These studies have shown that the effects of these factors differ in languages.
This dissertation examines the impact of vowel space and pharyngealized consonants on the degree of V-to-V coarticulation in three Yemeni Arabic dialects: Abyani Yemeni Arabic (AYA), Hadhrami Yemeni Arabic (HYA) and Ta’izzi Yemeni Arabic (TYA), using meaningful and nonce words as a test case. The impact of vowel space on V-to-V coarticulation has been investigated in many languages such as Swahili, Shona, English, Ndebele, Sotho Cantonese and Beijing Mandarin (Manuel, 1987, 1990, 1999; Mok, 2007). However, the impact of vowel space on V-to-V coarticulation has received no attention in Arabic. Hence, an acoustic experiment was conducted to investigate the impact of vowel space on V-to-V coarticulation in the three Yemeni Arabic dialects.

The effects of consonants with secondary articulations on V-to-V coarticulation have been examined in Russian, Polish and Bulgarian (Öhman, 1966; Purcell, 1979; Keating 1985; Choi and Keating 1991). There is a dearth of studies on the impact of pharyngealized consonants on V-to-V coarticulation in Arabic, with the exception of Hussein (1990). Hence, an acoustic experiment was conducted to examine the impact of pharyngealized consonants on V-to-V coarticulation in the three dialects of Yemeni Arabic. This dissertation attempts to provide a clear picture of the nature of V-to-V coarticulation in Arabic across consonants with or without secondary articulations.

The aims of the study are presented as follows:

- To establish the size of the phonemic inventory of the three Yemeni Arabic dialects.
- To investigate the effect of the phonemic inventory on the acoustic vowel space in the three dialects of Yemeni Arabic.
To compare the F1 and F2 z-scores for each vowel identity among the three dialects of Yemeni Arabic.

To examine the impact of the acoustic vowel space on V-to-V coarticulation in the three dialects of Yemeni Arabic.

To investigate the impact of pharyngealized consonants on V-to-V coarticulation in the three dialects compared to their nonpharyngealized counterparts.

To achieve these aims, three experiments were designed. Experiment 1 is designed to investigate whether the three Yemeni Arabic dialects exhibit a comparable phonemic inventory, acoustic vowel space, and F1 and F2 z-scores for each vowel identity (see Chapter 3). Experiment 2 is designed to test whether the vowel space impacts on V-to-V coarticulation in the three Yemeni Arabic dialects (see Chapter 4). Experiment 3 is designed to examine the impact of the pharyngealized consonants on the degree of V-to-V coarticulation in the three Yemeni Arabic dialects (see Chapter 5).

1.2 Vowel inventory size and vowel space

Languages differ in the organization and size of their phonemic vowel inventories from three to twenty-four vowels (Maddieson, 1984). The theory of Adaptive Dispersion was first used by (Liljencrants & Lindblom, 1972). The theory provides rules to account for cross-linguistic characteristics observed in vowel inventories. It gives predictions regarding the influence of vowel system size on the general organization of acoustic vowel spaces, (Liljencrants & Lindblom 1972; Lindblom 1986). This theory states that vowels of a given language should be extremely perceptually dispersed from one another (Liljencrants & Lindblom 1972). This means that the larger the inventory size, the more perceptually distinct the vowels. The
theory states that the demand for sufficient contrast between vowels in a phonemic inventory will result in an adaptive dispersion of these vowels. Bradlow (1995) stated that languages with large inventories expand their acoustic vowel space.

Many studies investigated the validity of this theory (i.e., dispersion theory) (Engstrand and Krull, 1991; Bradlow, 1995; Meunier et al., 2003; Livijn 2000; Al-Tamimi and Ferragne 2005, and Becker-Kristal 2010). The previous studies have been controversial; some of the previous studies lend credence to this theory such as (Bradlow, 1995; Al-Tamimi and Ferragne 2005; Becker-Kristal 2010), while others do not provide evidence to the theory such as (Engstrand and Krull, 1991; Meunier et al., 2003; Livijn 2000).

Engstrand and Krull (1991) investigated the acoustic vowel spaces of seven languages (Spanish, Japanese, Swahili, Bulgarian, Romanian, Swedish and Hungarian). Engstrand and Krull (1991) concluded that there is no correlation between the inventory size and the expansion of the acoustic vowel space.

Bradlow (1995) examined the acoustic vowel spaces of English with 11 vowels and Spanish with 5 vowels. Bradlow (1995) found that English has a larger vowel space than that of Spanish. In another study, Meunier et al. (2003) compared the acoustic dispersion of vowels in three languages: English with 11 vowels, French with 10 vowels and Spanish with 5 vowels. Meunier et al. (2003) found that the findings of their study did not support the theory of adaptive dispersion: that a crowded vowel system influences the size of the acoustic vowel space.

Based on acoustic data from 28 languages, Livijn (2000) concluded that there is little correlation between the number of vowels in inventories and the size of the acoustic
space. Becker-Kristal (2010) investigated the phonemic properties of 555 vowel inventories and their phonetic realizations. Becker-Kristal (2010) found that there is a clear correlation between the number of vowels and the acoustic space size of vowel inventories. Becker-Kristal (2010) suggested that the findings of his study gave credence to this theory.

There is a paucity of studies on the acoustic vowel space of Arabic dialects in general and Yemeni Arabic in particular. The only study in this regard was conducted by Al-Tamimi and Ferragne (2005), which examined the acoustic vowel spaces and positions of French which has an 11 vowel systems and two Arabic dialects: Moroccan with 5 vowel systems and Jordanian Arabic with 8 vowel systems. The results of the study were compatible with the theory of adaptive dispersion: the size of the vowel inventory affects the size of the acoustic vowel space (i.e., the larger the vowel inventory, the larger the acoustic vowel space). Al-Tamimi and Ferragne (2005) found that the acoustic vowel spaces of Jordanian Arabic and French are larger in size compared to Moroccan Arabic. There is a slight difference in the vowel positions of the two languages. The low vowel [a] is more centralized in Moroccan Arabic compared to Jordanian Arabic and French.

Until recently, the acoustic vowel space in Arabic has received little attention in contrast to the studies of other languages such as Spanish, Japanese, Swahili, Bulgarian, Romanian, Swedish, English, French, German, Modern Greek and Hungarian (Engstrand and Krull, 1991; Bradlow 1995; Meunier et al. 2003; Kristal 2010; Livijn 2000). In the absence of a study on the size of the vowel inventories and the acoustic vowel spaces of Yemeni Arabic dialects, an acoustic experiment (Experiment 1) was conducted to compare the size of the vowel inventories, the
acoustic vowel spaces and the F1 and F2 z-scores for each vowel identity of the three dialects.

The findings of the first experiment support our hypotheses (i.e., hypothesis 1 and 2). The three dialects have comparable acoustic vowel space because of the small vowel inventory size of the three dialects. Additionally, the findings show that the F1 and F2 z-scores for each vowel identity, except the F1 z-score for /i:/, are not the same among the three dialects. As can be seen in Chapter 3, the findings of the first experiment corroborate the dispersion theory and the previous studies that also lend credence to this theory on the impact of inventory size on the acoustic vowel space. The statistical tests do not show any significant difference in the size of the vowel space area of the three dialects. Hence, we argue that the three Yemeni dialects are comparable in their acoustic vowel space.

1.3 Impact of vowel space on V-to-V coarticulation

V-to-V Coarticulation differs from language to language and from dialect to dialect. The idea of output constraints hypothesis was first proposed by Manuel (1978, 1990, 1999). Manuel (1987, 1990, 1999) suggested that there are linguistic constraints that would influence coarticulation and called such constraints “output constraints”. Manuel (1987, 1990, 1999) gave a clear picture of language differences in V-to-V coarticulation. Manuel (1987, 1990, 1999) suggested that if a language has only one phoneme in a particular region of the vowel space, then this engenders coarticulation without causing perceptual confusion. Based on her hypothesis, V-to-V coarticulation is controlled in each language by the requirement that the perceptual contrast among vowels be preserved, which can be strict in some languages and vice versa. There
ought to be less V-to-V coarticulation in languages with larger vowel inventories, where there is more possibility of perceptual confusion, than in languages with small vowel inventories, where coarticulation may result in articulatory/acoustic overlap of adjacent vowel spaces. Hence, a crowded vowel space would restrict the degree of V-to-V coarticulation allowed. Manuel (1987, 1990, 1999) was also circumspect in suggesting that there are some other factors (e.g., speech style and individual differences) that could influence the role of phonological contrast in coarticulation.

Manuel and Krakow (1984) compared V-to-V coarticulation in Swahili, American English, and Shona. Manuel and Krakow (1984) found that Swahili and Shona, which have 5 phonemes, exhibited more V-to-V coarticulation than English, which has a crowded vowel inventory. Manuel (1987 and 1990) compared three Bantu languages, Sotho that has 7 phonemes which are more crowded in the low and mid vowel regions than Shona and Ndebele vowel spaces. Ndebele and Shona both have 5 phonemes. Manuel (1987 and 1990) found that Ndebele and Shona exhibited more V-to-V coarticulation for the target low mid vowel /a/ in the F2 dimension than Sotho that has a more crowded vowel space. Manuel (1987, 1990) proposed that linguistic variance (i.e., languages differ in the number of their vowel systems) would affect V-to-V coarticulation.

Choi and Keating (1991) examined V-to-V coarticulation in four languages: Russian, Polish and Bulgarian (with 5 or 6 vowels) and used American English (with 11 vowels) as a reference. Choi and Keating (1991) found that four languages exhibit different degrees of V-to-V coarticulation. The study also showed that American English allowed the most V-to-V coarticulation compared to the other languages
(Russian, Bulgarian and Polish). Cho (2004) also suggested that the output constraint hypothesis is used to explain language difference in coarticulation.

Okalidou and Koenig (1999) investigated V-to-V coarticulation in Modern Greek, which has 5 phonemes and American English, a language with a crowded vowel space comprising 13 to 15 vowels, depending on the dialect in use. Greek speakers showed more flanking vowel effects than American English speakers in the F2 dimension.

Beddor et al. (2002) compared Shona that has 5 vowels with American English and found that American English exhibited more V-to-V coarticulation than Shona. The results of this study were inconsistent with the previous studies (Manuel and Krakow 1984; Manuel 1987, 1990; Okalidou and Koenig 1999) except for Choi and Keating (1991).

Han (2007) found that there was no difference in V-to-V coarticulation between Korean which has 8 phonemes and Japanese that has 5 phonemes. Han (2007) found that inventory size did not play any role in V-to-V coarticulation and speculated on other factors that contributed to V-to-V coarticulation in languages.

Mok (2012) investigated V-to-V coarticulation in two Chinese languages: Cantonese and Mandarin, using eight speakers of Hong Kong Cantonese and eight speakers of Beijing Mandarin. Cantonese has 8 vowels and Mandarin has 5 vowels. The findings of the study revealed that Cantonese and Mandarin did not differ in the degree of V-to-V coarticulation in either F1 or F2 dimension. Mok (2012) found that vowel inventory was not the main factor that influenced V-to-V coarticulation. Mok (2012)
suggested that vowels in small inventories were not found to coarticulate more, than vowels in large inventories.

The findings of previous studies have been somewhat controversial; some lend credence to the output constraints hypothesis and while others do not. In this study, speech data from three Yemeni dialects have been investigated to test whether vowel space affected V-to-V coarticulation in the three Yemeni Arabic dialects. Since the three Yemeni dialects exhibit a small acoustic vowel space compared to the languages that have larger inventory size, we assume that the three Yemeni Arabic dialects exhibit a comparable degree of V-to-V coarticulation (i.e., the three dialects have a greater degree of V-to-V coarticulation). The findings of Experiment 2 do not support our hypothesis (i.e., hypothesis 4) and also do not support the output constraints hypothesis. The three dialects differ in the degree of V-to-V coarticulation. However, the three dialects have comparable acoustic vowel space.

1.4 Impact of pharyngealized consonants on V-to-V coarticulation

Pharyngealization is a unique feature in Semitic languages such as Arabic and Hebrew. The term ‘pharyngealization’ refers to consonants produced with a secondary constriction in the back of the vocal tract and a primary constriction in the dental or alveolar region which impacts following and preceding vowels by lowering the F2 and raising the F1 and F3 formant frequencies (Ghazali, 1977).

Coarticulatory impacts of V-to-V coarticulation are known to differ from language to language. Öhman (1966) found that Russian exhibited the weakest V-to-V coarticulation compared to Swedish and American English, due to the presence of
secondary articulation of consonants in Russian such as palatalization, which restricts freedom of the tongue to coarticulate. On the other hand, Keating (1985) stated that consonants with secondary articulation must block V-to-V coarticulation. Furthermore, Choi and Keating (1991) examined Ohman’s suggestion by comparing palatalized and non-palatalized consonants in Russian, Bulgarian Polish, and used American English as a reference. Choi and Keating found that secondary articulation did not by itself block V-to-V coarticulation. The four languages exhibited different degrees of coarticulation, whereas American English allowed it the most. In addition, Hussein (1990) suggested that consonant type (pharyngealized consonants) was not the main factor that decided whether the coarticulation should take place or not. There might be some other factors that influenced V-to-V coarticulation such as speech rate, speaker, vowel identity, and language.

Since pharyngealized consonants affect vowel formants of the vowels following or preceding them, and some studies found that consonants with secondary articulation either block or reduce the degree of V-to-V coarticulation, an acoustic experiment was conducted to investigate the degree of V-to-V coarticulation in the pharyngealized consonants compared to their nonpharyngealized counterparts in three Yemeni Arabic dialects. The main aim of this experiment is to shed light on the acoustic correlates of pharyngealized consonants on V-to-V coarticulation in three Yemeni Arabic dialects: AYA, HYA and TYA, which is ignored in most of the previous studies. The findings of Experiment 3 do not support the hypothesis (i.e., hypothesis 5) that pharyngealized consonants reduce the degree of V-to-V coarticulation in the three Yemeni Arabic dialects. Hence, we argue that consonants
with secondary articulation do play a role in reducing the degree of V-to-V coarticulation in the three dialects.

1.5 An overview of Arabic

Arabic is a Semitic language spoken by approximately 250 million Arabic speakers all over the world. The term 'Semitic' relates to a family of languages such as Arabic, Hebrew, Aramaic and certain ancient languages such as Phoenician and Akkadian, constituting the main subgroup of the Afro-Asiatic family. These languages have several linguistic characteristics in common such as the 3 letter root system (the k-t-b) and the pattern system (a pattern is imposed on the basic root k-t-b→kataba).

The term ‘Semitic’ was used by the German scholar Schloezee during the 19th century and was derived from the name Shem, son of Noah. Semitic languages are divided into three main branches (Rabin, 1971; Frayha, 1981). The Eastern Branch which consists of Assyrian (spoken in lower Euphrates) and Babylonian (are not in use), the Western branch is made up of Aramaic (are not in use), Phoenecian (are not in use) and Hebrew (is spoken in Israel) and the Southern and Northern Branches. The Southern Arabian languages comprise a group of languages spoken in Yemen such as Sabaen, Minaen, Himyarite, Ethiopic Ge’ez and Mahri-Socotri. All of the Southern languages, except Mahri-Socotri, are not used in Yemen. The Classical Arabic, Modern Standard Arabic, all other dialects of Arabic including Yemeni Arabic belong to the Northern Arabic.

Arabic is spoken as a first language in all countries of the Arabian Peninsula (i.e., Yemen, Jordan, Oman, Iraq, Bahrain, Lebanon, Qatar, Palestine, Saudi Arabia, United Arab Emirates, Kuwait and Syria) and in the Arab countries of Africa (i.e., Egypt,
Algeria, Libya, Djibouti, Morocco, Sudan, Tunisia, Somalia and Mauritania. These countries are called Arab world countries because their residents speak Arabic as a first language.

Classical Arabic is the language of the Holy Quran. Modern Standard Arabic is adapted from the classical Arabic and is now being used in schools, mosques, the media, and official conversations between educated Arabs in all Arab countries. Khoja (2002) suggested that Modern Standard Arabic is a simplified form of Classical Arabic. The main difference between classical Arabic and Modern Standard Arabic is that Modern Standard Arabic has modernized and expanded vocabulary.

Arabic dialects (i.e., Yemeni, Jordanian, Omani, Iraqi, Bahraini, Lebanese, Qatari, Palestinian, Saudi Arabian, Emirates Arabic, Kuwaiti and Syrian) differ from country to country in both vocabulary and pronunciation. Despite the differences in vocabulary and pronunciation in the above-mentioned dialects, native speakers of Arabic understand each other. On the contrary, many speakers of Arabic face difficulty in understanding the dialects spoken in Algeria, Morocco and Tunisia. So, Arabic speakers resort to Modern Standard Arabic instead.

The sound system of Arabic consists of 28 consonants and 6 vowels. 3 of the 6 are long vowels and 3 are short vowels. The short vowels are not written in Arabic orthography. The short vowels are indicated with diacritics. These diacritics are not used in ordinary writing because native speakers can easily understand the intended words from the context.
1.6 Yemeni Arabic dialects

Yemeni Arabic is one of the Arabic varieties. It is spoken in Yemen with various distinct dialects throughout the country. Yemeni dialects differ from one region to another in both vocabulary and pronunciation. The term Yemeni Arabic is only a cluster of Yemeni Arabic varieties that distinguishes the dialects spoken in Yemen from the other dialects spoken in other Arab countries.

Yemeni Arabic can be subdivided into several main dialects according to its geographical zones or ethnic backgrounds with distinct vocabulary, phonology and some syntactical differences. The main dialects spoken in the northern part of Yemen are Sana’ani, Ta'izzi, Tihami, Dhamari, and Mahwiti (Behnstedt 1985; Watson 1999; Watson 2000; and Simeone-Senelle 1996). The dialects spoken in the southern part of Yemen are Adeni, Abyani, Hadhrami, Lehji, Shabbwani, Mahri and Soqotri (see Habtoor 1989; Vonhave 1996; Adhuraibi 1998; Al-Saqqaf 1999, Watson 2012; Mohdar 2012, 2016).

Yemeni Arabic is one of the colloquial varieties of Arabic dialects. It is used for daily communication and has no official status; Modern Standard Arabic is used for official purposes, commerce, education and media in Yemen. Simeone-Senelle (1996) states that the Arabic dialects of Yemen are spoken as a mother tongue in most parts of the country except in two provinces of the southern part of Yemen: Al-Mahra and Soqotra. The dialects of these two regions are different from the other Yemeni Arabic dialects. The mother tongue of the Yemeni Arabic people differs from province to province. For example, the mother tongue of Yemeni people who were born and raised in Abyan province is called Abyani Yemeni Arabic. There are varieties in each
province in Yemen. The three Yemeni Arabic dialects which have been investigated in this study are used in everyday communication. Modern Standard Arabic is the language of official and literary communication as well as education and religious sermons in Mosques.

1.6.1 Abyani Yemeni Arabic
AYA is one of the Yemeni Arabic varieties spoken in the southern part of Yemen. Abyan governorate which was historically a part of Al-Fadhli Sultanate has distinctive vocabulary, morphology and phonology compared to the other Yemeni Arabic dialects. In Abyan itself, there are different varieties of Abyani Arabic such as Yaafi‘i Abyani Arabic, Awadhali Abyani Arabic and Fadhli Abyani Arabic. The term AYA used in this study only describes one of the Abyani Arabic varieties spoken by Al-Fadhli tribes in Abyan. The data were recorded from the researcher’s extended family that belongs to Al-Fadhli tribes. The other varieties spoken in Abyan province are not included in the study.

1.6.2 Hadhrami Yemeni Arabic
HYA is one of the Yemeni Arabic varieties spoken in the southern part of Yemen, in Hadhramaut Province. The term Hadhrami Yemeni Arabic used in this study refers only to Hadhramaut Al-Wadi because there are diverse varieties of HYA, i.e. Hadhramaut Al-Wadi (the valley region) and Hadhramaut Al-Sahal (the coastal region). There are some phonological and lexical differences between Hadhramaut Al-wadi and Hadhramaut Al-Sahal. One of the differences between the two varieties of HYA is that Hadhramaut Al-Sahal is characterized by the presence of consonant clusters word initially by deleting the vowel of the first syllable, while Hadhramaut
Al-Wadi does not allow consonant clusters. For example, in Modern Standard Arabic, the word /basʕal/ is pronounced as /bsʕal/ in Hadhramaut Al-Sahal, while Hadhramaut Al-wadi pronounces it as /basʕal/. In addition, Hadhramaut Al-Wadi does not allow consonant clusters. For example, the word /bint/ in Modern Standard Arabic is pronounced as /binit/ in Hadhramaut Al-Wadi, whereas Hadhramaut Al-Sahal allows final consonant clusters. Thus, the native speakers of Hadhramaut Al-Sahal pronounce the word /bint/ as it is pronounced in Modern Standard Arabic.

The data for this study has been recorded from Doctoral and Masters students who are studying at the EFL University and Osmania University and from their families who are staying in Hyderabad, India. The native speakers of HYA belong to Hadhramaut Al-Wadi. The other variety spoken in Hadhramaut is excluded from this study (See Al-Saqqaf, 1999).

1.6.3 Ta’izzi Yemeni Arabic

TYA is a variety of Yemeni Arabic spoken in Taiz governorate. It has some distinct vocabulary and phonology from the other Yemeni Arabic dialects. There are different varieties in Taiz itself such as Sharabi Ta'izzi Arabic, Hubaishi Ta'izzi Arabic and Al-Hugariah Ta'izzi Arabic. The term TYA has been used in this study to refer to the people of Taiz who are living in the countryside of Taiz in Al-Trubah. The data for this study were recorded from Doctoral and Masters students who are studying at the EFL University and Osmania University and from their families in Hyderabad, India. All the speakers of this study are speakers of Al-Trubah Ta'izzi Arabic; the other varieties spoken in Taiz province are excluded from this study (See Ali, 2000).
1.7 Research questions

The research questions that this study addresses are stated as follows:

- Are the phonemic inventories of the three Yemeni Arabic dialects comparable in size?

- What is the effect of the phonemic inventory on vowel space in the three dialects of Yemeni Arabic?

- Do the three Yemeni Arabic dialects exhibit invariant F1 and F2 values for each vowel identity?

- Does the small vowel space of the three Yemeni Arabic dialects allow more V-to-V coarticulation?

- Do pharyngealized consonants impact on the degree of V-to-V coarticulation in the three dialects of Yemeni Arabic?

1.8 Research hypotheses

The following hypotheses of the study have been designed to investigate the experimental results of the study. These hypotheses are structured to produce conclusions from the acoustic data which answer the questions mentioned in section 1.7 of this study. The hypotheses are formulated as follows:
Hypothesis 1: The phonemic inventories of the three dialects of Yemeni Arabic are comparable in size.

Hypothesis 2: The smaller the phonemic inventory size, the smaller the acoustic vowel space.

Hypothesis 3: The F1 and F2 z-scores for each vowel identity are invariant among the three dialects of Yemeni Arabic

Hypothesis 4: V-to-V coarticulation may be dependent on vowel space: the smaller the acoustic vowel space, the greater the V-to-V coarticulation.

Hypothesis 5: The degree of V-to-V coarticulation may be dependent on the presence of secondary articulation feature in a language: Consonants with secondary articulations reduce the degree of V-to-V coarticulation in the three Yemeni Arabic dialects.

1.9 Outline of the dissertation

This study has been organized and presented in six different chapters. A brief overview of each of the chapters has been presented below:

Chapter 2.1 consists of seven sections. A comprehensive description of Yemeni Arabic speakers of each dialect is discussed in Section 2.2. A questionnaire that was given to the speakers to elicit information from Yemeni Arabic speakers is reviewed in Section 2.3. Section 2.4 is dedicated to describe the instructions that were given to the Yemeni speakers orally before the recording procedure. Section 2.5 describes the stimuli of all the experiments. Recording tools and procedure are reviewed in Section
2.6. Section 2.7 describes the acoustic analysis of the three experiments. The purpose of vocal tract normalization is explained in Section 2.8. Section 2.9 discusses the statistical measurements that were used for conducting the three experiments of study on the three Yemeni Arabic dialects.

Chapter 3 presents an acoustic experiment examining the vowel inventory size, acoustic vowel space and F1 and F2 values for each vowel identity in three Yemeni Arabic dialects. Section 3.1 discusses the purpose of conducting this experiment. Section 3.2 will address the issue of conducting this experiment. Section 3.3 will answer the questions and hypotheses postulated in Section 1.7 and 1.8 which attempts to examine the size of the phonemic inventory of each dialect and its impact on the size of the acoustic vowel space in the three Yemeni dialects.

Chapter 4 describes an acoustic experiment designed to test whether the three Yemeni Arabic dialects undergo the same degree of V-to-V coarticulation as it was hypothesized in the previous studies. Section 4.1 discusses the aim of this experiment. Section 4.2 will posit the reason behind conducting the experiment. Section 4.3 will provide answers to the questions and hypotheses postulated in Section 1.7 and 1.8. The vowel positions and vowel formants of V1 and V2 of each data set are shown in Section 4.3. It also shows how vowel space impacts on V-to-V coarticulation in the three Yemeni Arabic dialects. Section 4.3.1 discusses the results of V-to-V coarticulation at the vowel midpoint in AYA. The findings of V-to-V coarticulation at the vowel midpoint in HYA are shown in Section 4.3.2. Section 4.3.3 presents the results of V-to-V coarticulation at the vowel midpoint in TYA.
Chapter 5 deals with an acoustical experiment that was designed to examine the extent of V-to-V coarticulation in pharyngealized consonants compared to their nonpharyngealized counterparts. Section 5.1 discusses the purpose of conducting this experiment. Section 5.2 will address the issues of the experiment. Section 5.3 will provide answers to the questions and hypotheses postulated in Section 1.7 and Section 1.8. Section 5.3.1 discusses the results of V-to-V coarticulation at the vowel onset, midpoint and offset in AYA. The findings of V-to-V coarticulation at the vowel onset, midpoint and offset in HYA are shown in Section 5.3.2. Section 5.3.3 presents the results of V-to-V coarticulation at the vowel onset, midpoint and offset in TYA.

Chapter 6 is divided into two main sections. Section 6.1 gives an introduction of the main ideas of the study. Section 6.2 provides a summary of the findings of the previous acoustic and statistical analyses. Recommendations and suggestions for further research are described in Section 6.3. Chapter 6 is followed by the bibliography and appendices.