THE MODIFICATION OF ENGLISH /S/+ CONSONANT ONSET CLUSTERS BY LEVANT ARABIC SPEAKERS

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ABSTRACT

This thesis investigates the production of English word initial /s/+ consonant clusters (sC) in the speech of eleven adult native Levant Arabic speakers (LAs). In particular, the study investigates the modification strategies that are utilised by LAs when articulating English sC clusters. This study controlled for some of the extra-linguistic factors, which might have an impact on the production of these clusters: length of exposure to North American culture, level of proficiency and onset time of learning. A word-reading task was assigned to elicit the data. The production of these words was compared with that of nine native Canadian English speakers (CEs).

The findings of this study are distinct from those of previous, related inter-language studies (Al-Saidat, 2010; Gouskova & Hall, 2007; Al-Shuaibi, 2006, Selkirk, 1981), which concluded that Arabic English as a second language (ESL) speakers have a tendency to insert a vowel in consonant clusters as a strategy (i.e., epenthesis) to facilitate the articulation of these clusters. However, the acoustic analysis employed in this study showed that the targeted clusters were articulated without vowel insertion. Our acoustic analysis leads us to conclude that the strategy in producing sC clusters among our study's sample of LAs has nothing to do with epenthesis. Instead, LAs produce clusters with a difference in the length of the /s/ and of the following consonant closure. In particular, the /s/ duration is shorter and the consonant closure is longer.

It is our hope that the new light shed on this phenomenon will further inform teaching practice for those working with Arabic ESL learners, while also sparking further discussion and research in the inter-language research community.

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TABLE OF CONTENTS

Contents	Page

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ANOVA	ANalaysis Of Variance
C	Consonant
CEs	Canadian English speakers
ESL	English as a Second Language
IELTS	International English Language Testing System,
L1	First Language
L2	Second Language
LAs	Levant Arabic speakers
M	Mean
MDH	Markedness Differential Hypothesis
Ms	Milliseconds
MSA	Modern Standard Arabic
SSP	Sonority Sequencing Principle
TOEFL	Test of English as a Foreign Language
V	Vowel

CHAPTER One: INTRODUCTION

1.1 Purpose of the Present Study

A considerable amount of research has investigated consonant cluster production. Studies in this field have shown that second language (L2) speakers pronounce consonant clusters with different degrees of difficulty depending on many variables; such as cluster type, cluster length, sonority, manner of articulation and the preceding phonological environment (Davidson, Jusczyk, & Smolensky, 2009; Cardoso, 2008; Yavas & Barlow, 2006; Abrahamsson, 1999; Carlisle, 1998; 1991a; 1991b; Eckman & Iverson, 1993; Broselow & Finer, 1991).

Learners from different language backgrounds appear to have different preferences for cluster simplification strategies, starting from vowel epenthesis, to substitution or deletion of certain consonants in a cluster. Recent studies have claimed that Arabic speakers of English as a second language (ESL) unconsciously insert an epenthetic vowel between syllable-initial consonants as a modification strategy to avoid onsets that are disallowed in their native dialect, thus making words more easily pronounceable (Al-Saidat, 2010; Gouskova & Hall, 2007; Al-Shuaibi, 2006; Selkirk, 1984). On the other hand, other researchers support the notion that native speakers of certain Arabic dialects such as Levant Arabic (LA) and Najdi, a subdivision of the Gulf Arabic dialect, should not have difficulties in producing the word-initial consonant clusters that arise in English as they already exist in their first language (L1) (Daana, 2009; Alezetes, 2007; Kiparsky, 2003; Abboud, 1979).

The two commonly suggested modification strategies, derived from research on Arabic speakers of English, are consonant cluster deletion and vowel epenthesis. The latter can be further divided into (i) anaptyxis, that is when a vowel is inserted between two consonants (CC⇨CVC), and (ii) prothesis, that is when a vowel is inserted before the cluster (CC⇨VCC). Both types are utilised for initial consonant cluster simplification by speakers of many other languages such as Brazilian Portuguese, Chinese, Farsi, Japanese, Korean, Spanish and most dialects of Arabic (Boudaoud, 2008; Cardoso, 2008; Hansen, 2001; Eckman & Iverson, 1993; Carlisle, 1991a).

While there is a wealth of studies on some Arabic dialects such as Cairene, a subdivision of the Egyptian Arabic dialect, and Iraqi and Najdi Arabic speakers' inter-language syllabification (Alezetes, 2007; Karimi, 1987; Abboud, 1979), few studies have explored how speakers of other Arabic dialects, specifically LAs, deal with consonant clusters when speaking ESL (Itô, 1989; Broselow, 1984, 1983).The present study investigates the nature of such modification. Although there exist a reasonable number of explanatory studies of the articulatory difficulties of Arabic speakers when speaking English, a very limited number of these studies have investigated epenthesis acoustically. This is mainly due to the very small number of analysts in the discipline of acoustic analysis (Ayyad, 2011). The present study uses the computer software program Praat to analyse speech sounds. This software allows generating waveforms and wide- and narrow-band spectrograms that enhance certain frequency regions. In addition, this software program allows segmenting and labelling words and shows the intensity shape. Thus, the analysis does not depend on the aural skill or perception of the investigator but is more objective.

This study sets out to examine LAs' production of initial consonant clusters, and the type of modification that is utilised when articulating these clusters. Only word initial /s/+ consonant clusters (sCs) will be examined, while other clusters are left for future investigation. A distinctive feature of this study is that it controls the effect of extra-linguistic variables such as length of contact with the English language, level of proficiency and the onset time of learning ESL, to prevent the results from being contaminated because of the interference of other factors. Attempts have been made to determine how these factors individually or collectively influence the ability of L2 learners or non-native speakers to acquire native-like pronunciation abilities or intelligibility in a language (Flege & Liu, 2001). In addition, the current study investigates whether there are gender differences in consonant cluster production. Although gender has received much attention from L2 phonology researchers, only a limited number of studies have focused on the production of consonant clusters during the acquisition of a L2.

This study uses speech samples of eleven adult LAs with a high level of proficiency in English. All participants have lived in Canada for a minimum of three years; this minimum residency level is selected to ensure that the participants had been exposed to the English language for a reasonable period of time. In order to extend our knowledge of sC production in LAs, a broad range of initial sC clusters is investigated. By incorporating these variables and testing how they affect the clusters' production, the study hopes to provide a comprehensive insight into epenthesis phenomena and will explain phonological issues in LA production of sC clusters. More importantly, the study advocates a dialogue between researchers in theoretical linguistics and applied linguistics, in order to gain a comprehensive understanding into L2 acquisition of consonant clusters.

Understanding modification strategies that are adopted by Arabic speakers during their L2 acquisition of consonant clusters will enrich the pedagogical field. Educators' understanding and awareness of these difficulties and unintelligibility that confronts their students when articulating consonant clusters would enable them to better tailor their teaching methods to improve their students' pronunciation of these clusters. Instructors should rely on objective techniques, such as acoustic measurements, to evaluate their students' difficulties rather than depending on the judgment of their ears alone.

1.2 Research Questions

The following questions are addressed in this study**:**

- Is there any evidence of epenthesis in the production of s-clusters by adult LAs?
- To what extent do LAs pronounce sC clusters differently than CEs?
- Is there any correlation between sociolinguistic factors, particularly gender and nationality and the accuracy of sC cluster production?

1.3 Outline of the Study

This study is organized as follows: Chapter two starts with briefly describing Modern Standard Arabic (MSA), followed by a discussion of Arabic and Levant Arabic syllable structure in comparison to English syllable structure, and a brief review of different linguistic and extra-linguistic factors that affect consonant cluster pronunciation acquisition. A summary of previous related studies will follow, with a special focus on studies that deal with Arabic dialects. Chapter three describes the methodology and data collection procedures. Chapter four presents the findings that were gathered through this study. Chapter five discusses and interprets the results obtained from the data analysis. Finally, chapter six highlights the significance of the study's results, the study's limitations, and makes some suggestions for future, related research.

CHAPTER Two: REVIEW OF RELATED LITERATURE

Consonant clusters, as a distinctive feature in most languages, have appealed to many linguists and educators as an object of study. A large number of studies have focused on the variability associated with consonant cluster modification strategies. This chapter sheds light on Modern Standard Arabic (MSA) and, in particular, on the Levant Arabic (LA) dialect, as well as on the comparison between English and Arabic syllable structure, with a special focus on LA. The next section focuses briefly on linguistic factors affecting the acquisition of a second language (L2), particularly: first language (L1) interference, the Markedness Differential Hypothesis (MDH) and the Sonority Sequencing Principle (SSP). The following section describes the effect of sociolinguistic factors on the acquisition of the L2. The final section discusses different accounts and theories for difficulties in acquisition of L2 consonant clusters, which leads to the common modifications that are utilised when producing sC consonant clusters.

2.1 Modern Standard Arabic and the Levant Arabic Dialect

Arabic is the native language of more than 422 million people residing in 22 countries who are known by the common term, “the Arab world”, which refers generally to the Middle East and North Africa. In addition, Arabic is spoken in areas bordering on or near to the Arab world, such as Ahwaz in Iran, and some parts of Turkey, Chad, Mali, Senegal and Eritrea (UNESCO, 2012). Arabic is the fifth most spoken language in the world and the most spoken of the Semitic languages, which include, in addition to Arabic, Amharic, Hebrew, Aramaic and Tigrinya. Other Semitic languages, such as Ugaritic, Phoenician and Canaanite are extinct. It is important to note that what is generally referred to as “the Arabic language” is not a single linguistic variety; rather, it is a collection of different dialects and sociolects.

Classical Arabic is an older literary form of the Arabic language and is typically used in the Holy Quran, and was used during the days of the Caliphates. Because of that, classical Arabic is considered by most Muslims to be sacred and it is the language used for Muslims' prayers; however, classical Arabic is not the language LAs use on a daily basis. MSA derivative of classical Arabic, with modern vocabulary, and it is now widely used in Arab school systems, books, media, newspapers and news broadcasts.

Modern spoken Arabic dialects can be divided roughly into two groups: Western Arabic and Eastern Arabic. Western Arabic is spoken in Libya, Tunisia, Algeria and Morocco; while Eastern Arabic can be further divided into Egyptian, Levant, Iraqi and Gulf Arabic; while other subdivisions may also exist. LA is spoken in the area of the eastern Mediterranean coastal strip of people living in Lebanon, the central and the northern parts of historic Palestine, the northwest of Jordan and the west of Syria.

2.1.1 Arabic phonology. Classical Arabic phonology consists of 34 phonemes and it is distinguished by rich consonantal sounds and by fewer vocalic sounds. It has 27 consonants, three vowels /a, i, u/, each of which may be long or short, and two diphthongs /ai/ and /au/ as well as two semivowels /w/, /j/ (Omar, 1991).Arabic dialects are mostly oral languages; while the written material is almost always in MSA. This occasionally leads to mismatches when the phonological inventory of sounds in a particular dialect differs from that of MSA. For instance, /g/ and /ʧ/ do exist in some spoken dialects, particularly in LA, but they do not exist in MSA and therefore they do not have a written form (McCarthy, 1981). On the other hand, some Arabic dialects, Egyptian and its subdivisions for example, lack the MSA phonemes /ð/ and /θ/, and replace /z/ with /g/ (Kirchhoff et al., 2002). The absence of these phonemes in these dialects is the cause of pronunciation problems when most Egyptians, as well as other Arabic speakers, pronounce English words containing these sounds. The LA consonant inventory is presented in Table 2.1.

Table 2.1
Levant Arabic Consonant Inventory. Adapted from *Handbook of the International Phonetic Association* (1999, p.51) and McCarthy (1994, p. 203)

	Bilabial	Labio-Dental	Dental	Alveolar	Post – Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	b		tˤ t dˤ d				k g	q		ʔ
Nasal	m		n							
Fricative		f	θ ð ðˤ	s z	ʃ	sˤ		x ɣ	ħ ʕ	h
Affricate					dʒ					
Trill				r						
Approximant						j	w			
Lateral approximant					l					

2.2 English Phonology

The English phonetic system has 25 consonant sounds, ten vowels and five diphthongs (Ladefoged, 1993). The English consonant inventory is presented in Table 2.2.

2.3 Comparison between the Levant Arabic and English Consonant Inventories

Both the LA and English phonetic systems share 19 consonants as shown in Figure 2.1. Some of these common consonants are not completely identical in terms of their articulation. For instance; the point of articulation of /t/, /d/ and /n/ in English is alveolar, but in Arabic it is dental. With the regard to /t/ and /d/, both are pronounced with the tongue tip flat on the alveolar ridge in Arabic; however, in

American English both are articulated by placing the tip of the tongue toward the upper front teeth without touching them.

Table 2.2
English Consonant Inventory. Adapted from *Handbook of the International Phonetic Association* (1999, p.41)

	Bilabial	Labio-dental	Dental	Alveolar	Post-alveolar	Palatal	Velar	Glottal
Plosive	p b			t d			k g	
Affricate					tʃ ʤ			
Nasal	m			n			ŋ	
Fricative		f	θ ð	s z	ʃ ʒ			h
Approximant				ɹ		j	w	
Lateral Approximant				l				

The phoneme /r/ is pronounced differently in Arabic and English; /r/ is a retroflex approximant in North-American English [ɹ] but trilled in Arabic [r], especially in word-final position. With a retroflex /r/, the tip of the tongue is curved back toward the roof of the mouth but does not touch it, while with a trilled /r/, the tongue vibrates against the roof of the mouth. Thus, it is crucial to train Arabic ESL learners not to trill it. The /h/ sound occurs in word- initial and word-medial positions in English, but not in final positions (e.g., *horse*; *behalf).* In Arabic, the /h/ sound occurs in all positions, e.g., *hamed* 'praise'; *nahir* 'river'; *miktabeh* 'library'.

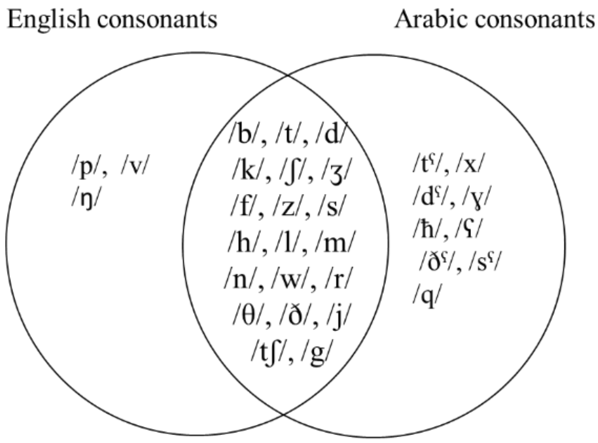

Figure 2.1: Phonological diagram of LA and English consonants.

With regard to /p/, /v/ and /ŋ/, these consonantal phonemes do not exist in most LA dialects. The phoneme /p/ exists in English as a phoneme while it exists as an allophone of /b/ in LA; conditioned by the phonetic environment, it occurs only before voiceless consonants in a few Arabic words. The phonemes /g/ and /tʃ/ are very common in LA, although both are absent in MSA (McCarthy, 1981). Mostly people who live in rural areas have these two sounds in their dialects. In the majority of instances, the uvular plosive /q/ is replaced with the glottal /ʔ/ or the velar /g/, for instance, /raqam/ ‘number’ pronounced as /raʔam/ or /ragam/. The sound /q/ is used in certain areas in Syria and Lebanon, but not in Jordan (Al-Wer, 2007). The only voiced, post-alveolar affricate that exists in Arabic is /ʤ/. The phoneme/ŋ/ doesn't exist in Arabic at all; meanwhile, in English, it has some restrictions in occurrence, since it only occurs in word-medial and word-final rather than initial positions. In the next section, an outline of Arabic and English syllable structures is presented.

2.4 Arabic Syllable Structure

Onsets are obligatory in LA syllable structure. Codas are permitted; however complex codas are restricted to two consonants and can only arise in word-final position. Coda clusters are also subject to further limitations, particularly sonority sequencing restrictions, and these are frequently enforced through epenthesis. (For more details refer to Gouskova & Hall, 2007). LA syllable structure is shown in Table 2.3.

LA syllable structure is considered restricted since it permits: (i) light or open syllables which include CV and CVV; (ii) closed or heavy syllables, which include CVC and CCVC; (iii) super-heavy syllables, which include CVVC, CVCC, $CCVC_iC_iC$, $CCVC_iC_i$. and $CVVC_iC_i$ with gemination in the coda and $C_iC_iC_jVC$ with gemination in the onset. As far as consonant clusters are concerned, this study will focus particularly on the syllable structure of LA that has consonant clusters in the onset position.

Table 2.3
LA Syllable Structure

	Syllable	Example	Gloss
1	CCVVC	/kbɪər/	‘large’
2	CCVC	/fhɪm.to/	‘understood him’
3	$CCVC_iC_i$	/nkabb/	‘was spilled’
4	$C_iC_iC_jVC_iC_i$	/ssfʌrr/	‘become yellow’

Levant Arabic shares what Levelt & van de Veijver (2004) described as one of most difficult syllable types, namely CCVCC. This structure occurs in onset as well as coda clusters, as in a word like /kbirt/ (I have grown up) and /ʕrift/ (I knew). The CCVVC syllable structure is the most frequently used one among LAs.

It is documented that MSA and some Arabic dialects do not permit initial consonant clusters at all (Abushihab, 2010; Kiparsky 2003; Abu-Salim, 1980;

McCarthy, 1979). As far as the LA dialect is concerned, consonant clusters are allowed in LA in onset or coda positions as a result of historical changes (Daana, 2009; Btoosh, 2006; Abu-Abbas, 2003; Kiparsky, 2003; McCarthy, 1979; Al-Ani, 1970), which resulted in the deletion of high vowels in open syllables to shorten initial Ci.C- to CC.

Across languages, there seems to be an optimal ordering of elements with respect to the syllable peak. The sequence of consonants in an onset cluster is organized from the least to the most sonorous. That is to say, each C in an initial consonant cluster should be lower in sonority than the following one and higher than the preceding one. The consonants' sonority hierarchy is distributed depending on their manner of articulation (Clements, 1990), as stated in the following example, where elements to the left are less sonorous and elements to the right are more sonorous:

Stops < Fricatives < Nasals < Liquids < Glides < Vowels

Interestingly enough, in contrast to the relatively extreme restrictions on word– initial consonant clusters sequences in most languages, LA allows all possible permutations of its consonantal phonemic inventory (Colhoun, 1971). Table 2.4 provides some examples of word-initial consonant clusters that abide by the SSP and others that violate the SSP.

The Sonority Sequencing Principle applies to the codas of words such as /dars/ 'lesson' and /bint/ 'girl'; It also explains why a word such as /ħiml/ 'load' is sometimes realized as [ħimil]: since the /-ml / coda does not exhibit a falling sonority and thus violates the SSP, an epenthetic vowel may serve to restore the correct sonority sequencing (Kenstowicz, 1986, p. 120).

Initial CC clusters are also sometimes broken up by a prothetic vowel preceded by a glottal stop, regardless of whether they violate the SSP or not. For instance, /klab/ ‘dogs’ may be pronounced as /ʔiklaab/: in this case, a glottal stop followed by a short vowel is inserted in the word-initial consonant cluster in order to satisfy the preference that a word may not begin with a consonant cluster.

Table 2.4
Examples of Initial Consonant Clusters with Respect to SSP

	Wor1d-Initial Consonant Clusters with No Violation of the SSP		
		Examples	**Gloss**
1	A stop followed by a glide as in /bw/	/bwaab/	‘doors’
2	Affricative followed by liquid as in /dʒl/	/dʒluud/	‘skins’
3	A stop followed by a liquid as in /bl/	/blaad.na/	‘our country’
4	A stop followed by nasal as in /tm/	/tmalmal/	‘complained’
5	A fricative followed by a nasal as in /sl/	/slaħ/	‘weapon’
6	A nasal followed by a liquid as in /mr/	/mraaje/	‘mirror’
	Word-Initial Consonant Clusters With Violation of the SSP		
		Examples	**Gloss**
1	A liquid followed by a fricative as in /rf/	/rfuuf/	‘shelves’
2	A nasal followed by a stop as in //md/	/mdam.mar/	‘collapsed’
3	A nasal followed by a fricative as in /ms/	/msam.mam/	‘poisoned’
4	A nasal followed by a glottal stop as in /mʔ/	/mʔattem/	‘dark’
5	A stop followed by another stop as in /kt/	/ktaab/	‘book’
6	A fricative followed by another fricative as /ħs/	/ħsaan/	‘horse’

Gemination in Arabic can be described as consonant lengthening (McCarthy, 1981). Gemination is a phonological property of LA as all 29 consonants in LA can be geminated (Khattab, 2007). Geminates are included in the class of allowable initial CC-clusters, which mostly came about as a result of total assimilation, especially when the definite article /l/ assimilates to the following consonant, as in these examples adopted from Abu-Abbas, Zuraiq & Abdel-Ghafer (2011).

a. /daar/ ‘a house’ /ddaar/ ‘the house’

b. /tiin/ ‘figs’ /ttiin/ ‘the figs’

When a geminate occurs at the end of a word and is followed by another word that begins with a consonant cluster, the resulting CCC cluster is usually separated by an epenthetic vowel which breaks up the geminate to become CVCC (Abu-Abbas, Zuraiq, & Abdel-Ghafer, 2011). For example:

a. /madd bsˤaatˤ/ > /mad.dib.sˤaatˤ ‘he stretched a carpet’
b. /zatt ktaab/ > /zat.tik.taab/ ‘he threw a book’
c. /ʕadd xjuul/ > /ʕad.dix.juul/ ‘he counted horses’

Gemination involves consonant copying over intervening phonemes; an example of that is the CCCVCC structure, which appears in enough noun and verb forms, which makes it worthy of discussion (Beesley, 1998). CCCVCC syllable structure conveys the general meaning of becoming a certain state or color. Thus, LA allows three consonants in the onset position; in such syllables, the initial two consonants should be geminates, and the final consonants in the syllable should be geminated consonants. Examples of that are:

a. /ɣɣbarr/ “became dusty”
b. /ʃʃqarr/ “be of fair complection ”
c. /sswadd/ “became black”

2.5 English Syllable Structure

English syllables consist of an optional onset, an optional coda, and a nucleus-coda rime. Syllables may begin with one or more consonants, with the single vowel mandatory in a syllable. In the coda position, consonant clusters are also allowed.

Syllables can also be classified as open or closed; when a syllable ends with a consonant, it is called a closed syllable, and when a syllable ends with a vowel it is called an open syllable.

English allows a wide variety of possible syllables, in comparison with other languages, as seen in Table 2.5. English permits initial consonant clusters up to three consonants, as in *strong* /strɔŋ/ and final consonant clusters up to four, as in *texts* /tɛksts/.

Table 2.5
English Syllable Structure

	Syllable	Example	Word
1	CCVC	/stɑp/	*Stop*
2	CCVCC	/plænt/	*Plant*
3	CCCV	/streɪ/	*Stray*
4	CCCVCC	/splɪts/	*Splits*
5	CCCVCCC	/skrɪpts/	*Script*s

Each language has special restrictions on the type of consonant sequences that may form a cluster. Most of the English two-consonant clusters have a fricative or a stop followed by a liquid or a glide, such as in *gray* /greɪ/, *blue* /blu/, *swing* /swɪŋ/. In addition, /s/ can be followed by a voiceless or nasal stop, for example *stick* /stɪk/ and *snail* /sneɪl/, or by /f/ or /v/, as in some loanwords like *sphinx* /sfɪŋks/ and *svelte*/svɛlt/. The /CCC/ sequence always has the consonant /s/ as the first consonant , one of the voiceless stops /p/, /t/and /k/ as a second consonant, followed by one of the liquid or glide consonants /w/, /j/, /r/and /l/ as the final consonant, as in *strike* /straɪk/, *squad* /skwɑd/ and *splash* /splæʃ/.

2.6 Different Accounts for Difficulties in Acquisition of L2 Consonant Clusters

Although the influence of extra-linguistic factors on L2 acquisition and production is well recognized, many researchers have attributed the pronunciation difficulties experienced by non-native speakers to other linguistic factors, particularly:

the effects of the L1 (Flege, Yeni-Komshian, & Liu, 1999), the Markedness Differential Hypothesis (MDH) proposed by Eckman (1977); and the Sonority Sequencing Principle (SSP) proposed by Clements (1990).

2.6.1 Effects of the first language (L1). Numerous studies have observed the interference of native or first language (L1) on the production of the L2. Most of these studies attempted to provide a better understanding of the role of the L1 in the acquisition and production of L2 consonants and vowels. As stated by Zsiga (2003), L1 phonemes or articulatory patterns are often transferred to the L2 by non-native speakers. This basically refers to the use of L1 patterns in the context of L2 pronunciation. L1 transfer can lead to a non-native-like L2 pronunciation which could result in poor communication between native and non-native speakers. For example, in the case of Vietnamese ESL learners, Sato (1984) found that native speakers of Vietnamese often have difficulties with word-final consonant clusters as they do not occur in their L1. Sato indicated that deletion is the most common modification strategy when pronouncing final clusters. He also stated that Vietnamese ESL learners tend not to produce final consonantal segments after diphthongs as most diphthongs in Vietnamese occur in open syllables, so they tend to delete or sometimes replace certain English consonants, in particular /s/, /z/, /l/, /ð/, /f/, /v/, when they occurr in word-final position. For example, Vietnamese speakers may produce the final /z/ as /s/, and they may pronounce the final /l/ as /n/. In general, non-native speakers' L1 tends to influence their attempt at producing English consonants.

In a study involving 18 native Japanese university students, Bada (2001) examined the influence of the L1 on the production of English consonants, specifically interdental fricatives. The study's subjects had had over eight years of English education in the United States. The effect of their L1 was assessed based on a set of reading tasks involving the two English interdental fricative consonants /θ/ and /ð/. The pronunciation errors were calculated and detected across three positions: word initial, word medial and word final. As expected, these fricative sounds posed a considerable constraint on English pronunciation by the Japanese. The findings from the study showed that the /θ/ sound was produced wrongly most often in the word initial and word medial positions because of the interference of the L1. They rather observed a few errors in the word final interdental fricatives among the Japanese learners of English. The /θ/ sound was replaced with [t], [s] and [z] for the three positions, respectively. Voiced /ð/was the most difficult for the Japanese and was mainly pronounced as [d] in word medial position. Similarly, the /ð/in word final position was replaced with [t], [s] sounds. According to Bada, this mispronunciation occurred because the Japanese language does not have the /θ/ and /ð/consonantal sounds.

Other studies have focused on parallels between L2 learners' spoken and written language performance with respect to novel phonemic contrasts. For example, Ota, Hartsuiker, & Haywood (2009) found that native speakers of Arabic have difficulty perceiving the English /b/ and /p/ since the Arabic language does not have this phonemic contrast. Their findings suggested that when speakers do not have a phonemic contrast in their L1, they may exhibit confusion in producing or perceiving this contrast in their L2.

Research in L2 production of consonant clusters has indicated that epenthesis of a vowel often occurs when L2 speakers produce a vowel between consonants in a sequence which is phonotactically not permitted in their L1 (e.g Davidson, Jusczyk, & Smolensky, 2009; Broselow & Finer, 1991). Consonant deletion and vowel epenthesis are considered the main strategies of consonant cluster modification used by non-native speakers for consonant cluster simplification (Weinberger, 1997). The two modification strategies are often used for both initial and final clusters. For example, Tarone (1980) reported that Korean speakers learning English repaired [stop+liquid] clusters by inserting a schwa between the two consonants, e.g. *class* [kəlæs].

Al-Shuaibi (2006, p. 306) investigated the phonotactic patterns produced by Yemeni speakers in the pronunciation of English syllable-initial and final-consonant clusters. Al-Shuaibi used Windows Media Player to analyze the speech data. Speech data were transcribed in phonetic transcription based on the IPA. A trained phonetician was asked to check the precision of the transcribed data. The findings revealed that Yemenis seem to have difficulties in pronouncing initial and final English consonant clusters, especially /CC-/ and /-CCC/, as these types of syllable structures do not exist in the Yemeni dialect, and that they had the tendency to insert three types of vowel sounds /ə/, /ɪ/, / and /ɒ/ as a modification strategy, with the most common ones being /ə/ and /ɪ/. The following examples illustrate this:

/tɛkəstəs/ instead of /tɛksts/ ‘texts’

/dərɪŋk/ or /ədrɪŋk/ instead of /drɪŋk/ ‘drink’

Another study by Al-Saidat (2010, p. 129) aimed at investigating the types of insertion errors made by Jordanian English language speakers and discovering the sources of such errors. Participants were Jordanian university students who majored in English language and literature; all of them were at the upper intermediate English language proficiency level. Participants were asked to read a list of words with different syllable structures. The students’ pronunciation was recorded and then compared with the target language norm. Speech sounds were phonemically transcribed and two native speakers of English were consulted to evaluate the pronunciation of the participants. The findings of this study showed that CCC clusters were problematic for the Jordanian participants, since these clusters do not occur in their L1 syllable structure, whereas CC did not pose any difficulties. Clusters with three members were modified unconsciously by inserting a vowel, namely /ɪ/ after the first consonant in the initial and the final positions. Vowel insertion occurred after the first consonant sound, as in the following examples:

/sɪkræp/ ‘scrap’

/sɪtreɪt/ ‘straight’

Al-Saidat also stated that cluster modification strategies can vary across level of proficiency; the participants’ stage of development in English language had a significant role in consonant cluster production. The source of simplification in consonant cluster production would be due to language interference as well as participants’ stage of development in the English language, while the former was more prominent than the latter. The findings of this study are consistent with those of previous studies, such as Al-Shuaibi (2006) and Kharma & Hajjaj (1989); basically, that it is common for Arabic speakers of English to use epenthesis if the syllable structure is absent in their L1, as the absence of these structures makes it challenging for Arabic speakers of English to produce these clusters in the way of native English speakers.

2.6.2 Markedness differential hypothesis (MDH). Several previous studies have investigated the acquisition of L2 consonant clusters. The issue of whether difficulties with consonant cluster production are due to the universal principle of markedness or whether L2 speakers are transferring some features of their native language when acquiring syllable structure is a principal theme in the research on this subject (e.g., Carlisle, 1998; Eckman, & Iverson, 1993; Broselow, 1984; Tarone, 1980). According to the Markedness Differential Hypothesis (MDH), originally proposed by Eckman (1977), learning difficulties in the L2 might arise when the existence of a phonological feature in the target language is more marked than in the native language, where marked means less frequent, more complex and not easy to articulate. Several longitudinal studies found that L2 learners acquired consonant clusters in the onset before those in the coda position; they also acquired two-member clusters before three-member clusters in several target languages (Yoo, 2004; Carlisle, 1998; Eckman & Iverson 1993). It is therefore hypothesized that codas are more marked than onsets and that CCC clusters are more marked than CC clusters. An example study used markedness to clarify learners' acquisition progress. In the acquisition of English consonant clusters by Koreans (Yoo, 2004), the study found that the Korean participants' acquisition order of consonant clusters is: CC onset > CCC onset > CC coda > CCC coda. In the process of L2 acquisition, the Korean participants acquire the unmarked sequence before producing the corresponding marked sequence.

2.6.3 Sonority sequencing principle theory (SSP). The Sonority Sequencing Principle (SSP) is assumed to be a universal hierarchy that determines the allowable or preferred sequences of consonants within syllables (Gierut, 1999). The SSP requires that complex onsets must rise in sonority, and complex codas must fall in sonority (Clements, 1990), with the nucleus being the sonority peak. Most English onset clusters follow this principle: the sonority distance of the first segment in the cluster is lower than the second segment in clusters such as *small*, *snail*, *slow*). The only clusters that violate the SSP involve fricative /s/ followed by a plosive in words such as *speak, stay* and *scant*.

Levant Arabic onset clusters often violate SSP, as we discussed earlier. The examples below show how the consonant sequence flouts the SSP in LA:

/mʕallem/ ‘teacher’ /rkab/ ‘climb’

/nmidd/ ‘extended’ /nkabb/ ‘was spilled’

These examples show that the sonority drops from the first segment to the second segment in the cluster. Accordingly, most onset consonant clusters in English are less marked than those in Levant Arabic; since LAs are moving from a more marked system in LA to a less marked one in English, they are expected not to face difficulty with English onset consonant clusters.

Languages that permit consonant clusters in onsets and codas are following distinctive patterns in terms of sonority distance between the segments (Gierut, 1999). As the sonority distance between the segments in a cluster increases, the sequence is more natural. For example, the following clusters, /dr-/ or /tr-/ (moving from lowest to highest sonority) are more natural than the clusters /sl-/ or /fr-/ (moving from middle to highest sonority). This is also the pattern for codas. For example; the clusters /-rd/ or /-lk/, which have the greatest sonority distance, are more natural than the clusters /-rm/ or /-ns/, which have low sonority distance.

Certain sequences do not abide by the SSP hierarchy rule as /st-/, /sp-/ and /sk-/, as they show negative sonority sequence when they go from higher to lower sonority when occurring in an onset (Gierut, 1999). Consonants in the syllable margin that have the same sonority also do not abide by the SSP hierarchy rule; these are known as sonority plateaus (Clements, 1990) and exist in only a few languages, including English. For example, the words *sphere* and *fact* have flat sonority distances that do not abide by the SSP hierarchy rule (Gierut, 1999).

Several studies have adopted SSP theory as their theoretical framework to justify difficulties in consonant cluster production (Davidson, Jusczyk, & Smolensky, 2009; Abrahamsson, 1999; Gierut, 1999; Eckman & Iverson, 1993; Carlisle, 1991b). A study by Carlisle (1991b) investigated the validity of the theory by examining the production of /sl-/ and /st-/ initial words in English by eleven participants who speak Spanish as their native language. Spanish does not contain either of those onset clusters so Spanish ESL learners would be expected to have difficulties with both. The initial /sl-/ cluster conforms to the SSP (fricative+liquid), while the initial /st-/ cluster violates it (fricative+plosive). The SSP would therefore predict that Spanish ESL speakers would have more difficulty with the /st-/ initial words than with the /sl-/ initial words. Participants were given a reading assignment that consisted of 290 sentences with each sentence containing one word starting with either /sl-/ or /st-/. The environment that preceded these target onsets was strictly controlled. As expected, the results showed that participants developed 36% epenthesis before /st-/ and 25% before /sl-/, which indicated that the frequency of modification in clusters that violated the SSP was statistically higher than the frequency of modification in clusters that did not violate the SSP.

In another study also conducted by Carlisle (1991a), he again investigated epenthesis in relation to the SSP, this time with respect to sonority distance. In his study, Carlisle examined 14 native Spanish speakers' pronunciation of different English sC sequences: fricative+nasal (/sm-/ and /sn-/), and fricative+liquid (/sl-/). Since the sonority distance in the fricative+nasal clusters is smaller than in the fricative+liquid clusters, the SSP would predict that the fricative+nasal clusters would present more difficulties for the Spanish ESL learners. He followed the same procedure as he had for previous data collection. The subjects' output showed differences in pronouncing the three given patterns. The study revealed that epenthesis occurred 29% for /sl-/, 38% for /sm-/, and 33% for /sn-/. The findings of that study confirmed the more sonority distance in onset clusters, the less frequent epenthesis the participants had.

Other studies took a similar approach in examining the SSP theory to determine if the sonority distance between the Cs in the onset consonant cluster plays a vital role in making some patterns of an onset consonant cluster easier than others. Abrahamsson (1999) examined two different onset patterns with no violation of the SSP. The researcher focused on fricative+liquid (/sl-/) and fricative+nasal (/sn-/) clusters, which have less sonority distance between them. He found that participants, who were Spanish speakers learning Swedish as L2, modified /sn-/ less frequently than /sl-/. However, the stimuli that he utilized consisted of only 44 /sl-/ onsets and 67 nasal onsets preceded by /s/.

According to the SSP, when clusters are more marked, learners tend to have less difficulty than when clusters are relatively less marked. A study by Carlisle (2006) regarding the acquisition of /st-/, /sl-/ and /sn-/ clusters by 16 Spanish speakers showed that /sn-/ was modified less than /sl-/; corresponding with the SSP that indicates that /sn-/ is less marked than /sl-/.

Anderson (1987) used spontaneous speech to produce consonant clusters for Mandarin and Egyptian Arabic speakers of English. Results of that study revealed that speakers of both languages made more modifications of onset and coda clusters as their length increased. That study showed that Egyptian Arabic speakers made no modification of the one-member onsets, while they modified more than 7% of the two-member onsets. That study indicated that as the length of onsets increases, the frequency of modification, whether by deletion or epenthesis, significantly increases.

There is support in the literature suggesting a special status of /s/ clusters (Boyd, 2006; Kaye, 1992; Selkirk, 1984; Vennemann, 1982; Fudge, 1969). For example, Broselow (1983) supported the ‘specialty case’ of the sC sequences. In that study, Broselow reported that Arab L2 speakers of English appear to treat /s/+ stop clusters as a singleton in terms of epenthesis, which has never been separated by epenthesis. Onsets, on the other hand, which do not violate the sonority sequencing, are readily separated by epenthesis. However, the uniqueness of this cluster also comes from its being the only cluster that may be followed by a stop consonant or a nasal in the onset cluster.

A very recent study by Al Tamimi & Shboul (2013) provided a comprehensive quantitative account of all possible MSA coda CVCC syllables in relation to the SSP. Of the 494 lexical items investigated, they found that 42% of cases abide by the SSP, 49% violate the SSP and only 9% have flat sonority. In general, they found that 58% of the consonant clusters violate the SSP. The researchers found no evidence confirming the role of the SSP in articulating word-final consonant clusters in MSA CVCC codas, in contrast with long-standing phonological norms that rely heavily on this principle.

2.7 The Effect of Extra-Linguistic Factors on the Acquisition of L2

Several linguistic studies have been conducted on L2 phonetics. These studies have attempted to help us to further understand the cognitive process that influences L2 acquisition and production (see Gass & Selinker, 2001; Gass & Marlos Varonis, 1994; Poulisse & Bongaerts, 1994; Schmidt, 1990). There is a general awareness that certain L2 consonants are not accurately pronounced by non-native speakers or L2 learners (Flege, Yeni-Komshian & Liu, 1999). Studies of language production have shown that L2 pronunciation difficulties experienced by non-native speakers are influenced by a number of factors, including gender, the effect of the first language (L1), age at onset of learning, length of L2 immersion and the frequency of use of the L2 (Flege & Liu, 2001; Flege, Yeni-Komshian & Liu, 1999). Rababah (2003) investigated difficulties that Arab learners of English confront when learning English. He attributes these difficulties to several variables, i.e. students begin learning English language at grade seven; language teachers are native speakers of Arabic; English is not used in daily situations whereas, Arabic is used everywhere.

2.7.1 Gender differences. There is adequate evidence to claim that gender plays a critical role during language acquisition. Females are, on average, more advanced in language development than males. Female children begin to talk earlier than males; they articulate language sounds better, and they acquire a wider range of vocabulary than male children of the same age. Signell's (2012) results showed that Swedish female students learning ESL outperformed male students in the syntactic maturity of their English. Park (2008) indicated that Korean females have better articulation of some of the English consonant clusters than do Korean males. A study by Frey (1995) indicated that syllabification for females was more sensitive to vowel and accent quality than was that of males. In addition, some studies showed that there are gender differences in acquisition of consonant clusters; however, most of these studies focused on native speakers of the language. A study on native speakers of English showed that female children acquire the pronunciation of several English consonant clusters at an earlier age than males (Hand, Freilinger, Bernthal, & Bird, 1990). Another study by Adda-Decker & Lamel (2005) showed that female native speakers of both English and French had better average recognition results than their male counterparts. A study by Lin (2003) investigated the acquisition of consonant clusters by Chinese speakers of English. In that study, females had fewer errors than males. However, other studies indicated no gender differences in L2 acquisition (such as Elliot, 1995; Tahta, Wood, & Loewenthal, 1981; Piske, MacKay, & Flege, 2001) concluded “the results obtained for gender do not lead to any strong conclusions” (p. 200). Results of gender differences effect on the acquisition of L2 showed that females are generally better than males; however, these results are not conclusive.

2.7.2 Age at onset of learning. Several studies of L2 production have shown that age at the onset of learning plays a critical role in the pronunciation abilities of non-native speakers (Trofimowich & Baker, 2006; Flege & Liu, 2001). This observation is supported by the Critical Period Hypothesis (CPH), which posits that adult learners may find it more difficult to acquire native-like L2 pronunciation than do children (Flege, 1987; Lenneberg, 1967). Lenneberg (1967), who introduced the CPH into linguistic research, argued that a foreign accent in L2 pronunciation cannot be easily overcome after the age of puberty. The critical period of language learning presents certain constraints on the acquisition of native-like L2 pronunciation. Actually, several studies have also found that early onset of language learning improves acquisition of native-like L2 pronunciation (Flege & Liu, 2001; Oyama,1978). Thus, non-native speakers are more likely to pronounce their L2 consonants with detectable foreign accents when learning begins after puberty.

The difficulty surrounding the acquisition of L2 with native-like accuracy after the age of puberty raises questions about the optimal age to achieve or master native-like pronunciation proficiency. Asher & Garcia (1969) observed that non-native speakers who were younger than 12 years old showed higher pronunciation accuracy than those aged 13 to 19 years. Foreign accent was more noticeable in the L2 pronunciation among those above age 13. Thus, in the case of ESL learning, the earlier an individual starts to learn English, the more likely s/he is to achieve pronunciation proficiency.

2.7.3 Length of immersion in the L2. The association between the length of exposure to the L2 and pronunciation proficiency has also been observed (Flege, Frieda, & Nozawa, 1997; Flege & Fletcher, 1992, Flege & Liu (2001). The Flege & Fletcher (1992) study, in which two groups of participants whose native language is Spanish were included, attempted to demonstrate this perceived relationship. The accuracy of their English pronunciation in relation to the length of exposure to the L2 was assessed using a set of sentences and words. Participants in the first group had been exposed to English for almost seven years, while the participants in the second group had over 14 years of exposure. The second group showed more accurate pronunciation than the first group.

In a related study, Flege & Liu (2001) observed that the high level of pronunciation accuracy observed among the L2-experienced student was attributed to the L2 motivation they received from their teachers and colleagues for whom English was the native language. This result further suggests that longer exposure to formal learning coupled with social and environmental motivations enhances L2 pronunciation proficiency.

2.8 Summary

This chapter outlined the main features of the Arabic language with a special focus on the LA dialect. The distinctive features of both Arabic and English syllable structures was the main focus. The main characteristic regarding LA syllable structure is that consonant clusters are permitted in coda position as long as they abide by the SSP; they are also permitted in onset position regardless of the sonority of the segments. Several factors that affect the acquisition of a L2 were discussed such as (i) age at onset of learning, which favors the acquisition of a L2 before puberty over beginning at a later stage in life; (ii) the length of immersion in a L2 increases learners’ intelligibility; (iii) the similarity of the L1 and L2 syllable structures, according to which L2 learners would have more intelligibility if the L1 and L2 have more similar syllable structures.

A large number of studies which provided different accounts of consonant cluster production were reviewed: L1 transfer is considered a principal factor of pronunciation difficulties, as it involves transfer of syllable structure and syllabification rules from the L1, which might lead to a non-native-like L2 pronunciation. Non-native speakers might adopt different modification strategies during L2 acquisition of consonant clusters as a result of L1 transfer, such as deletion or epenthesis. Epenthesis was of special interest, as it is suggested in the literature that it is commonly used by Arabic speakers. Sonority distance is another explanation for difficulties in consonant clusters production: ESL speakers may have more difficulties with clusters which to some extent are more marked according to the sonority distance than with those that are less marked. Since there are different accounts as to what affects consonant cluster production, the causes of modification strategies that are utilized by LAs learning English are open to debate. This study sets out to investigate the modification strategies that are used by LAs in the production of sC clusters; in particular using acoustic analysis instead of the human ear alone to determine this modification strategy. Two groups will be involved in this experimental study; native Canadian English speakers (CEs) and Levant Arabic speakers (LAs). The following chapter introduces the methodology of this study.

CHAPTER Three: RESEARCH DESIGN

This chapter will now outline the methodology employed in this study.

3.1 The Participants

Two groups participated in this study; Levant Arabic (LA) speakers and Canadian English (CE) speakers, with the total group being 20 adult participants. All speakers tested had no speech or hearing pathology based on self-reports; and all LA participants reported that they had passed one of the English proficiency tests (IELTS or TOEFL) within the past seven years.

Participants were recruited from the University of Lethbridge, Lethbridge, Alberta, Canada and through personal contacts. A purposive sampling method was used to recruit potential participants for the experimental group. Participants were selected because they had particular characteristics that were of interest to the researcher. In order to be able to control for extra-linguistic factors, a questionnaire was completed by each participant (Appendix A). The participants in the experimental group included 11 LAs who had lived in Canada for over three years. This minimum residency level was selected to ensure that the participants had been exposed to the English language for a reasonable period of time. Seven of them were males and four were females. All LA participants migrated from the Levant region in the Middle East and speak the same Arabic dialect. More specifically, the participants migrated from the following countries: Jordan (n=3), Lebanon (n=2), Palestine (n=4) and Syria (n=2). The participants were either professional workers or graduate students at the University of Lethbridge, with their ages ranging between 30 and 50, with an average age of 36 for both sexes. All the participants had been learning English as a second language (ESL) in their country of origin for at least six years of formal instruction, starting around age ten.

The CE group included nine born Canadians who speak English as their mother tongue. Their ages ranged between 20 and 50 years, with an average age of 35 years. Two were professors at the University of Lethbridge and the remaining subjects included both graduate and undergraduate students. Table 3.1 shows the demographic information regarding the participants for both the LA and the CE groups.

Table 3.1
Demographic Information Regarding the Participants.

	LA				CE
Nationality	**Jordan**	**Syria**	**Lebanon**	**Palestine**	**Canada**
Female	1	1	2	0	4
Male	2	1	0	4	5
Total	11				9

3.2 Data Collection

This data collection section lays out the stimuli and procedures used to elicit, record, segment and score data. The study utilized word list reading as the basis for the data collection. Before engaging in the collection of any data, the participants were informed about the purpose of the study, the procedure to be followed and the benefits of the study. In addition, demographic information such as age, gender, and educational background, as well as information about their prior English-language learning experience was collected from the participants (Appendix A). Demographic information was used to examine whether there was any correlation between participants' articulation pattern and their experience with English-language learning.

3.3 The Stimuli

Participants were recorded while they were engaged in a word list-reading task. In order to elicit their best level of accuracy in pronunciation, they were asked to read 20 isolated English words in a word list. Twenty target words from 20 subjects resulted in 400 tokens. All target words were word-initial /s/+ consonant (sC) clusters, with this being the special focus here, as there are very limited previous studies on the acquisition of English-language consonant clusters among LAs. A set of sC onset clusters were selected: /s/+ nasal, /s/+ stop and /s/+ liquid. Nasal consonants are generated by stoppage of the vocal tract while releasing the sounds freely through the nose. Stop consonants are produced when there is a complete blockage of the air tract without airflow through the nose. Liquid consonants are generated when the airflow continues along the sides of the tongue but is blocked from going to the middle of the mouth by the tongue. English has two liquid phonemes, one lateral, /l/ and one rhotic, /ɹ/; however in Arabic /l/ is interdental while it is alveolar in English (International Phonetic Association, 2009). Table 3.2 provides a list of target consonant cluster tokens that were included in the word-list reading task.

Table 3.2
Target Consonant Cluster Tokens

Cluster Type	**Cluster**	**Cluster Word**	
s+stop	/sp/	spoon	Speak
	/st/	stick	Star
	/sk/	skull	Skeleton
s+nasal	/sm/	small	Smooth
	/sn/	snail	Snow
s+liquid	/sl/	slam	Slow
s+stop+liquid	/spl/	splash	Split
	/spr/	spray	Spread
	/skr/	scrub	Scream
	/str/	strategy	Strawberry

3.4 Audio Recording and Materials

The data were collected by the researcher and each participant was interviewed individually. Most of the recording sessions were held at the University of Lethbridge, though some were held at the participants' homes. Participants were given a word list on paper, and they were asked to read the words as naturally as possible. To reduce the possibility of changes in speech, which might result from awareness of being audio-recorded or monitored, a friendly and informal short conversation with the participants regarding their life experiences in Canada was carried out prior to the recording. The participants were first allowed to go through the selected words for approximately three minutes, and to ask questions regarding any words with which they were unfamiliar. They were also advised to pause between each word for readability. The recording for each participant lasted approximately ten minutes, and the collection of demographic information took approximately another ten minutes.

Recordings were done in December 2012 using an Edirol / Roland R-09HR, 24-bit/96 kHz recorder. Nine recordings were done with an IPhone® recording application, called the iSLR Field Recorder, which was used to record the participants' speech. Each recorded file was titled and compressed in .WAVE format. A short explanation for participants was given on how to use both devices, in order to produce and obtain good audio quality. Participants were asked to place the recorder at about 15 cm distance away from their mouths (Ladefoged, 2003).

3.5 Segmenting the Speech Stream

Once the recordings were uploaded, the Praat software program was used to analyse the speech sounds (Boersma & Weenink, 2012). To ensure maximal consistency across tokens and in order to show higher formants; spectrographic settings for the view range were placed at 4,000 Hz for males and 5,000 Hz for females. Since females have higher pitch than males because their vocal folds are shorter and smaller than males, this frequency range is recommended to get a good visual take on the formants (Ladefoged, 2003). To eliminate background noise and to show adequate speech data for phoneme identification, the dynamic range was set at 30.0 dB (Ladefoged, 2003). A text grid was automatically created by Praat. Tiers were labeled as word, cluster, and 1st C, 2nd C and 3rd C, resulting in five tiers; each speech object as well as the corresponding text grid was selected to be able to segment and label each token in terms of word, cluster and consonant intervals. After the data had been fed into Praat, the initial segmenting points were determined manually by the researcher; the boundaries of each target word were identified by placing the cursor on the onset and then the offset of each word; then each word was labeled. The acoustic waveforms for each token were examined carefully to identify the cluster and the /s/ boundaries. The onset and the offset of fricative /s/ were identified by marking with a boundary where high frequency energy appears and where frequency energy ends. The oral closure was marked by looking for the point where there was a distinct drop in the intensity with a loss of energy in the higher formants (see Figure 3.1); the letter X represents the oral closure.

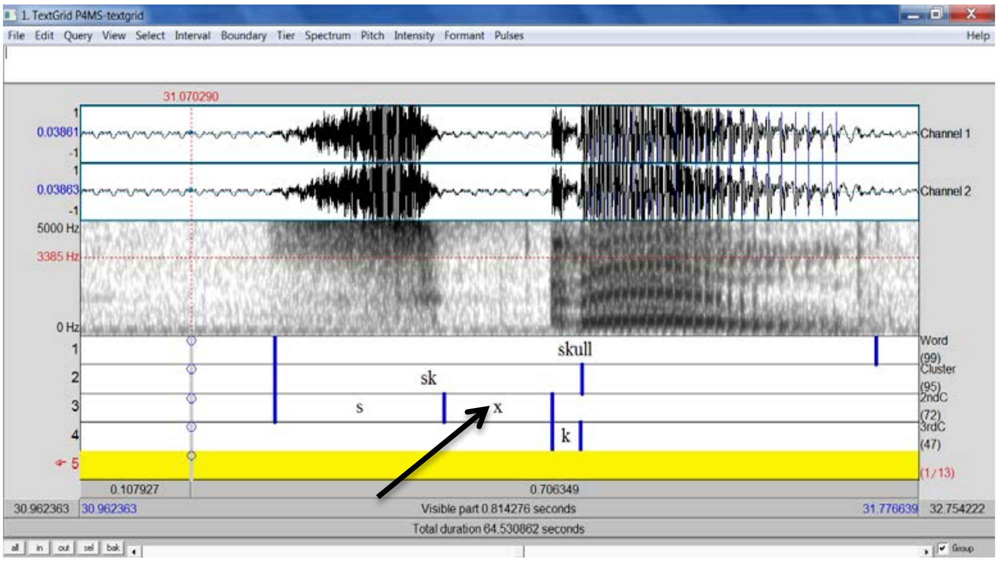

Figure 3.1: The segmentation of the word “*skull*” using Praat software
X= closure of the oral stop

Figure 3.1 illustrates the labelled waveform display of a token of the word *skull* produced by a male LA speaker. During segmentation, when it was difficult to determine a boundary point, the researcher counted on the spectogram display and on her auditory judgment.

Once the speech signal had been segmented and labeled, the duration of every elicited /s/ was measured as well as the oral closure. All interval durations were extracted using a Praat script to investigate whether vowel insertion (epenthesis) occurs between consonants and in the initial positions of English syllables. The same procedures were followed for all 400 tokens. Unclear tokens where it was hard to segment the s-cluster, due to background noise or tokens that were mispronounced were labeled as a missing value in the duration analysis. Twenty-six tokens in total were omitted. Table 3.3 shows the total data collected which consisted of 374 of /sC(C)/.

Table 3.3
Total Data of /sC(C)/ Collected from LA and CE Groups

Cluster Type	**Cluster**	**N**
s+stop	/sp/	38
	/st/	40
	/sk/	34
s+nasal	/sm/	36
	/sn/	37
s+liquid	/sl/	40
s+stop+liquid	/spl/	38
	/spr/	40
	/skr/	35
	/str/	36

It has been suggested that vowel epenthesis is the most common modification strategy used by Arab learners of English. The findings of recent studies have concluded that Arabic speakers of English unconsciously insert an epenthetic vowel between consonants and in the initial positions of English syllables to make words more easily pronounceable (Al-Saidat, 2010; Gouskova & Hall, 2007; Al-Shuaibi, 2006; Selkirk, 1984).

3.6 The Acoustic Measurements

The present study investigates the occurrences of vowel epenthesis in the initial consonant clusters. For instance, the study investigated which sound, if any, was inserted and in which position in the cluster, since such modification may easily influence the measurement of the cluster duration. If vowel epenthesis occurred, the duration of the /s/ consonant was measured as well as the duration of the epenthetic vowel. Epenthesis was checked manually by visually scanning the spectogram and the waveforms. Vowel epenthesis was identified by looking for a sharp change in energy at the onset or the offset of clear formant structure. Although there are a reasonable number of existing, explanatory studies of the English language and of the articulatory difficulties of Arabic speakers learning/acquiring it, only a very limited number of these studies investigated epenthesis instrumentally, for example (Gouskova & Hall, 2007).

Meanwhile, measuring the duration of the /s/ consonant as well that of the oral closure was another focus of the present study. Thus, the durational means for both groups, LAs and CEs, were calculated for the purpose of investigating how differently the LA group produce these types of clusters in comparison with the production of same by the CE group. Figure 3.2 shows the wave form for the word *slept* without an epenthetic vowel, and Figure 3.3. Shows the same word with an epenthetic (prothesized) vowel.

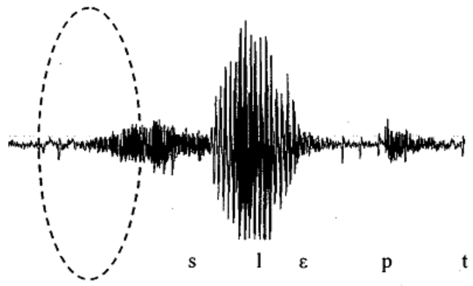

Figure 3.2 The segmentation of the word “slept” [adopted from Boudaoud, 2008].

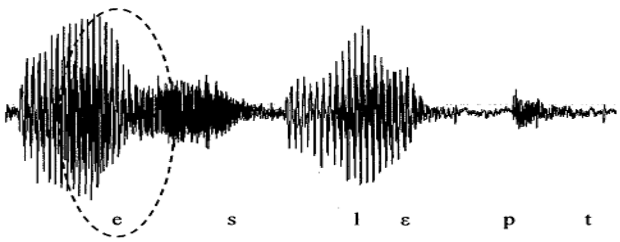

Figure 3.3 The segmentation of the word “slept” with a prothesized [adopted from Boudaoud, 2008].

3.7 The Statistical Analysis

Independent-sample T-tests were performed to examine whether there was a statistically significant difference in the production of the fricative /s/and the oral closure between native CE speakers and LA speakers, taking the subjects’ L1 and cluster types into account as independent variables. In addition, a one-way ANOVA test was performed to determine if the differences observed in the /s/ and the oral closure duration among the four groups (Jordanian, Lebanese, Palestinian and Syrian) are statistically reliable. The following questions were used to guide the research:

1. Is there any evidence of native language (L1) interference, specifically epenthesis, in the production of s-clusters by adult LA speakers?
2. To what extent do LAs pronounce the s-cluster differently than the CEs?
3. Is there any correlation between gender, nationality and the accuracy of s-cluster production?

3.8 Summary

This chapter has provided an explicit description of the research design, participants' bio-data, and the data collection procedure. Additionally, it provided a full description of the consonant clusters under study in this research. The chapter also illustrated the audio-recording material that was used to elicit the data and the way the speech stream was segmented using Praat software. Finally, the chapter presented a brief description of the statistical software SPSS that was used to investigate the data that were collected. The next chapter will explain the findings emanating from statistical analyses of these data.

Chapter FOUR: THE FINDINGS

The first three chapters of this thesis were devoted to introducing the background and the methodology of the current research; the aim of this chapter is to outline the results and the statistical analyses of the data collected. The current chapter is comprised of four major sections: section 4.1 reports on the results regarding epenthesis; section 4.2 reports on the results related to s-duration measurements; section 4.3 reports on the results of oral closure measurements; and section 4.4 reports on cluster-specific findings. While there was a good deal of variability within the LA group and between the LA and CE groups, a number of general findings surfaced.

4.1 Results of the Linguistic Variables

4.1.1 Epenthesis. The focus of this section was to investigate vowel epenthesis among the LA participants. The first phase of the data analysis was to investigate whether or not vowel epenthesis occurred. By looking at where the vowel formants are located in the spectrogram, we can tell whether the participants produced the first syllable of the given tokens as (CVC), (VCC) or as (CCV). Vowels normally have three distinct formants that appear to be different from consonants, which noticeably appear as dark bands based on the vowel position.

Epenthesis was checked manually by visually inspecting the spectrograms for the word-initial consonant clusters. Surprisingly, given the prediction made in previous studies using the judgment of the human ear only, the analysis here showed that all clusters were articulated by LAs without any epenthesis (see figure 4.1 for an example). Although epenthesis was not a strategy used in cluster articulation, there was a significant difference in the /s/ duration as well as the duration of the oral closure between both groups, which will be further explored in the next section.

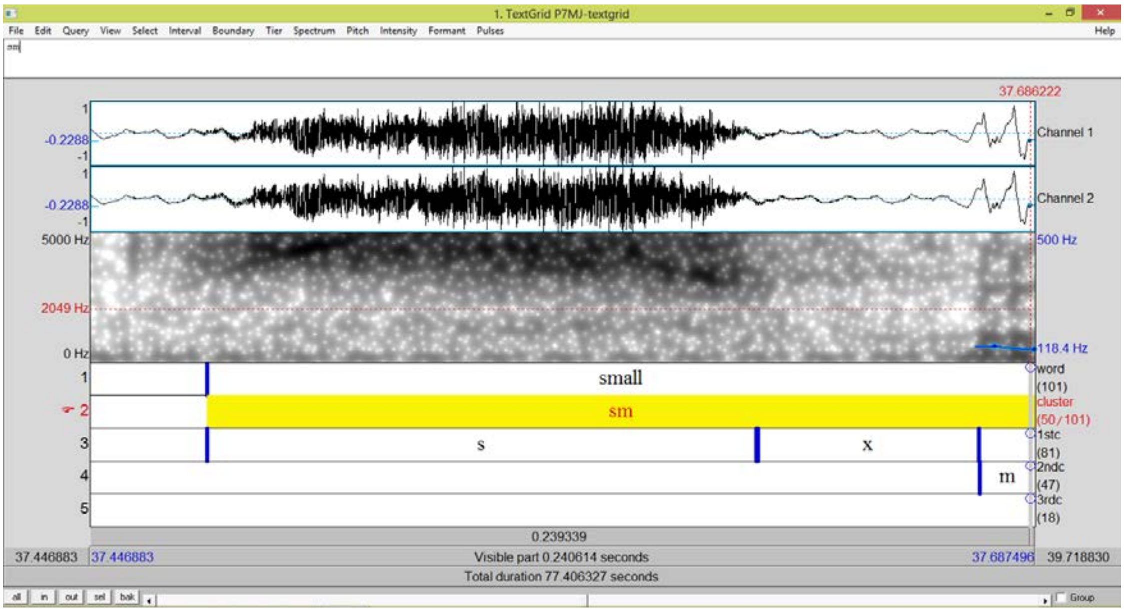

Figure 4.1: Segmentation showing no epenthesis before or after /s/ in the target word small.

4.1.2 S-duration. Since the data did not show vowel epenthesis, a decision was made to investigate the duration of the initial /s/ segments in the clusters for both groups. This helped in measuring the duration differences between both groups and helped in seeing if LAs had difficulties in /s/ production. An independent sample t test was conducted in order to interpret the effect of group differences in the production of /s/ segments. As shown in Table 4.1, the CEs were significantly different from the LAs in terms of their /s/ duration ($P < 0.001$), with CEs (M = 0.157 ms) and for LAs (M = 0.132 ms) conditions. Pronunciation duration of CEs was approximately 19% longer than LAs. /s/ (t= 10.165, P < 0.001).

Table 4.1

Mean /s/ Duration (in ms) for LA and CE Groups

Group	**Fricative /s/**
LAs	0.132ms
CEs	0.157ms

*$P < 0.001$

4.1.3 Oral closure. Since the data show a significant difference in the /s/ duration between the two groups, a decision was taken to investigate the duration of the oral closure in the clusters. A significant difference was observed in the mean duration between CEs and LAs (t= -7.564, $P < 0.001$). Contrary to the results for the fricative /s/, the mean duration of the oral closure for LAs (M = 0.082) was found to be relatively longer than that of the CEs (M = 0.058; Table 4.2).

Table 4.2
Mean Oral Duration (in ms) for LA and CE Groups

Group	**Oral closure**
LAs	0.082
CEs	0.058

* $P < 0.001$

An example of this is provided in Figures 4.2 and 4.3. The figures show two pronunciations of the word stick. The waveform and spectrogram clearly show that for the CE speaker the /s/ is longer and the oral closure (marked by x on the third tier) is shorter than for the LA speaker.

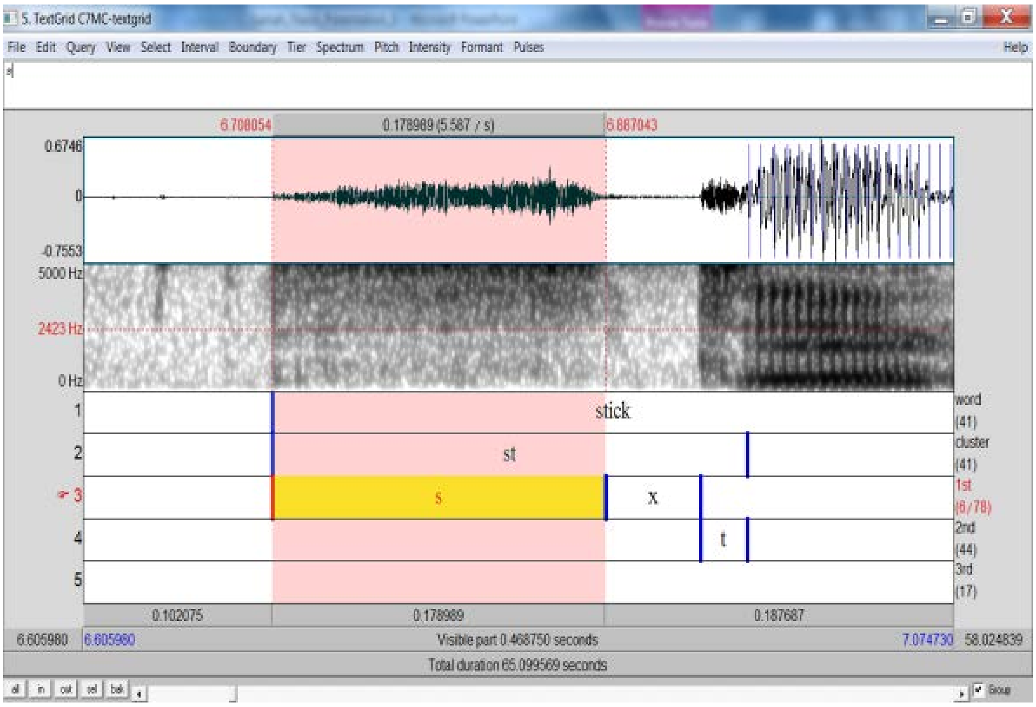

Figure 4.2: The segmentation of the word "stick" by CE male participant

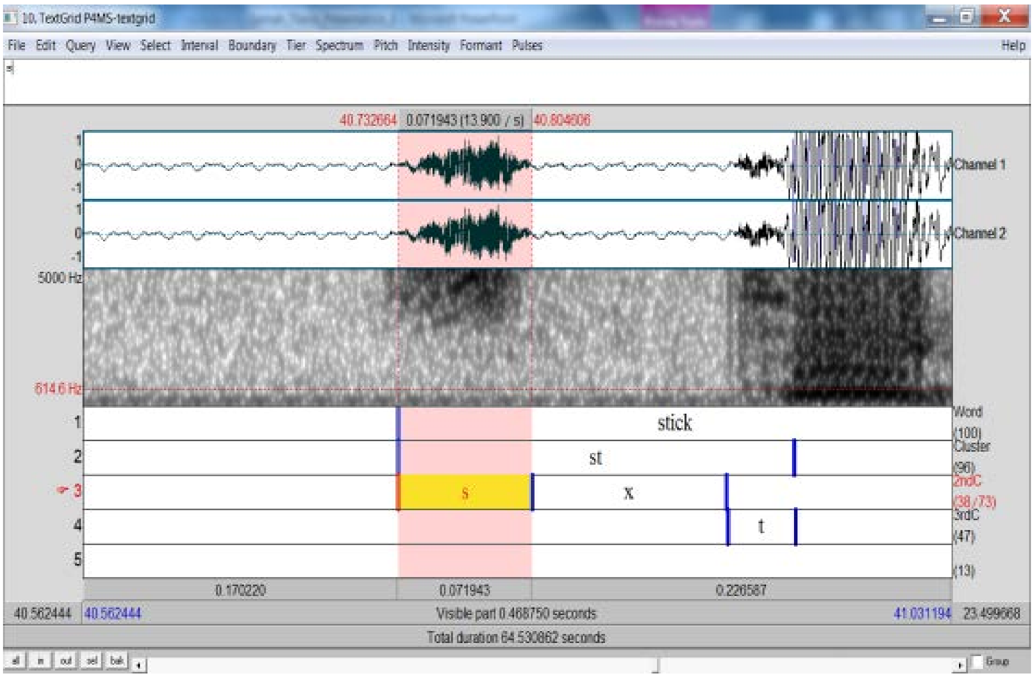

Figure 4.3: The segmentation of the word "*stick*" by LA male participant

4.2 Extra-Linguistic Variables

Two extra-linguistic variables were tested: gender and nationality.

4.2.1 Gender. Gender difference effects were found in the durational production of /s/. Among the LAs, females *(M* = 0.123 ms) had a longer duration production of /s/ as compared to the LA males *(M* = 0.118 *ms)*, t (218)3.481, *P* < 0.001. Differences in the production of /s/ were also found among the CEs. Canadian females *(M* = 0.168 *ms*) tend to produce a longer /s/ than males (*M* = 0.156 ms).

Table 4.3
Mean /s/ Duration (in ms) for Both Genders

Gender	**Fricative /s/**	
Group	**LAs**	**CEs**
Females	0.123ms	0.168ms
Males	0.118ms	0.156ms

** P < 0.001*

However, there were no significant (*P* > 0.05) differences between genders within the same group in relation to the pronunciation of the oral closure (Table 4.5). Both LA genders *(M* = 0.080 and *M* = 0.082 for females afnd males, respectively) had longer (*P* < 0.001) closures as compared to the CE of both genders *(M* = 0.060 and *M* = 0.056 for females and males, respectively).

Table 4.4
Mean /x/ Duration (in ms) for Both Genders of the LA and CE Groups.

Gender	**Oral closure**	
Group	**LAs**	**CEs**
Females	0.080ms	0.060ms
Males	0.082ms	0.056ms

4.2.2 Nationality. The post hoc test clearly showed that differences ($P < 0.001$) exist across some nationalities in terms of the production of the /s/. As can be seen from Table 4.5, Syrian /s/ duration (*M* = 0.142 *ms)* was longer ($P < 0.001$) than that of both Palestinians (*M* = *0*.113 ms) and Lebanese *(M* = 0.118 ms*)*. However, there were no durational differences ($P > 0.05$) between Syrian (*M* = 0.142 ms) and the Jordanian participants *(M* = 0.127 ms). In addition, the Palestinian /s/ was shorter ($p < 0.001$) than that of the Jordanians. In the meantime, there were no differences ($P > 0.05$) between the Jordanian and the Lebanese (*M* = 0.118 ms) /s/ duration. As well, the production of Syrian participants is the closest to that of CEs, but there was a remarkable distance between that of the Palestinians and of the CEs.

Table 4.5
Effect of Levant Nationality on /s/ Duration (in ms)

Nationality	Fricative /s/
Lebanese	0.118b
Jordanian	0.127ab
Syrian	0.142a
Palestinian	0.113c

Values with different letters are significantly ($P < 0.001$) different.

In general, the post hoc test showed no clear nationality-related differences in terms of the closure duration among the four groups (Table 4.6), except that of Syrians *(M* = 0.096), which was higher ($P < 0.001$) than that of other nationalities considered in this study.

Table 4.6
Effect of Levant Nationality on Oral Closure (in ms)

Nationality	Oral Closure
Lebanese	0.078ms
Jordanian	0.080ms
Syrian	0.096ms*
Palestinian	0.082ms

* $P < 0.001$

4.3 Two-Way ANOVA of the Effect of L1 and of Gender

In order to determine what affected the variation of the production of the /s/ and the x oral closure (gender, L1, or the interaction of both factors) we ran a two-way ANOVA. The test indicated a significant main effect of gender F (1, 396) = 28.006, $P < 0.001$, partial eta = 0.066 and first language F (1,396) = 105.423, $P < 0.001$, partial eta = .210 on S-duration indicating that males of both groups had shorter pronunciation duration than females, and CEs had longer /s/ duration than LAs (Table 4.7). However, there was no significant ($P > 0.05$) interaction effect between gender and L1 indicating that the production of /s/ does not differ between males and females with respect to their L1 , $F(1, 396) = 1.011$, $P = 0.315$, partial eta = 0.003. The effect of the L1 factor on the production of /s/ was higher (21%) than the effect of gender (7%). The means and standard deviations for each group are shown in Table 4.7.

Note: *Partial eta* is a measure of the strength of the relationship between two variables.

Table 4.7
Descriptive Statistics for the Effect of L1 and Gender on s-Duration (in ms)

	First	***Mean***	***SD***	***Number***
Males	LAs	0.118	0.028	140
	CEs	0.148	0.039	100
	Total	0.131	0.036	240
Females	LAs	0.132	0.030	80
	CEs	0.169	0.029	80
	Total	0.151	0.035	160

Furthermore, the two-way ANOVA indicated a significant main effect CE, F (1,370) = 52.494, $P < 0.001$, partial eta = 0.124, of the L1 on oral closure, showing that LAs had shorter oral closure duration than CE. However, there was no significant effect of gender F (1, 370) =.077, $P = .782$, partial eta = 0.00, or interaction F (1, 370)

= .856, *P* = .355, partial eta = 0.002 between L1 and gender on oral closure. This indicates that the production of oral closures does not differ between genders; nor does it differ between males and females with respect to their L1. The means and standard deviations for each group are displayed in Table 4.8.

Table 4.8
Descriptive Statistics for the Effect of L1 and Gender on Oral Closure (in ms)

	L1	Mean	SD	Number
Males	LAs	0.083	0.034	129
	CEs	0.057	0.023	95
	Total	0.072	0.033	224
Females	LAs	0.081	0.032	77
	CEs	0.061	0.027	73
	Total	0.071	0.031	150

4.4 Cluster-Specific Findings

This section sets out to check the durational differences of the three sC sequences. This section is organised by cluster type. In section 4.4.1, we report on the results of clusters with falling sonority [/s/+ stop]. In section 4.4.2, we report on the results of clusters with rising sonority [/s/+ liquid]. In section 4.4.3, we report on the results of clusters with rising sonority [/s/+ nasal]. Finally, in section 4.5, we report on a comparison among the three cluster types to investigate whether there are types of cluster that are more marked than are others. Within each section, the mean duration of /s/ and oral closure is analysed for both groups as well as the duration difference between genders.

4.4.1. Clusters with falling sonority [/s/+ stop]. The independent sample t-test was conducted to compare the duration of the [/s/+ stop] between the LA and CE groups, as shown in Table 4.9. Results showed that CEs had longer (*P* < 0.001) /s/ duration (*M* = 0.150 ms) than the LAs *(M* = 0.119 ms). However, the LAs' oral closure (*M* = 0.092 ms) was significantly longer (*P* < 0.001) than that of the CE group

(*M* = *0*.066). That is to say, LAs produced a shorter /s/ than the CEs when pronouncing the [/s/+ stop] cluster. Looking further into the duration difference between genders within the same group in terms of [/s/+ stop] production (Table 4.8), results showed that the LA female group had significantly ($P < 0.001$) longer /s/ duration (*M* = 0.120ms) and shorter oral closure duration (0.089ms) than LA males (0.112ms and 0.097ms, for /s/ duration and oral closure duration, respectively).

Table 4.9
Mean Duration (in ms) of [/s/+ stop] for Both Genders

	LAs		CEs	
	S	X	S	X
Females	0.120ms	0.089ms	0.173ms	0.069ms
Males	0.112ms	0.097ms	0.141ms	0.065ms

*$P < 0.01$

The independent sample t-test was performed to compare the duration of the oral closure in the [/s/+ stop] cluster between LA and CE groups (Table 4.10). It was found that a significant mean difference exists between both groups, with CE (*M* = 0.066ms) and LA (*M* = 0.092ms) conditions ($P < 0.001$). This suggests that LAs exaggerate the duration of the oral closure.

Table 4.10
Mean Duration (in ms) of /s/ and Oral Closure in sC Clusters for LA and CE Groups

	S duration	Oral closure
LAs	0.119ms	0.092ms
CEs	0.150ms	0.066ms

* $P < 0.001$.

4.4.2. Clusters with rising sonority [/s/+ liquid]. The results indicated that CEs (*M* = 0.174 ms) produced the /s/ in [/s/+ liquid] clusters 31% longer ($P < 0.001$) than the LAs (*M* = 0.126 ms). Oral closure of LAs (*M* = 0.056 ms) was significantly longer ($P < 0.001$) than that of the CEs (*M* = 0.032 ms; Table 4.11)

Table 4.11
Mean Duration (in ms) of [/s/+ liquid] for LA and CE Groups

	S duration	**Oral closure**
LAs	0.126ms*	0.056ms
CEs	0.174ms	0.032ms

*$P < 0.001$

A more detailed analysis was conducted to compare the mean of the [/s/+ liquid] between genders within the same group (Table 4.12). Females in both groups produced longer /s/ in these clusters (M = 0.137ms and 0.188ms for females in the LA and CE groups, respectively) than males (M = 0.120ms and 0.163ms, respectively). For the oral closure, gender differences were detected only in the CE group, where females produced longer ($P < 0.001$) oral closures (M = 0.86 ms) than did males (M = 0.027ms).

Table 4.12
Mean Duration (in ms) of [/s/+ liquid] for Both Genders

	LAs		**CEs**	
	S	X	S	X
Females	0.137ms	0.057ms	0.188ms	0.086ms
Males	0.120ms	0.054ms	0.163ms	0.027ms

4.4.3 Clusters with rising sonority [/s/+ nasal]. The analysis revealed that LAs (0.131 ms) did indeed produce a significantly ($P < 0.001$) shorter /s/ in [/s/+ nasal/] clusters than the CEs (M = 0.169; Table 4.13). However, the LA group showed significantly ($P < 0.001$) longer oral closure (M = 0.052) than the CE group (M = 0.030).

Table 4.13
Mean Duration (in ms) of [/s/+ nasal] for LA and CE Groups

	S duration	Oral closure
LAs	0.131ms	0.052ms
CEs	0.169ms	0.030ms

A gender-related difference was found in terms of the [/s/+ nasal] production (Table 4.14). The LA females tended to have a longer /s/ duration ($P < 0.01$, M =0 136 ms) than males in the same group (M = 128 ms). A similar result was found for the Canadian, females (M =179ms) and (M =160ms) for Males. With the regard to the oral closure, gender differences were detected only in the CE group, where females produced longer ($P < 0.001$) oral closures (M = 0.56 ms) than did males (M = 0.033 ms).

Table 4.14
Mean Duration of [/s/+ nasal] for Both Genders

	LAs		CEs	
	S	X	S	X
Females	0.136ms	0.056ms	0.179ms	0.056ms
Males	0.128ms	0.050ms	0.160ms	0.033ms

4.5 Comparison among the Three Cluster Types

As shown in the table 4.15, the consonant cluster type was found to affect the duration of the /s/ as well as the duration of the closure. Measurements of the data among CEs showed that the duration of the /s/ in [/s/+ stop] clusters was shorter than that in the [/s/+ nasal] and [/s/+ liquid] clusters. The mean duration of the /s/ for the [/s/+ nasal] and [/s/+ liquid] clusters was found to be markedly higher (0.174) and (0.169) respectively, than the mean duration of the /s/ for the [/s/+ stop] which was (0.150).

Table 4.15
Findings Specific to Cluster (in ms)

	S+ Stop		S+ liquid		S +Nasal	
	S duration	Oral closure	S duration	Oral closure	S duration	Oral closure
LA	0.119ms	0.092ms	0.126ms	0.056ms	0.131ms	0.052ms
CE	0.150ms	0.066ms	0.174ms	0.032ms	0.169ms	0.030ms

A less consistent pattern was found in the duration of the cluster types among the LAs. The difference in duration of /s/ between the [/s+ liquid] and [/s/+ nasal] clusters among LAs was insignificant ($P > 0.001$), suggesting that LAs produce /s/ for both cluster types with the same duration. However, when comparing the mean duration of the /s/ in [/s/+ stop] clusters, which was ($M = 0.119$ms), to the duration of /s/ in [/s/+ liquid] and [/s/+ nasal] clusters ($M = 0.126$ms) and ($M = 0.113$ms) respectively, we found that the durational differences was statistically significant ($P < 0.001$). Again, it can be concluded that LAs produce the /s/ in [/s/+ stop] clusters shorter than that in [/s/+ liquid] and [/s/+ nasal] clusters. Overall, these durational differences were significant ($P < 0.001$), indicating that the difference between each cluster type with the regard to /s/ duration was persistent and may not be attributed to coincidence.

With regard to the oral closure duration, the mean differences between [/s/+ liquid] ($M = 0.056$ms), and [/s/+ nasal] ($M = 0.052$ms) among the LA group was insignificant ($P > 0.05$). However, a marked difference was found with regard to the oral duration of [/s/+ stop] ($M = 0.092$); the duration of closure was found to be markedly high. A similar pattern was found for the CEs as there were no meaningful differences in the production of [/s/+ liquid] and the [/s/+ nasal] ($M = 0.32$) and ($M = 0.030$) respectively. However, the results showed that the CE group tended to pronounce the [/s/+ stop] with longer closure duration ($M = 0.066$ ms), compared to the other two cluster types.

To summarise, the findings of this study indicated that participants in the LA group did not have epenthesis in any of the existing clusters. While epenthesis did not occur when the LAs articulated the sC, there was however a significant difference between the LAs and the CEs in their production of the /s/ duration and oral closure.

Nationality-related differences among the LAs were found in favor of Syrians, as their production of the sC was the most comparable to that of CEs. Interestingly, there were gender-related differences in both groups of the study, as females had longer /s/ duration in all cluster types than did males in the same group. However, the variation of the production of the /s/ and the oral closure was not because of gender effect; a significant main effect of first language (L1) was observed for the production of /s/ and the oral closure.

CHAPTER Five: DISCUSSION

5.1 Epenthesis or Something Else?

The findings of this study appear to be distinct from the findings of previous inter-language studies of the same or related phonological phenomena. Other studies Al-Saidat, 2010; Gouskova & Hall, 2007; Al-Shuaibi, 2006; & Selkirk, 1981) have claimed that Arabic ESL speakers from different origins tend to insert a vowel before or within word-initial consonant clusters as a strategy to facilitate the articulation of these clusters. However, the acoustic analysis performed in this study showed that the participants articulated the targeted clusters without epenthesis; instead, the /s/ is shortened while the closure of the following C is lengthened, which may create the perceptual impression of an epenthetic schwa, but is not in fact epenthesis. Even though some of the cluster sequences in English, such as /str/ and /sp/ do not exist in the Levant dialect, LA participants in this study articulated sC clusters without any epenthesis.

The combination of extending the duration of the oral closure, while abbreviating the duration of the preceding /s/ appears to be serving the purpose of facilitating the sC articulation for LAs in English. The consistency in shortening the /s/ and lengthening the oral closure prohibited the LAs from achieving what is called Standard English pronunciation.

However, the rates of accuracy that LA participants in this study demonstrated when articulating word-initial clusters cannot be compared directly to the rates of accuracy of speakers of other Arabic dialects studied (Al-Saidat, 2010; Gouskova & Hall, 2007; Al-Shuaibi, 2006; Kharma & Hajjaj, 1989). Participants in this study experienced less difficulty in producing sC clusters in comparison with other Arabic speakers, who use epenthesis as a modification strategy; with such modification simply changing syllabification of the word.

5.2 Sonority Sequencing Principle (SSP) and Universal Markedness

As mentioned earlier, in section 4.5 , the targeted sC clusters did not disclose the existence of epenthesis among LA participants of this study. The three cluster sequences were further examined in relation to their markedness and SSP. The finding suggested that there is a durational differences between clusters that violate the SSP (/s/+ stop) and those that do not (/s/+ nasal and /s/+ liquid). Based on Clement (1990), the order of acquisition of the sC clusters follows this sequence: /sl/>/sn/>/st/; where “>” means less marked and easy to acquire or articulate. The common prediction is that L2 speakers are sensitive to less markedness i.e., /s/+ liquid and /s/+ nasal than the more marked /s/+ stop.

As shown in the result of the comparison in Table 5.1 both LAs and CEs, respectively produced /s/+ stop clusters with a shorter /s/ duration as compared to (/s/+ liquid and /s/+ nasal). That is to say, clusters that violate the SSP, which show negative sonority sequence were articulated with shorter /s/duration as compared to those that abide by the SSP hierarchy, which were articulated with longer /s/ duration.

Table 5.1
Findings Specific to Cluster (in ms)

	S+ Stop		S+ liquid		S +Nasal	
	S duration	Oral closure	S duration	Oral closure	S duration	Oral closure
LA	0.119ms	0.092ms	0.126ms	0.056ms	0.131ms	0.052ms
CE	0.150ms	0.066ms	0.174ms	0.032ms	0.169ms	0.030ms

We had the reverse finding with regard to oral closure; clusters that violate the SSP (/s/+ stop) were articulated with longer oral closure duration while clusters that abide by the SSP were articulated with shorter oral closure duration as shown in table

5.1. As mentioned previously in section 2.4, LA initial consonant clusters often violate the SSP; due to this violation, LA word- initial consonant clusters are more marked than English word-initial consonant clusters, which generally obey the SSP. Interestingly enough, the findings of this study revealed that both groups LA and CE treated the clusters the same way. Both groups had the same clusters order in regard of the durational differences.

5.3 Impressionistic vs. Acoustic Analysis

This study used Praat software as a method to analyze the speech sounds under study. The use of acoustic analysis of speech ensures the credibility (i.e., scientific objectivity) of the findings and the measurements. The studies cited previously used phoneticians' or simply native English speakers' auditory impressions to evaluate the pronunciation of the participants. Depending on our ear to evaluate ESL pronunciation is not an adequate form of acoustic quality evaluation. Human hearing is capable of recognizing slight differences; however, it is not capable of taking account of what acoustic analysis provides. Utilising acoustic analysis eliminates any human subjectivity or bias that could exist in auditory analysis.

5.4 Effect of Extra-Linguistic Factors / Uncontrolled Variables Effect

5.4.1 Gender. The findings of this study showed that the pronunciation of female LAs was more comparable to that of native English speakers than was that of male LAs as shown in section 4.2.1. LA females of this study had a longer duration production of /s/ as compared to the LA males, which indicates that their production is relatively closer to CE participants of this study than LA males do. In keeping with the results of this study, research supports the common belief that during their L2 acquisition, female pronunciation has its own unique features and their pronunciation tends to be more proximate to that of native speakers than is men's (Adda-Decker &

Lamel 2005; Lin, 2003; Frey, 1995; Hand, Freilinger, Bernthal, & Bird, 1990; Weiss, 1970).

5.4.2 Nationality. The production of clusters by the Syrian participants, which was the most comparable to that of the CEs (see 4.2.2), could be due to the fact that the Syrian participants were involved in an English pronunciation-training program for one year. This program is specifically designed for immigrant professionals who wish to seek employment in their field of expertise in Canada. Enrollment in this training program might have benefited the Syrian participants in solving any epenthesis issues they might have had, the assumption being that an earlier articulation instruction program might have made them more aware of the problem of epenthesis. Previous studies have shown that, when acquiring a L2, non-native speakers persist in retaining their foreign accents, even highly proficient speakers of a non-native language (e.g., Flege & Hillenbrand, 1987; Tahta, Wood, & Loewenthal, 1981).Particularly, the perception and production of certain non-native phonetic contrasts constitutes an extreme challenge for non-native speakers (e.g., Flege, 1988; Goto, 1971). Several studies have revealed the importance of perceptual pronunciation training, whether human or computer-assisted, in having better pronunciation and intonation for non-native speakers of the English language (Auberg, Correa, Locktionova, Molitor, & Rothenberg, 1998; Strange & Dittmann, 1984).

5.4.3 Extra-linguistic factors / controlled variables. Concerning the extra-linguistic factors that we have controlled for, it is expected that such sociolinguistics factors would alleviate a non-native-like second language (L2) pronunciation. The LAs' accuracy of s-cluster production was close to that of the CEs, as the length of exposure to the English language and the onset time of learning English would have a major effect on their production of the sC clusters. The findings of this study are consistent with other related studies that have advocated the idea of a critical period for language learning. That is to say, the younger the L2 learners, the more likely they are to acquire pronunciation proficiency (Flege & Liu, 2001; Flege, 1987; Asher & Garcia 1969; Lenneberg, 1967). All participants of this study started learning English before the age of puberty, which might explain the absence of epenthesis in the LA articulation of the sC clusters. This study was also in accordance with Oyama (1978), who found that L2 learners, who began learning English before puberty, pronounce L2 words more accurately than those learning a L2 later in their lives.

The participants in this study consisted of professionals with exposure to the English language and culture for a minimum of three years, while seven out of 11 participants in this study spent more than eight years in North America. This could positively influence their English pronunciation and intelligibility in comparison with that of participants selected for the other studies cited, who may have had shorter experience living in an English-language environment. The matter of the duration of exposure by the subjects to the L2 under consideration and their concomitant effectiveness in their pronunciation has been observed in the LA group in this study. The positive effect of the length of immersion in L2 on enhancing articulation proficiency in the L2 was indicated by Flege, Frieda, & Nozawa, (1997) and by Flege & Fletcher, (1992), who found that the longer the exposure to the L2, the better the L2 articulation accuracy. In addition, the greater pronunciation accuracy of participants of this study might be attributed to the effect of everyday language use and the environmental motivation by their peers and colleagues, as indicated also by Flege & Liu (2001).

What motivates LA speakers to use this alternative strategy when articulating sCs? Does this strategy substitute for vowel epenthesis? To what extent does this strategy affect the syllabification of a word? The answer to these questions is not within the scope of this thesis and needs to be investigated in-depth in subsequent research. However, for now, we can attribute the durational differences in the production of sC clusters to the speakers' native accent as stated by Dobrovolsky & Katamba (1996). Previous research has illustrated that L1 speakers intuitively know that certain L2 words sound uncommon and they often try to modify the segment sequences of these words to follow the pronunciation requirements of their L1. Abu-Rabia & Kehat (2004) had the same point of view; as they demonstrated that even though some adult ESL speakers may attain a relatively high mastery of a L2; still, they seem not to be able fully to get rid of their foreign accent.

CHAPTER Six: LIMITATIONS AND FUTURE DIRECTIONS FOR RESEARCH

This study was limited to investigating the notion of epenthesis in the production of word-initial sC clusters among LA participants. Two groups participated in this study; CEs and LAs, with 20 participants in total. A larger study pool may reduce some statistical uncertainties and make the results of the study more convincing. This study focused on the LA dialect; therefore, the results of this study might not be generalised to other Arabic dialects. Other Arabic dialects might have quite a different phonological structure than that of LA, which may result in different difficulties during L2 acquisition. Further studies to measure the rate of accuracy in consonant clusters production by speakers of different Arabic dialects are recommended.

The sample used in this study consisted of highly educated professionals who had great motivation to master the pronunciation of the English language and who had lived in the North American culture for at least three years, while most of the sample had lived eight years in North America. Therefore, the results of this study might be limited to the setting used in this study. Given this, it can be suggested that future, related studies might examine the production of English consonant clusters using differing samples of subjects, for example: (i) a mix of new immigrants with immigrants who were immersed in North American culture for a longer period, (ii) a mix of professionals with non-professionals, (iii) a mix of highly educated and with less educated subjects, and/or (iv) a mix of subjects from ESL and from EFL settings so as to be able compare their results with those of this study. Broadening the sample scope with respect to the aforementioned factors, would allow more generalization of the findings found in this study.

Previous perceptual studies that investigated the acquisition of L2 consonant clusters have demonstrated the existence of an epenthetic vowel in syllable-initial consonant clusters as a modification strategy (Al-Saidat, 2010; Al-Shuaibi, 2006). The present study in particular meant to investigate only the production of word-initial sC's; perception tests weren't part of this thesis research. The spectrograms and the waveforms of the speech sounds were carefully examined and we did not find any epenthesis; thus we concluded that LA participants didn't use epenthesis as a strategy, but rather a shortened duration of /s/ combined with a lengthened duration of the following closure. Native speakers of English might be thinking that they hear epenthesis when listening to such ESL speakers, but what actually might be taking place is a lengthened closure; thus; perceptual tests would have been a good addition to this study. For future work, perceptual tests would be a good companion methodology along with the production test we used, to see how native English speakers rate the pronunciation of the LA speakers, and whether they hear epenthesis or not. By forging a link between LAs' speech production and speech perception, we could really know whether or to what degree auditory impression is that different from acoustic measurements employed here.

Another limitation of this study is its exclusive investigation of epenthesis in word-initial sC clusters. Future studies might utilize other cluster sequences in both the onset and coda positions that are not present in this study. It is worth noting that the stimuli used to collect data in this study was restricted to reading of words instead of full sentences, which helped participants to focus on the tasks and not be distracted with other vocabulary. Moreover, I tried to control the vocabulary used in the stimuli. The target words were selected to be part of what might be called everyday vocabulary. It may be of interest to utilize other techniques of data collection such as reading sentences and/or natural conversation to test the effect of such methods on the production of initial consonant clusters.

To summarise, the strategy in producing sC clusters among LAs in this study has nothing to do with epenthesis; what is taking place instead is a difference in the length of /s/ and the oral closure. I conclude that LAs experience less difficulty in producing sC clusters in comparison with other Arabic speakers, who use epenthesis as a modification strategy; I explain that initial clusters are allowed in LA regardless of the sonority of the segment. Indeed, the LA dialect permits complex onset whether or not the consonant sequence respects the SSP sequence. When the SSP is considered, given the point just made, articulating these clusters should not be, nor apparently are they, problematic for LAs. This justifies the absence of the epenthesis strategy in the production by LAs of sC clusters.. Finally yet importantly, I have highlighted the influence of extra-linguistic factors such as subjects' proficiency and the length of immersion in North American culture, important factors that could have an impact on the production of sC clusters in this sample group.

In short, I hope this research has provided some insightful findings that contribute to a pool of findings related to L2 acquisition. The analysis introduced here may prove to be constructive and useful for not only LAs, both teachers and learners, but also those who share the same language backgrounds. It is our hope that these new findings will further inform teaching practice for those working with LA ESL learners, spark further discussion, and inspire further research among those working in the inter-language research community.

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APPENDICES

Appendix A

Participant's Demographic Information

Name:

Gender:

Age:

----- 20-25

------25-30

------30-35

------35-40

------40-50

- Country of origin?
- What is your current level of education?

---- 4-year degree

-----Masters

------PhD or more

- How long have you lived in an English-speaking country?
- Which country?
- Are you currently working? YES NO
- If yes, what is your profession?
- Are you currently a student? YES NO
- If yes, what is your Major?

- Have you been taught English in your home? YES NO

- How many years of English instruction did you receive in school?
    - Less than 3 years
    - 3 – 6
    - 6 - 9
    - More than 10

- How many other languages do you speak?

Language	Fluent	Good	Poor