Investigating Native English Speakers' Perception of Novel Arabic Phonemes after First Exposure

Hala Alwohaibi

College of languages and translation
King Saud University, Riyadh, Saudi Arabia

Author: Hala Alwohaibi

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This study reports on an experiment carried out to investigate native English speakers' perception of selected Arabic phonemes after first exposure to a controlled naturalistic input of a weather report. It closely follows Brown's model of L2 speech perception and L1 feature geometry (1998), which seeks to relate theories of segmental phonology to L2 speech perception and the first exposure treatment of Gullberg et al. (2010). Eight Arabic sounds were carefully selected for the experiment: /b/-/d/ which are found in both English and Arabic; /x/-/ɣ/ which are not found in English but are distinguished by features which are distinctive in English [dorsal, voice, continuant], and lastly the contrastive pairs /ʔ/-/ʕ/ and /ħ/-/ħ/, where the latter phoneme in each pair is alien to the phonemic inventory of English. These pairs are distinguished by the feature [RTR (retracted tongue root)] which is lacking in the feature geometry of English. Participants were divided into an Arabic control group, English+ group with prior exposure to Arabic, and an English group with no prior exposure to Arabic. The results from an AX discrimination task confirmed Brown's hypothesis that L2 perception of non-native contrasts is constrained by the L1 feature geometry.

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Chapter One

1. Introduction

In second language acquisition (SLA) research, it is recognised that second language (L2) adult learners encounter great difficulty when attempting to learn L2 non-native sounds (Best & Tyler 2007). This difficulty is mostly evident in the adult L2 learners' production of what is known as accented speech (Altenberg 2005; Zampini 2008). Infants and young children L2 learners, however, outperform adult L2 learners in learning L2 (native and non-native) sounds and achieving L2 native-like performance (Kuhl 2000). While acquiring both their first language (L1) and L2 at the same time, children learn to perceive and produce L1/L2 sounds that resemble adults' performance in that language. In other words, infants and young children, on the one hand, seem to be *language-general* perceivers and are able to discriminate phonetic features that are not present in their L1. On the other hand, older children and adults display *language-specific* patterns (Werker & Curtin 2005). Moreover, adult L2 learners struggle to acquire an L2 native-like performance and usually speak with a foreign accented L2 even with very long periods of residency in an L2 environment (Bohn & Flege 1992; Piske, MacKay & Flege 2001).

According to the critical period hypothesis, it remains true that the domain of L2 phonology is the least successful after puberty (Scovel 1988). Best & Tyler (2007: 3) posit that '[...] the infant and the adult could never truly perceive the same speech in the same way, nor could the L2 learner or bilingual perceive L2 *or* L1 speech in exactly the same way as native monolinguals of either language.' Thus, adults' L1 *language-specific* experience constrains the perception of L2 speech contrasts that are

phonologically different from those of the listener's native language, and this inaccurate perception of L2 non-native sounds can cause adult L2 learners to struggle with specific L2 sound contrasts (Best & Tyler 2007).

The role of speech perception in explaining the performance of L2 learners has received considerable acknowledgment in SLA by many researchers as early as Polivanov (1931) and Trubetzkoy (1969). Polivanov (1931) suggested that L2 phonemes¹ are perceived through the L1 system and that the difficulties in the production of L2 phonemes, i.e., the accented speech, may be due to L1 speech perception altering the accurate perception of L2 phonemes (Altenberg 2005). Furthermore, Trubetzkoy (1969) argued also that adult L2 learners' inaccurate production of L2 sounds is linked to inaccurate L2 perception. He also argued that the L1 linguistic system acts as a *phonological filter* through which the L2 sounds are perceived.

L2 production data are comparatively easier to collect and analyse than L2 perception data. Therefore, the foreign accented speech characteristic of adult L2 learners has been explained from the point of view of production difficulties by many researchers such as Lado (1957), Eckman (1977, 1981), Major (1987, 1990, 1998, 2001), and Zampini (2008). Thus, most observations and explanations of L2 phonology have been based on L2 production data rather than on L2 speech perception data. In addition to L2 production studies, L2 speech perception studies have also been conducted to try to observe and explain the reasoning of L2 perceptual difficulties. L2 speech perception research has shown that L2 adult learners do have *perceptual foreign accents* as well as having *foreign-accented speech* at the production level (Strange 1994, 1995; Strange & Shafer 2008; Trubetzkoy

¹ Phonemes are defined as 'the abstract phonological units underlying the surface sounds of a language'. (Davenport & Hannahs 2010: 244). The terms phonemes and sounds will be used interchangeably in this dissertation.

1969). In other words, adult L2 learners' perception is shaped by the perceptual system of their L1 and the difficulties they encounter in producing L2 sounds could be linked to the difficulties in perceiving those L2 sounds accurately (Brown 1998; Matthews & Brown 1998).

1.1. L2 Speech Perception and L1 Feature Geometry

As was previously mentioned, L2 phonology in SLA remains the least successfully acquired aspect of language, especially after puberty (Scovel 1988). As early as the 1960s, researchers such as Lenneberg (1967: 171) concluded that 'foreign languages have to be learned through a conscious and laboured effort'. Based on the findings of such L2 phonology research, it could be asserted that L1 phonology can render learners insensitive to certain properties of L2 input (Matthews & Brown 2004), as this would also explain the difficulties L2 learners face in the attainment of native-like phonology. According to Clements (1985), the phonemes of any given language consist of distinctive features that are organised into hierarchical constituents known as feature geometry. Consequently, L1 feature geometry constrains the acquisition of L2 segmental representations, leading to transfer of L1 properties into L2 acquisition (Brown 1998). Furthermore, Strange (1995) also proposed that many non-native L2 contrasts are difficult for adult L2 learners to be perceptually differentiated.

According to Segui et al. (2001:199), 'Listeners interpret a non-native illegal input sequence by assimilating this sequence to sound patterns that exist in their own language.' Moreover, the assimilation of L2 non-native segments into already similar phonetic categories in L1 can be explained according to the presence or absence of distinctive features of sounds in the feature geometry of the languages in question (Best 1994, Brown 1998). In other words, L2 learners' production errors are due to problems in the perception

of L2 sounds (Altenberg 2005). McAllister (1997) suggests that problems in L2 perception may be attributed to the level of accuracy in mapping L2 phonetic features into already existent L1 phonemic categories. Hence, there are many scholars who consider that differences between L1 and L2 account for the level of accuracy of the perception of L2 segments such as Flege in his Speech Learning Model (1995) and Best in her Perceptual Assimilation Model (1995).

Matthews and Brown's findings (1998) also support the previous research in L2 perception by proposing that the 'assimilation' of non-native segments into a phonological category already present in the L1 can be explained by distinctive features in feature geometry. This is to be contrasted with Best's (1995) explanation of perceptual ability of non-assimilated contrasts in terms of non-speech sounds, i.e., novel L2 segments. For example, English learners perceive the clicks of the Xhosa language as distinctive because these sounds are not categorised as speech sounds by English speakers.

Werker and Tees (1984) suggested that although adult listeners become insensitive to distinguishing non-native sounds, they do not lose the capability to respond to such sounds which are not phonemically distinctive in their L1. Brown (1998) has explored this concept further by proposing that the L1 feature geometry mediates between the incoming acoustic stimuli of a speech stream and the abstract linguistic system, thereby sorting the stimuli into perceptual categories. Thus, L2 sounds which can be classified within the features present in L1 would be able to pass through this geometry filter, whereas L2 sounds or features which are alien to L1 would be deflected away from it, which in turn would lead to inaccurate L2 sound perception. However, Brown (1998) revealed that high-level learners could be taught to discriminate and distinguish sounds in the L2 category where, over time, a

new feature geometry for the L2 sounds will be established within the learners' linguistic system.

So far, this paper has introduced the first part of this introductory chapter. The following section will introduce first exposure studies as this is one of the major components of this study. This will then be followed by the aim and the significance of the present study.

1.2. First Exposure Studies

Research in second language acquisition has traditionally focused on relatively pre/upper intermediate and/or advanced stages of L2 acquisition (Perdue 1996). Consequently, the literature that documents the very initial state of L2 acquisition, i.e. after adult first exposure to L2, is limited. L2 acquisition is different from that of L1 in that the learner is already equipped with a complete L1 linguistic system (Cook et al. 1979). As a result, several researchers have begun to examine the very initial state of L2 acquisition in what has come to be known as 'first exposure studies'. First exposure studies refer to a recent development within second language acquisition research that seeks to observe and explain the adult L2 learners' initial state through the use of controlled L2 input (Carroll 2014).

According to Carroll (2004), the primary goal of SLA is to describe and explain the nature of linguistic development from L2 first exposure to ultimate attainment. Moreover, SLA also aims to describe the developmental trajectory and to describe the role of L1 as a central issue (Major 2001). As was mentioned previously, most theories of adult L2 learning mechanisms are based on pre/upper intermediate and/or advanced stages where knowledge of an L2 has already been acquired. Perdue (1996) pointed out that this gap in the literature of adult L2 initial exposure is due to the fact that there are

few empirical studies that investigate adult first exposure to L2. Likewise, Vainikka and Young-Scholten (1998) emphasised the importance of collecting data at the initial state of L2 first exposure in order to increase our understanding of this significant period and to bridge this gap in SLA literature. In other words, first exposure studies can enrich our understanding of the adults' initial states of L2 exposure and L2 perception and in turn might present ideas for comparison between L1 child acquisition (Jusczyk 1997; Jusczyk et al. 1993) and L2 adult acquisition.

1.3. Aim of the Present Study

The purpose of the present study is twofold. First, to conduct an experiment to investigate English speakers' perception of selected Arabic sounds after first exposure to a controlled naturalistic input as in Gullberg et al.'s study (2010). Second, to investigate whether the feature geometry of L1 (English) affects the perception of English adult learners of novel L2 (Arabic) sounds (Matthews & Brown 1998). The experiment design closely follows the methods of Brown (1998) and Matthews and Brown's model of L2 speech perception (1998) in which the main focus is on the relationship between theories of L1 feature geometry and speech perception of a target language. That is, Brown's model of L2 speech perception seeks to explain why learners of a particular L1 are adept or not adept in discriminating certain sounds of a particular L2. This model predicts which sounds will present the least/most problems to L2 learners. The experiment in the present study aims to investigate whether novel sounds whose features are existent in the feature geometry of the L1 would pass through the 'geometry filter', and whether sounds that cannot be classified within the features present in the L1 feature geometry would be altered to be inaccurately perceived (Brown 1998; Matthews & Brown 1998). Thus, this paper seeks to confirm or otherwise Brown's model of L2 speech perception and effects of L1 feature geometry

on the perception of L2 novel sounds. Moreover, L2 teachers and learners equally appreciate identifying and explaining the factors that influence the degree of L2 foreign accents (Piske, MacKay and Flege 2001).

1.4. Significance of the Present study

In SLA, adult learners' L2 production has received serious attention in many studies such as, Archibald (1998) and Leather (1999). Young-Scholten and Archibald (2000), as previously mentioned, have pointed out that much of the available data come from the production of intermediate level learners with considerable L2 exposure. Limited attention has been directed to L2 perception. According to Altenberg (2005: 55) 'little attention has been paid to the issue of knowledge, as distinct from perception and production, in the acquisition of second language phonetics and phonology'. Furthermore, while there have been various investigations into the sensitivity to L1 phonotactic knowledge of infants and adult native speakers, there has been little attention paid to second language acquisition (Sebastián-Gallés & Bosch 2002).

As mentioned earlier, the present study aims to investigate English speakers' perception of selected Arabic sounds after first exposure to a controlled naturalistic input in an attempt to investigate whether the feature geometry of L1 affects the perception of adult L2 learners of novel L2 sounds (Matthews & Brown 1998). Few studies have explored adult L2 learners' perception at the initial state of learning. Therefore, this study aims to fill in this gap in the literature by conducting an experiment to investigate the perception of L2 novel sounds and the role of L1 feature geometry after first exposure. This is done by applying Brown (1998) and Matthews & Brown (1998) model, in which the main focus is on the relationship between theories of feature geometry and speech perception of a target language. To the best of my

knowledge no study so far has attempted such an investigation in a first exposure study.

In the next chapter, the literature on first exposure studies as well as L2 perception studies are reviewed. In chapter three, an overview of the methodological procedure, data collection technique and an account of the participants is detailed. Data analysis and findings are presented in chapter four. Finally, a detailed discussion of the results followed by the conclusion are presented in chapter five.

Chapter Two

2. Literature Review

2.1. First Exposure research in SLA

Recently in second language acquisition research, studies of first exposure to L2 have attracted attention and constituted a promising area of research. Specifically, such studies contribute to bridging gaps in the literature about the crucial first minutes/hours of naturalistic L2 contact. In so doing, they enrich our understanding of the adults' initial stages of L2 perception, noticing, and comprehension, and in turn present ideas for comparison between L1 child acquisition and L2 adult acquisition (Jusczyk et al. 1993). As mentioned earlier, many researchers such as Perdue (1996) suggested that empirical studies investigating adult first exposure to L2 are limited. Other researchers such as Vainikka and Young-Scholten (1998) considered that the collection of data at the initial state of L2 exposure is important in order to broaden our understanding of this significant state.

SLA's ultimate purpose is to describe the process of linguistic development from first exposure to L2 ultimate proficiency. As mentioned earlier, there is a gap in the literature regarding the crucial first minutes of L2 exposure. Such a gap has led many researchers to tackle this significant aspect of SLA theory and present important studies investigating the effect of controlled artificial and/or naturalistic input, such as Carroll, (2007, 2012, 2014), Gullberg et al. (2010, 2012), and Rast (2008, 2010) amongst many others.

This area of SLA is a relatively new one that started to take shape around the late 1990s (Schwartz & Sprouse 1996; Vainikka & Young-Scholten 1996). Therefore, different researchers have coined the term describing this area of

research differently. For example, it was coined as ‘ab initio’ by Han and Liu (2013), ‘minimal exposure’ by Gullberg et al. (2010, 2012), and ‘first exposure’ by Rast (2010) and Carroll (2013, 2014). Throughout this paper, it will be referred to as first exposure of L2.

The focus of this paper is to investigate adult L2 learners’ perceptual abilities of non-native L2 sounds after first exposure under the feature geometry model of Brown (1998) and Matthews & Brown (1998). It is, thus, necessary to point out that to the best of my knowledge no study has so far attempted such an investigation. Therefore, the literature in this paper on first exposure studies will present a general view of the major empirical studies of first exposure studies conducted so far, such as Carroll (2007, 2012, 2014), Gullberg et al. (2010), Han & Liu (2013), Rast (2008, 2010) and Park & Han (2008).

SLA researchers such as Carroll (2007, 2012, 2014), Gullberg et al. (2010), and Rast (2008) amongst many others have conducted L2 research investigating the effect of a controlled artificial and/or naturalistic input with adult L2 learners to examine adult L2 learners’ input processing abilities. Numerous studies have also investigated first exposure through implicit learning, for example Han & Liu (2013), Gullberg et al. (2010), Carroll (2012, 2014), and Carroll & Widjaja (2013). Overall, the major studies conducted in this area of inquiry of the initial stages of L2 acquisition are Gullberg et al. (2010, 2012) and Carroll (2012, 2014). The findings of these researchers make significant contributions to first exposure studies in SLA.

Gullberg et al. (2010, 2012) investigated L1 Dutch learners’ first exposure to L2 Mandarin with a naturalistic input of a fourteen minutes Mandarin weather report as the treatment. This treatment was then followed by the testing procedure to investigate the effects of input frequency on word recognition as

well as lexical mapping and segmentation. Gullberg et al.'s findings indicated a positive correlation between the frequency of input and results' accuracy. Such findings point out that adult L2 potential acquisition abilities are far higher than might be expected at first exposure (Gullberg et al. 2010, 2012). Nevertheless, Carroll (2014) considers Gullberg et al.'s findings to be optimistic, although they have a number of drawbacks. One of these drawbacks is the use of a weather report as the naturalistic input, as it employs simple sentences and basic linguistic properties that could account for the higher accuracy rate in the results. Interestingly, however, Han & Liu's findings in 2013 contradict those of Gullberg et al.'s (2010, 2012). Han & Liu (2013) exposed English and Japanese L1 learners to L2 Mandarin through the use of 10 video episodes with varied themes such as ordering food in a restaurant and bargaining in a shop. Each episode lasted for three minutes. Han & Liu concluded that these English and Japanese L1 learners of Mandarin struggled through all of the input processing tasks, which included free recall, comprehension, note taking, elicited imitation, and a working memory test.

Having presented one of the major studies and one of the opposing views, we now turn to another important study of first exposure. Carroll's research in 2012 and 2014 was conducted by exposing native speakers of English to L2 German to test for their segmentation abilities after first exposure. The treatment consisted of audio-visual stimuli presented as a name-learning task. Carroll's findings showed that learners could successfully segment L2 speech stream with about 90% accuracy rate and also map sound tokens to referents, even with low exposure frequency. Carroll (2012) suggested that segmentation abilities are evident in L2 learners even after limited numbers of incidental exposure. However, the high rate of accuracy in Carroll's results could be linked to the fact that the study investigated the acquisition of proper

names of L2 German, which are genetically similar to the learners' L1, English.

Other researchers have also investigated segmentation after first exposure, such as Rast (2010) and Shoemaker & Rast (2013). They also argued that the L2 learner's ability to segment linguistic components from L2 speech stream is evident and discussed the linguistic variables of input that may affect the L2 learner's segmentation ability, such as frequency of input and gestures. As previously mentioned, Carroll (2014) pointed out that the L2 learner's ability to segment the speech stream is evident at the initial phases of L2 acquisition and that L2 learners do segment this stream based on their linguistic knowledge of L1, as well as other newly acquired L2 linguistic knowledge. In other words, segmenting the lexical components of the input is due to the experience of complex parsing that L2 learners bring to the table (Carroll 2004).

On another note, it is necessary to point out that there are two studies which have been conducted to test for L2 learners' linguistic knowledge of phonotactic constraints after first exposure. These studies will be presented, as they are the closest to the aims of this study. The first study is conducted by Onishi et al. (2002), who tested L2 learners' linguistic knowledge of phonotactic constraints after a brief auditory experience in three treatments and tests. The aim was to test whether adult English speakers could acquire phonotactic regularities that are not present in English. The auditory treatments involved restricting specific consonants to specific syllable positions. Onishi et al. claim that their findings demonstrated that phonotactic constraints are rapidly learned from brief auditory experience and that some constraints are more easily learned than others (2002).

The other study is by Altenberg (2005), who created three experiments to examine the acquisition of English word-initial consonant clusters by native speakers of Spanish. These experiments consisted of a metalinguistic judgment task, a perception task, and a production task. The findings of Altenberg's study suggests that beginning as well as advanced L2 learners show an accurate knowledge of English phonotactics and that L1 transfer does not play a role in the learners' perception. However, this knowledge cannot be compared to that of a native speaker of English either in perception or production.

As a final point in this section, it should be noted that first exposure studies do contribute to elucidating adult L2 learners' linguistic abilities when faced with an unknown language for the first time. As mentioned earlier, there are a limited number of studies addressing this issue in SLA. Therefore, it is important for future research to address this matter. Thus, this study is an attempt to contribute to this area of research by presenting a study that is designed to replicate Gullberg's et al. (2010) treatment of a weather report to investigate English native speakers' perception of selected Arabic sounds under the feature geometry model of Brown (1998) and Matthews & Brown (1998). This study partially replicates the methods of Brown (1998) and Matthews & Brown's testing procedure (1998).

2.2. L2 Speech Perception

It is necessary to start this section by first presenting the view through which recent scholars in SLA approach L2 speech perception. According to Escudero (2005:7), 'speech perception is the act by which listeners map continuous and variable speech onto linguistic targets'. Escudero further explains that 'speech perception is learned through language experience, the number and nature of distinctive sound categories, i.e., the sound inventory

of a language, which can be seen to result from the mapping mechanism that has been developed to accurately classify the speech signal produced in a given language environment' (2005: 37). Diehl, Lotto & Holt (2004) also consider that adult L2 learners categorise acoustic-phonetic stimuli as language-specific sounds based on their language-specific perceptual system. Additionally, Escudero (2005: 36) posits that 'sound representation is a consequence of language-specific perceptual mappings which have developed through language experience'. Thus, speech perception is considered to mediate between the auditory input and the internally stored linguistic representations (Escudero 2005).

2.2.1. Language-Specific (L1) Perception and L2 Perception

As mentioned in the introductory chapter, infants and young children L2 learners outperform adult L2 learners in learning L2 sounds and in achieving L2 native-like performance (Kuhl 2000). While acquiring their first language and the L2 at the same time, every child learns to perceive and produce L1 and L2 sounds that resemble adults' performance in that language. However, language-specific perception starts to formulate in infants during their first year of life (Jusczyk et al. 1993; Polka & Werker 1994). Kuhl (2000) argues that infants develop from a universal auditory discrimination to a filtered language-specific perception as a result of language-specific experiences. As a matter of fact, language-specific experiences of specific sound systems of different languages can differ significantly from one another, leading to expected difficulties in L2 learning, especially with non-native sounds (Lado 1957). Lado (1957) posited that L2 non-native phonemes that have L1 native counterparts would be easy to learn, whereas non-native phonemes with no such counterparts would be difficult to learn. Thus, L2 sound perception is considered to be highly constrained by the learner's L1 linguistic experience,

i.e., by the sounds and perceptual processes of L1 (Escudero 2005). Likewise, Strange & Shafer (2008) suggested that the phonetic segments which are phonologically distinctive in L2, but not in the learners' L1, are often incorrectly recognised and categorised leading to L2 production difficulties.

Lado's hypothesis has been confirmed by the findings of many studies, for example, Best & Strange 1992; Halle, Best & Levitt 1999; Miyawaki et al. 1975; Sheldon & Strange 1982; Strange & Shafer 2008. These studies investigated the difficulty that the Japanese learners encounter in perceiving the English sounds /r/ and /l/ in comparison to the ease of perceiving the English sounds /r/ and /w/. The results of these studies suggest that since the /l/ sound does not have a counterpart in the Japanese L1 phonemic inventory, it is difficult to be perceived and learned by the Japanese learners, whereas since the English /r/ and /w/ do have a similar counterpart, they are easy to be perceived. Likewise, native English adult speakers have the same perceptual difficulty in differentiating the Hindi initial stops /ʈ/ and /ɖ/ (Werker et al. 1981; Polka 1991 in Strange & Shafer 2008; Polka 1992). Therefore, it is now argued that L1 language-specific perceptual knowledge affects the adult learners' L2 experience. In other words, adult learners' L2 perception is affected by their linguistically systematic perception of their native language (Brown 1998).

In the next section, a brief presentation of the several studies that addressed the reciprocal relationship between the perception and production of L2 sounds is presented, followed by a literature review of the different L2 speech perception models in SLA.

2.3. L2 Perception and Production

Having briefly presented L2 perception and production studies, I will now present a number of studies that have focused on the reciprocal relationship between the perception and production of L2 sounds. According to Borden, Gerber & Milsark (1983), Korean learners were more accurate in perceiving the English /r/-/l/ contrast than producing it. They proposed that perceptual abilities are essential for accurate L2 production. Similarly, Neufeld's (1988) findings showed that adult L2 learners are able to perceptually detect sound errors more than they are able to avoid producing these errors. Barry (1989) and Grasseger (1991) also argued that the more accurate the adult L2 learners' perception, the more accurate their production is. Furthermore, Barry (1989) and Grasseger (1991) pointed out that perceptual tests can be a suitable measure for observing and explaining difficulties in L2 sounds' perception and production. In addition to the previously mentioned studies, Flege (1993) and Rochet (1995) concluded that L2 perception develops before L2 production and it is a prerequisite to achieving a successful L2 production.

It is also necessary to clarify that there are many studies that hold an opposite view and have drawn different conclusions from those of the previously mentioned studies. These studies include for example, Goto (1971) and Sheldon & Strange (1982), who investigated the Japanese learners' acquisition of the English /r/-/l/ contrast, which is not present in Japanese phonemic inventory, and proposed that perceptual accuracy of the English /r/-/l/ contrast did not necessarily lead to accurate production. In a study of Dutch learners of English, Flege & Eefting (1987) concluded that there were considerable differences between the learners' production of the stop consonants /b/-/p/ in Dutch and in English, which suggested that the distinction between the two contrasts was not as clear in perception as in production. Moreover, Flege (1995) revealed that L2 learners may be able to

accurately produce non-native contrasts even though the same contrast was not accurately perceived by the L2 learner.

Furthermore, Miyawaki et al. (1975) conducted a study to test the effects of linguistic experiences on L2 perception. Their study showed that English and Japanese listeners differed significantly in the perception of /r/-/l/ contrast as these two phonemes contrast in English but not in Japanese. They reported that the English learners performed with a high accuracy rate in a discrimination task, whereas the Japanese learners performed relatively poorly. Miyawaki et al.'s (1975) results suggest that L1 linguistic experience affects L2 accurate perception.

Likewise, Aoyama et al. (2004) examined the role of L1 and the perception of phonetic similarities and dissimilarities between L1 and L2 sounds in the production of L2 English /r/ and /l/ sounds by L1 Japanese children and adult speakers. The tests were conducted twice separated by one year. In both tests, the children showed greater improvement than the adults in the production of L2 English /r/ than /l/. Again as previously mentioned, the study showed that children and adult Japanese listeners differed significantly in the production of /r/-/l/ contrast, as children are known to develop from a universal auditory discrimination system to a filtered language-specific perception as they grow older (Khul 1991).

Moreover, Iverson et al. (2003) also tested and compared the perception of English /r/ and /l/ by Japanese, German, and American adults. The results demonstrated that German adults in contrast to Japanese adults are more sensitive to the English /r/-/l/ contrast, because the German and the English languages are more closely related to each other than Japanese is to English. Iverson et al.'s (2003) findings show how L1 language-specific perception

can interfere with L2 perception. That is, the more different L1 and L2 are, the more difficult it is for L2 novel sounds to be perceived correctly.

Having established that L1 speech perception affects L2 production, due to language-specific linguistic experiences affecting the way that L2 learners perceive L2, we now turn to present the different models of L2 speech perception in SLA.

2.4. L2 Speech Perception Models in SLA

In SLA, it is commonly known that the most attested type of L2 sound perception is the learning of L2 new sounds in which the learners' L1 filters L2 perception, resulting in a failure to hear the differences between certain L2 sounds (Escudero 2005). According to Escudero (2005), this failure presents a much-debated issue within both phonological and phonetic L2 perception models that aim to explain L2 sound perception. As a result, different theoretical models exist in SLA literature regarding L2 speech perception. Many studies have attempted to investigate and explain L2 speech perception under each of these theoretical models, such as Best (1995), Brown (1998, 2000), Flege (1987, 1993, 1995, 2002, 2003), and Kuhl (1991, 1993, 2000). These different models addressed L2 sound perception with either a phonological or a phonetic approach, yet both of these approaches assume that the initial state in L2 sound perception is shaped and influenced by the learners' L1 linguistic experience. Needless to say that L2 sound perception's initial state is of great interest to this present study as it aims to investigate L2 sound perception's initial state after first exposure.

L2 speech perception research has shown that it is possible to measure the accuracy of the L2 learners' perception of the novel sounds of a new language as well as measure the L2 learners' linguistic abilities at the L2 initial state

(Escudero 2005). Furthermore, knowing how different L1 speakers and different L2 learners categorise the sounds of another language would provide an insight into the target language initial state (Escudero 2005).

The following section will present some of the different models and studies of L2 sound perception to establish the grounds, on which the present study has been based, namely the feature geometry theory of L2 speech perception.

2.4.1. The Native Language Magnet Model

One of the chief models that is based on a phonetic framework in L2 sound perception is proposed by Kuhl (1991, 1993, 2000). Kuhl (1991) argues that infants develop from a universal auditory discrimination to a filtered language-specific perception, as a result of language-specific experiences which form prototypes in the infant's perception. This in turn leads to a *perceptual magnet effect* in speech perception. These prototypical categories in the infant's perception 'functioned like a perceptual magnet for other category members' (Kuhl 1991: 93). However, as these infants grow to six months of age they gradually lose this ability, making a transition from a language-general to a language-specific state (Kuhl 1993; Werker & Curtin 2005). Accordingly, exposure to a specific language alters infants' perception (Kuhl 1993). The findings of Kuhl's studies supported the Native Language Magnet (NLM) theory, 'which describes how innate factors and early experience with language interact in the development of speech perception' (Kuhl 1993: 93).

NLM proposes that adult L2 perception is constrained by L1 language-specific linguistic experience and it acts as a filter that will make L2 acquisition of new sounds more difficult (Kuhl 2000). In other words, the

perception of L2 sounds is constrained by the L1 sound system, although the NLM model suggests that L2 learners can create new mappings for new L2 sounds (Kuhl 2000). Additionally, the NLM proposes that perceptual representations are stored in the memory, therefore, these perceptual representations differ for speakers of different languages so that the perception of any given L1 is entirely different from that of another language (Iverson & Kuhl 1996).

2.4.2. Perceptual Assimilation Model

Another model that is also based on a phonetic framework is the Perceptual Assimilation Model (PAM). PAM describes the process by which L2 learners perceptually assimilate non-native sounds into their own L1 phonemic inventory (Best 1995). It proposes three possible classifications. The first is that a prototype of some native phoneme is categorised according to goodness of fit that may range from excellent to poor. The second is that a consonant or vowel that fall somewhere in between native sounds is considered uncategorised (i.e., is roughly similar to two or more sounds). That is, uncategorised non-native sounds can be further sorted as a two category assimilation (a non-native sound may assimilate to two phonetically similar native sounds) or a single category assimilation (two non-native sounds assimilate equally well or poorly to a single native sound). The third is the non-assimilable sound that bears no detectable similarity to any native sounds (Best, McRoberts & Goodell 2001).

PAM proposes that infants hear and detect every articulatory gesture, and that later on as they grow, they learn to detect only those that signal sound contrasts in their L1 (Best 1984, 1995). It also proposes that the learners' sound perception is language specific. That is, L2 learners can perceive

sounds that are only similar to that of their native language. Thus, Best's PAM seeks to account for L2 perception of non-native contrasts and the way that these non-native sounds can be mapped onto the learners' sound system. It suggests that accuracy in the discrimination of non-native sounds depends on the way that these sounds are assimilated to the L1 sounds. L2 learners' linguistic perceptual device is tuned to L1 particular high-level features and will therefore have difficulty in detecting the L2 features. In other words, the L2 may have high-level features that signal contrasts that are actually low-level ones for the L2 learners. Consequently, the L2 sounds will be assimilated to the ones in the L1. As for the effects of exposure to L2 input, Best & Strange (1992) suggest that it may lead to the reorganisation of assimilation patterns in cross-language perception. PAM and NLM models have focused primarily on the L2 initial state of learning and non-native sound perception, unlike other models that have focused on the advanced stages of L2 learning, such as the Speech Learning Model (Best & Tyler 2007).

2.4.3. Speech Learning Model

The third phonetic model is Flege's (1995) Speech Learning Model (SLM). SLM theorises that the L2 initial state consists of L1 categories only. SLM is primarily concerned with experienced L2 learners and the ultimate attainment of L2 production (Flege 1995). Recently, however, SLM started to show interest in the ultimate attainment of L2 perception (Flege 2003). Moreover, SLM explains the process by which L2 learners acquire new and similar L2 sounds, and that new sounds can be acquired while similar sounds are very difficult to be acquired, because the assimilation of a similar L2 sound into an L1 category will inevitably lead to a change in the latter in order to cope with the L2 productions (Flege 1987, 1995). That is, L2 sounds that are similar to L1 sounds are less easily perceived in a native-like way than new

sounds are i.e., the perception of two L2 sounds as a single L1 sound, which results in an L2 contrast neutralization as one sound, for example, the case of the Japanese learners neutralization of the English /r/-/l/ contrast into the Japanese flap counterpart.

Furthermore, SLM proposes that adult L2 learners start with L1 language-specific linguistic expertise. This initial state may lead these learners to inaccurately perceive the phonetic differences between L2 sound contrasts or between L2 and L1 sounds because L1 phonology filters out L2 sound features or properties (Flege 1995). SLM proposes that the phonetic categories of the L1 and L2 are represented in a common phonological space, thus both of the L1 and the L2 sounds are reciprocally influenced. Hence, when a new L2 sound is similar to an L1 sound, it will dissimilate (Flege 2002). As a result, L1 and L2 perceptions by bilingual speakers will be different from those of native speakers of the same two languages, and so will their L1 and L2 (Flege, Schirru & MacKay 2003). On the other hand, when a new L2 sound is different from the L1, it will assimilate to represent both the L1 and L2 (Flege 1987). Flege's (1987) findings showed that native English learners of French could produce /y/ more accurately than /u/ because /y/ is more distant from French /u/ than from English /u/.

Once again, the basic view of SLM is that new L2 sounds are more easily learned than similar sounds (Flege 1995). Nevertheless, if the new L2 sounds contain features that the L1 does not have, then Brown's (1998, 2000) claims, which will be presented shortly, make an opposite point of view to Flege's SLM. Additionally, it seems that Flege's SLM holds an opposite view to Best's PAM as well. Unlike NLM, SLM assumes that adult L2 learners do not lose the abilities used by infants and children to acquire their L1, including the ability to form new phonetic categories (Flege & MacKay 2004). Flege (2009) suggested that L2 learners could detect phonetic differences between

L1 and L2 by utilising all the abilities used to acquire the L1. Still, SLM as well as PAM and NLM consider L2 perception to be language-specific.

Having presented three L2 perception models, all of which have a phonetic approach, we now turn to an L2 perception model that has a phonological approach. This model is of great importance to the present study as it forms the basis on which the study's hypotheses and research questions were based.

2.4.4. Brown's Phonological Interference Model

Brown's Phonological Interference Model (PIM) proposes that L1 feature geometry and phonological structure filter the L2 acoustic input, eliminating the ability to perceive cues in the L2 acoustic signal (Brown (2000)). The PIM posits that the L2 initial state is the L1 phonological structure. That is, adult L2 learners transfer the L1 feature geometry to the L2 learning. Moreover, the PIM proposes that L1 acquisition initially starts with a universal feature geometry which is provided by UG. According to Rice and Avery (1993), children have the ability to detect contrastive features in the input and as the child grows older, he/she loses this ability. Thus, the feature geometry of a particular language is present, only leading adult L2 learners to be constrained by the L1 feature geometry of their native language (Brown 1998; Brown & Matthews 1997).

Brown's PIM model predicts that adult L2 learners' perception of L2 phonological categories (i.e., phonemes) could be described according to two scenarios (Brown 1998, 2000). First, adult L2 learners perceive fewer sounds than the ones produced in the L2 because the L1 has fewer sound categories than the ones found in the L2. The most common case of this type involves the perception of two L2 sounds as a single L1 sound, which results in an L2

contrast neutralization, as in the case of Japanese learners of the English /r/-/l/ contrast which is neutralised into the Japanese flap category. Second, adult L2 learners perceive the same number of sounds as those produced in the L2 because L1 has the same number of sound categories. For example, the perception of an L2 contrast as a corresponding contrast in the L1. This is where phonetic differences between the L1 and L2 sound categories result in slight differences in sound categorization, as in the case of French learners of English /d/ and /t/ (Escudero 2005).

Phonemes in the notion of feature geometry are assumed to have an internal structure that is composed of a hierarchy of phonological features that are contained in the phonological component of Universal Grammar (Clements 1985). That is, the representation of a given sound in a given language is a subset of universal feature geometry. According to Rice and Avery (1993), the representation of a sound always makes it distinctive within a particular language. Hence, Brown's PIM aims to explain the influence of L1 phonology on the acquisition of L2 phonology, as well as identifying the level of phonological knowledge involved in such L1 influence.

Furthermore, the findings of Brown's study in which she tested the perception of English /r/-/l/ contrast by Japanese and Chinese L2 learners supported her PIM and feature geometry model (Brown 1998). The two English sounds have different feature geometries. This difference is based on the feature [coronal] which is present in the feature geometry of /r/ but absent in that of /l/. The results revealed that Chinese learners were able to accurately perceive the English contrast, whereas the Japanese learners were not. This is because Chinese feature geometry has a [coronal] contrast in the form of alveolar versus retroflex sibilants, whereas Japanese does not. Additionally, PIM and the feature geometry model are supported also by the findings of Brown (1998) and Matthews & Brown (1998) which revealed that Japanese speakers

learning English were unable to accurately discriminate between the contrasts /r/-/l/ and /s/-/θ/ which are distinguished by the features [coronal] and [distributed], respectively, both of which are absent in the Japanese feature geometry.

Brown's (1998) findings indicated that the difference between the Japanese and Chinese performance in all of the tasks was related to the subjects' L1, and that this was the key factor. Also, no significant correlation was found between the performance on all of the tasks and the number of years that English had been studied in both groups.

2.5. L1 Feature Geometry

As was mentioned in the introductory chapter, L1 phonology can render L2 learners insensitive to certain properties of L2 input (Matthews & Brown 2004). As a result, L1 feature geometry constrains the acquisition of L2 segmental representations, leading to transfer of L1 properties into L2 acquisition (Brown 1998). Thus, Feature Geometry is the theory of segmental representation that maintains that phonemes consist of distinctive features that are organised into hierarchical constituents (Clements 1985). According to the Feature Geometry theory, L1 perception and system is considered to be the starting point of the L2 initial state, where L2 learners perceive only L1 perceptual categories in the L2 input. Two predictions can be made regarding the starting point of the L2 perception scenario, which are the same two scenarios that were mentioned in the PIM model.

Brown (1998) posits that the study of similar contrasts will not contribute to the understanding of how a novel L2 representation is acquired, and that the study of completely new contrasts, such as Zulu clicks, will only tell us whether UG plays a role in L2 acquisition. Hence, Brown suggests that non-

native contrasts in which only one of the members is a phoneme in the learner's L1 should be the focus of future studies, due to the fact that it is the only scenario in which L2 learners can be tested to investigate if they can develop new L2 segments on the basis of already existing L1 features. The present study is an attempt to fill the gap in both areas of research (first exposure and L2 perception studies) by investigating the perception of non-native contrastive sounds after first exposure to L2.

To sum up, L2 sound perception models and studies present two opposing point of views. The first one holds that similar L2 sounds are easier to learn than dissimilar ones, such as Brown's PIM (1998, 2000), Best's PAM (1995), and Kuhl's NLM (2000). The other point of view holds that similar L2 sounds are difficult to learn, as in Flege's SLM (1995, 2003). As mentioned earlier, the first three models share the view that the presence of L2 sounds and features in the L1 results in the absence of L2 perceptual learning problems. However, the later assumes that native-like L2 perception is very difficult to achieve.

This chapter thus far has reviewed first exposure studies and four models of L2 perception, as well as the Feature Geometry theory. In the next section the hypotheses and research questions are presented.

2.6. Hypotheses and Research Questions

Based on the previously mentioned research of Brown (1998) and (Matthews & Brown 1998), it is hypothesised that L1 feature geometry mediates between the incoming acoustic stimuli of a speech stream and the abstract linguistic system, sorting the stimuli into phonemic perceptual categories (Matthews & Brown 1998). That is, novel L2 phonemes that are distinguished by a feature present in L1 phonology will be perceived more easily than those that are

distinguished by features absent in L1 phonology. Accordingly, the present study's research questions are as follows:

1. Which novel Arabic phonemes will be the least/most problematic to be perceived by adult native speakers of English at first exposure to Arabic? Can first exposure studies shed light on this?
2. Do the phonological features that distinguish languages affect the perceptual capacities of L2 learners of other languages (perceptual filtering)? That is, do L2 learners perceive L2 sounds the same way that native speakers do or do they perceive the non-native contrasts as the most similar L1 sounds?

Chapter Three

3. Methodology

3.1. The Study

The present study is based on the hypothesis that L1 English feature geometry will mediate between the incoming acoustic stimuli of the speech stream of Arabic L2, sorting the stimuli into phonemic perceptual categories (Brown 1998; Matthews & Brown 1998). That is, non-native Arabic L2 phonemes that are distinguished by a feature present in L1 English phonology will be discriminated and perceived more easily than those that are distinguished by features absent in L1 English phonology. An experiment was thus designed to investigate the effects of L1 English feature geometry on the accuracy of L2 learners' perception of novel L2 Arabic phonemic contrasts after first exposure (Brown 1998; of Gullberg et al. 2010; Matthews & Brown 1998).

To assess the hypotheses, it was necessary to test for contrastive phonemic pairs that are of four classifications, partially following Brown (1998) and Matthews & Brown's (1998) methods. The first is the contrastive phonemic pair /b/-/d/, both of which exist in the phonemic inventory of both English and Arabic. This pair also served as a control contrast for testing as will be explained shortly. The second is the contrastive phonemic pair /x/-/ɣ/, where both phonemes exist in Arabic but not in English. Nevertheless, the features necessary to distinguish between /x/ and /ɣ/ are present in the feature geometry of English, i.e., [dorsal], [voice] and [continuant] (Alotaibi & Meftah 2013; Davenport & Hannahs 2010). The third and the fourth are the contrastive phonemic pairs /ʔ/-/ʕ/ and /h/-/ħ/. All of the phonemes in these two pairs are present in Arabic, however, only the first member of each pair is present in English, i.e., /ʔ/ and /h/. Moreover, English feature geometry lacks the retracted tongue root [RTR] feature entirely (Esling 1999), which is

a necessary feature to distinguish between the contrastive pairs /ʔ/-/ʕ/ and /h/-/ħ/ (McCarthy 1994). Thus, both of the phonemes /ʕ/ and /ħ/ along with the distinctive feature [RTR] necessary to distinguish them are absent in English phonology.

English was chosen as an L1 for the present study because all of the L2 Arabic phonemes /ħ/, /ʕ/, /x/, and /ʁ/ do not exist in English, which provide a basis for comparison to systematically test the effects of L1 feature geometry on the perception of L2 non-native contrasts (Brown 1998). To the best of our knowledge, there are no studies that have attempted such a comparison between English L1 and Arabic L2 feature geometry before. Table 1 below outlines the contrasting feature geometry in each pair and its presence in English, Arabic or both. See Appendices 1 and 2 for the English and the Arabic consonant phonemic inventories.

Table 1. Eight Selected Arabic Phonemes and Feature Geometry Contrast

Phoneme	Phoneme Present in English	Phoneme Present in Arabic	Feature Contrast	Feature Geometry
/b/ /d/	✓ ✓	✓ ✓	[coronal]	Present in both
/x/ /ʁ/	× ×	✓ ✓	[dorsal, voice, continuant]	Present in both
/h/ /ħ/	✓ ×	✓ ✓	[RTR]	Present in Arabic Only
/ʔ/ /ʕ/	✓ ×	✓ ✓	[RTR]	Present in Arabic Only

Furthermore, since this study also investigates English speakers' first exposure to novel Arabic L2 sounds, the experiment included a treatment in the form of an Arabic weather report, partially following the methods of Gullberg et al.'s first exposure study (2010). The input in the weather report was controlled as to contain a balanced number of occurrences of the phonemes in question.

3.1.1. Participants

43 adults participated in this study (17 males and 26 females), ranging in age from 18 to 60 years old. The gender and age of the participants were not variables. The participants were recruited electronically. The consent form, the biographical data questionnaire, the treatment, and lastly the testing were all delivered electronically through Google Forms, which provided an online link that was distributed through emails, Twitter, and Facebook. Each participant signed a consent form and completed a self-reporting biographical data questionnaire to detect any prior exposure to or knowledge of Arabic before proceeding to watching the weather report, which was followed by the testing. As a control measure, participants were asked to indicate if they had studied Linguistics to check for variables in their responses in comparison to those who reported no prior study of linguistics. Those who had studied Linguistics may have had an advantage over those who had not, which may have led the participants to identify linguistic properties better than those who had not. See Appendix 7 for the consent form, biographical data questionnaire, treatment, and testing.

The 43 participants were divided into to three groups (cf. Brown 1998; Matthews & Brown 1998). The first group was the native English L1 group with no prior exposure to Arabic ($n = 20$), henceforth, English group. The second group was the native English L1 group with prior exposure to Arabic

who reported either a pre-beginner or an intermediate level of Arabic as an L2 (n = 10), henceforth, English+. Both of the first and the second groups served as the experimental groups for the present study. Finally, a group of native Arabic L1 speakers (n = 13) served as a control group, henceforth, Arabic group. The three groups were recruited as such because finding answers to our research questions requires comparing the perception accuracy of the native English speakers (with no prior exposure to Arabic) with that of the native English speakers who reported exposure to Arabic prior to the testing. Thus, the comparison between the results of these two groups will reveal whether prior exposure to Arabic plays a role in the perception accuracy of the selected non-native phonemic contrasts. The Arabic control group served as the basis on which the study relied on to validate the testing procedure, compare the results with the first and second groups, and confirm, refute or refine the present study's hypotheses (cf. Brown 1998; Matthews & Brown 1998). See Tables 2 and 3 for demographic information about the three groups.

Table 2. Demographics of the Three Groups according to Gender

Gender		groups			Total
		English	English+	Arabic	
Male	N	10	4	3	17
	%	50%	40%	23.1%	39.5%
Female	N	10	6	10	26
	%	50%	60%	76.9%	60.5%
Total	N	20	10	13	43
	%	100%	100%	100%	100%

Table 3. Demographics of the Three Groups according to Age

Age groups		Groups			Total
		English	English+	Arabic	
18 - 24	N	2	2	5	9
	%	10%	20%	38.5%	20.9%
25 - 34	N	6	4	7	17
	%	30%	40%	53.8%	39.5%
35 - 44	N	8	2	0	10
	%	40%	20%	0%	23.3%
45 - 60	N	4	2	1	7
	%	20%	20%	7.7%	16.3%
Total	N	20	10	13	43
	%	100%	100%	100%	100%

3.1.2. Input and Treatment

Inspired by Gullberg et al.'s study (2010), the treatment involved an audio-visual input of a genuine weather report in Arabic that was created by ArabiaWeather.com and made available on YouTube. The weather report was aided by gestural highlighting and was made available online to the participants through Google Forms. The weather report was entirely in Arabic and lasted for approximately five minutes. Care was taken in choosing this specific weather report from YouTube to include a balanced number of occurrences of the eight Arabic phonemes under investigation (see Appendix 5).

Participants were instructed to ensure that their computers' speakers were working properly and that they were sitting in a quiet place before watching the weather report and before proceeding to listen to the test items. The weather report and the test items were both delivered by a male native Arabic

speaker to control for variance in sound quality. See Appendices 4 and 6 for the IPA phonetic transcription and English translation of the weather report.

3.1.3. Testing

An online test was presented at the end of the weather report to test the participants' perception of the eight selected Arabic contrastive phonemic pairs. No pre-test was carried out in order to avoid revealing the focus of the study to the participants. The participants were instructed to listen to 45 individual audio-video stimuli that corresponded to multiple-choice test items in a randomized order as a control measure. Each stimulus consisted of minimal Arabic pairs that differed only in their onset consonants, for example, (baar/daar). Since the treatment was delivered by a male native speaker of Arabic, for the sake of consistency and as a control measure, a male native speaker of Arabic also produced all stimuli.

In order to be as naturalistic as possible, each test word containing the phoneme under investigation was inserted in the following short phrase [qull _____ marra θaanija] 'say _____ once again', which was uttered by a male native speaker of Arabic and recorded digitally using Audacity software. The test words were then clipped and grouped into minimal pairs, e.g., /baar/ and /daar/. All audio files were then uploaded to YouTube in order to be used in Google Forms. All tasks were AX discrimination tasks in which participants were instructed to indicate as quickly and as accurately as possible after listening to each audio-video stimulus of a minimal pair whether each pair of test item contained two different words or two instances of the same word by choosing 'Same' or 'Different' (Brown 1998; Matthews & Brown 1998). According to Brown (1998), if an L2 learner does not distinguish between two sounds in this type of a task, the assumption is that the phonological representations of this learner's L1 lack the necessary

structure to facilitate distinguishing between the two sounds. The answers were tabulated into Excel spreadsheets through Google Forms in preparation for analysis.

The 45 stimuli of minimal Arabic pairs were prepared for the three experimental contrasts /ʔ/-/ʕ/, /h/-/ħ/, and /x/-/χ/. The contrast /b/-/d/ was also included as a control contrast /b/-/d/ because both phonemes are present in the phonemic inventory of both English and Arabic. As a result, all the participants across the three different groups are expected to perform well in the /b/ and /d/ contrast. Lastly, a group of identical pairs, which served as foils, were included. The purpose of these foils was to ensure that participants' poor performance on the task was not because the task in itself was difficult. If the task itself was difficult, then we would expect the participants to perform poorly on the foil items as well (Brown 1998).

As for the experimental contrast /x/-/χ/, although they are not present in the English phonemic inventory, the features [dorsal, voice, continuant], which are necessary to distinguish them, are present in the English feature geometry. Thus, the English participants in both English groups (i.e., English and English+) are expected to perceive the /x/-/χ/ contrast with a high degree of accuracy, although not as accurately as the Arabic participants because both phonemes exist in Arabic.

In comparison, the non-native contrasts /h/-/ħ/ and /ʔ/-/ʕ/ are distinguished by the feature [RTR], which is absent in the English feature geometry. This means that not only the non-native phonemes /ħ/ and /ʕ/ are absent in English, but also the feature necessary to distinguish them (i.e., [RTR]) is absent too. Accordingly, the English participants (with no prior exposure to Arabic) are expected to perform poorly. The English+ participants (with previous exposure to Arabic) are expected to perform better than the English

participants (with no prior exposure to Arabic), but not as well as the Arabic participants. See Tables 4, 5, 6, and 7 below for the minimal pairs for each contrast.

Table 4. /b/ and /d/ Minimal Pairs

IPA of Test Pair	Gloss	Arabic Pair	Answer
baab/daab	door/snake	باب/داب	Different
baar/daar	obedient/house	بار/دار	Different
baan/daan	occur/near	بان/دان	Different
biir/diir	well/town	بير/دير	Different
buur/duur	heath/houses	بور/دور	Different
balal/dalal	wet/pamper	بلل/دلل	Different
ball/dall	wet/lead	بل/دل	Different

Table 5. /x/ and /y/ Minimal Pairs

IPA of Test Pair	Gloss	Arabic Pair	Answer
xaab/yaab	disappoint/absent	خاب/غاب	Different
xadar/yadar	dizzy/betray	خدر/غدر	Different
xaali/yaali	empty/expensive	خالي/غالي	Different
xeer/yeer	goodness/other	خير/غير	Different
xaliil/yaliil	friend/thirst	خليل/غليل	Different
xalal/yalal	malfunction/cuffs	خلل/غلل	Different
xilaal/yilaal	through/crops	خلال/غلل	Different
xaar/yaar	weaken/attack	خار/غار	Different
xafiir/yafiir	soldiers/numerous	خفير/غفير	Different
xuus/yuus	bamboo/dive	خوص/غوص	Different

Table 6. /h/ and /ħ/ Minimal Pairs

IPA of Test Pair	Gloss	Arabic Pair	Answer
haal/ħaal	cardamom/condition	هال/حال	Different
haan/ħaan	to ease/due time	هان/حان	Different
haḍḡar/ħaḍḡar	to desert/rock	هجر/حجر	Different
haram/ħaram	pyramid/campus	هرم/حرم	Different
haadi/ħaadi	quiet/one	هادي/حادي	Different
hazam/ħazam	defeated/decided	هزم/حزم	Different
haam/ħaam	wander/hover	هام/حام	Different

habb/habb	blow/seed	هب/حب	Different
hala/hala	proper noun/dessert	هالا/حالا	Different
haamil/haamil	cast off/pregnant	هامل/حامل	Different
huruub/huruub	escape/wars	هروب/حروب	Different

Table 7. /ʔ/ and /ʕ/ Minimal Pairs

IPA of Test Pair	Gloss	Arabic Pair	Answer
ʔeeʃ/ʕeeʃ	what/rice	ايش/عيش	Different
ʔamr/ʕamr	order/proper noun	أمر/عمرو	Different
ʔaɖʒal/ʕaɖʒal	destiny/rush	أجل/عجل	Different
ʔaθar/ʕaθar	trail/found	أثر/عثر	Different
ʔajn/ʕajn	where/eye	أين/عين	Different
ʔuufi/ʕuufi	paid/healed	أوفي/عوفي	Different
ʔibar/ʕibar	needles/examples	إبر/عبر	Different
ʔalam/ʕalam	pain/flag	ألم/علم	Different
ʔamad/ʕamad	duration/pillar	أمد/عمد	Different
ʔamal/ʕamal	hope/work	أمل/عمل	Different
ʔasaf/ʕasaf	regret/tamed	أسف/عسف	Different

Finally, six identical Arabic pairs were included (e.g. baan/baan) as a control measure. The correct response for all the previously discussed stimuli items is ‘Different’. However, the correct answer is ‘Same’ for these identical pairs. If a participant responded incorrectly to these items with ‘Different’, it might mean that he/she answered without listening to the audio, answered randomly, or might be having hearing problems. Therefore, two participants, who did not perform well in two or more of the six items, were eliminated before the final number of participants was finalized to 43. See Table 8 below for the identical pairs.

Table 8. Identical Pairs

IPA of Test Pair	Gloss	Arabic Pair	Answer
baan/baan	occur/occur	بان/بان	Same
duus/duus	stump/stump	دوس/دوس	Same
ʕamad/ʕamad	pillar/pillar	عمد/عمد	Same
huruub/huruub	escape/escape	هروب/هروب	Same
ʕafiir/ʕafiir	numerous/numerous	غفير/غفير	Same
ʔajn/ʔajn	where/where	أين/أين	Same

3.2. Preliminary Analysis

First, since /b/ and /d/ are sounds that exist in the phonemic inventory of both English and Arabic, participants in all three groups are expected to distinguish these sounds accurately. Second, non-native contrasts that are distinguished by features present in the English feature geometry (i.e., /x/-/ɣ/) are predicted to be discriminated and perceived accurately by the English speakers (both the English group and the English+ group), though not as accurately as the Arabic speakers. Third, non-native contrasts that are distinguished by features absent in the English feature geometry (i.e., /h/-/ħ/ and /ʔ/-/ʕ/) are predicted to be discriminated poorly by both English groups. The English+ group is, however, predicted to be more accurate than the English group, but to be less accurate than the Arabic group.

Chapter Four

4. Results

4.1. Statistical Tests and Data Analysis

Statistical analysis was performed using the statistical software package SPSS version 20 for Windows. First, the data were described using descriptive statistics (mean, median, and standard deviation) which were calculated to describe the numerical quantitative variables in the answers, i.e., ‘Same’ or ‘Different’. Table 9 below shows the mean, median, and standard deviation of the participants’ answers. In general, there are obvious differences between the three groups’ results within the four different phonemic contrasts. For instance, in the first phonemic contrast /ʔ/-/ʕ/, we find that the Arabic group had the highest scores, whereas the English group with no prior exposure to Arabic had the lowest scores.

Table 9. Descriptive Statistics of the Results

Phonemic Contrast	English Group			English+ Group			Arabic Group		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
/ʔ/-/ʕ/	1.37	1.36	0.23	1.56	1.64	0.14	1.99	2.00	0.03
/h/-/ħ/	1.16	1.15	0.14	1.28	1.30	0.20	1.97	2.00	0.05
/x/-/χ/	1.83	1.80	0.13	1.90	2.00	0.16	1.96	2.00	0.09
/b/-/d/	1.46	1.36	0.26	1.57	1.57	0.16	1.99	2.00	0.04
Identical Pairs	1.96	2.00	0.09	1.93	2.00	0.09	1.97	2.00	0.06

A normality test (Shapiro-Wilk Test) was run to determine whether the data were normally distributed, which in turn determines which SPSS statistical tests to be used. The results of the test indicated that the data were not normally distributed, as will be explained below. Thus, the non-parametric

test Kruskal-Wallis was utilized to find out any significant differences between the medians of the three groups' results (English group, English+ group, and Arabic group). In addition, Maan Whitney test was utilized to find out any significant differences between each two speaker groups separately. In general, analysis tests' results are considered significant when $p < 0.05$. Finally, T test was utilized to find if the variable of having studied Linguistics before could have affected the English groups' results.

4.1.1. Shapiro-Wilk Normality Test

Shapiro-Wilk normality test is a numerical method of assessing data normality, which is a powerful and more appropriate test for small sample sizes (< 50 samples). Shapiro-Wilk normality test was run on the data obtained from the three different speaker groups (English group, English+ group, and Arabic group). In data analysis in general, data from a particular group is considered normally distributed if the data set from all speaker groups had a p value > 0.05 . In case of any violation of the normality assumption of the data distribution in any speaker group or data set, the whole set of data is considered not normally distributed. The data of all speaker groups indicated that the data were not normally distributed ($p < 0.05$). Therefore, as mentioned earlier, the non-parametric statistical tests Kruskal-Wallis and Maan Whitney tests were utilized in the data analysis accordingly. See Appendix 8 for the normality test results for the four different phonemic contrasts and the identical pairs.

4.1.2. Kruskal-Wallis Test

The non-parametric Kruskal-Wallis test was utilized in the analysis of the present data because, as mentioned earlier, the data were found to be not

normally distributed. Kruskal-Wallis test was utilized to find out any significant differences between the medians of the three speaker groups' results (English group, English+ group, and Arabic group). In general, analysis tests' results are considered significant when $p < 0.05$. In this study, the Kruskal-Wallis test revealed significant differences between the medians of the three speaker groups within the four different phonemic contrasts, except for the identical pairs' results where there were no significant differences between the medians, which is not unexpected for a control measure where all participants answered correctly with 'Same'². On the other hand, in each minimal pair of the four phonemic contrasts the correct answer is 'Different', whereas the answer 'Same' is considered an error.

Table 10 below shows the significant differences between the medians of the three speaker groups. As can be seen in Table 10, the Arabic group outperformed the other two groups (English group and English+ group) in all the experimental phonemic contrasts as expected in the hypothesis (median = 2.00). Table 10 also shows that the English+ group outperformed the English group in all the experimental phonemic contrasts as expected in the hypothesis of the present study. Thus, the English group performed poorly in comparison with the other two groups. The fact that the Arabic group outperformed the other two groups while the English group performed the worst in all the experimental phonemic contrasts supports the hypothesis that L1 feature geometry alters L2 perception accuracy of non-native phonemes and mediates between the incoming acoustic stimuli of the Arabic speech stream, sorting the stimuli into phonemic perceptual categories leading to inaccurate L2 perception of the non-native phonemic contrasts.

² It must be noted that two of the participants had two or more wrong answers in the identical pairs and were therefore eliminated and not included in the final number of the 43 participants.

Table 10. Significant Differences between the Medians of the Three Speaker Groups (Kruskal-Wallis)

Phonemic Contrasts	Groups' Medians			
	English	English+	Arabic	P value
/ʔ/-/ʕ/	1.36	1.64	2.00	< 0.001
/h/-/ħ/	1.15	1.30	2.00	< 0.001
/x/-/χ/	1.80	2.00	2.00	0.006
/b/-/d/	1.36	1.57	2.00	< 0.001
Identical Pairs	2.00	2.00	2.00	0.385

Moreover, as predicted in the preliminary analysis of the results, the Kruskal-Wallis test also revealed significant differences between the medians of the three speaker groups across the experimental non-native phonemic contrasts, as shown in Table 10 above. As previously anticipated, the non-native experimental phonemic contrasts which are distinguished by features absent in the English feature geometry (i.e., /ʔ/-/ʕ/ and /h/-/ħ/) were perceived less accurately by both of the English groups compared to the Arabic group. However, the English+ group was more accurate and performed better than the English group, but less accurate than the Arabic group. As for the non-native experimental phonemic contrast /x/-/χ/, which is distinguished by features present in the English feature geometry, they were perceived by the English speakers (both the English group and the English+ group) as accurately as the Arabic speakers, as expected. In fact, the English+ group had a perfect median score of a 2.00, which is exactly the same median score for the Arabic group, while the English group had a near perfect median score of 1.80. As for the control phonemic contrast /b/-/d/, where both phonemes exist in the phonemic inventory of both English and Arabic, all three groups were expected to distinguish these sounds accurately. However, the English group surprisingly did not perform as expected in comparison to the other non-native phonemic contrasts (see Table 10 above). The English group

scored a median of 1.36 in the control phonemic contrast /b/-/d/ as well as in the experimental phonemic contrast /ʔ/-/ʕ/. The unexpected results of the English group in the /b/-/d/ contrast will be discussed later. Next, the results of the Maan Whitney test, which was utilized in order to evaluate and compare the performance of each two speaker groups separately are presented.

4.1.3. Maan Whitney Test

The non-parametric test Maan Whitney was utilized in the analysis of the present data to compare the performance of each two speaker groups separately. First, the English and the Arabic groups' results will be presented followed by the Arabic and English+ groups' results and finally the English and the English+ groups' results. Table 11 below shows the significant differences between the median scores of the English and Arabic groups within the four different phonemic contrasts. The Arabic group significantly outperformed the English group in all of the four different phonemic contrasts with significant differences ($p < 0.001$) and ($p < 0.002$). With the exception of the control phonemic contrast /b/-/d/, these results once again support the hypothesis of this study, which states that non-native L2 phonemes that are distinguished by a feature present in L1 phonology will be discriminated more easily than those that are distinguished by features absent in L1 phonology. For the identical pairs, there was no significant difference as explained earlier. As with the Kruskal-Wallis results discussed above, there was a significant difference between the English and Arabic groups with respect to the control phonemic contrast /b/-/d/, which is unexpected since both phonemes exist in both English and Arabic. These surprising results of /b/-/d/ contrast will be discussed later.

Table 11. English and Arabic Groups

Phonemic Contrasts	Groups' Medians		
	English	Arabic	P value
/ʔ/-/ʕ/	1.36	2.00	< 0.001
/h/-/ħ/	1.15	2.00	< 0.001
/x/-/χ/	1.80	2.00	0.002
/b/-/d/	1.36	2.00	< 0.001
Identical Pairs	2.00	2.00	0.700

Table 12 below shows the differences between the median scores of the Arabic and English+ groups within the four different phonemic contrasts. As can be seen, the differences between the medians of the two speaker groups with respect to the experimental phonemic contrasts /ʔ/-/ʕ/ and /h/-/ħ/ are significant ($p < 0.001$). That is, the Arabic group significantly outperformed the English+ group in both phonemic contrasts, as expected by the hypothesis. In contrast, there was no significant difference in the results of the experimental phonemic contrast /x/-/χ/ between the Arabic and English+ groups. Once again, these results support the hypothesis that non-native L2 phonemes that are distinguished by a feature present in L1 phonology will be discriminated more easily than those that are distinguished by features absent in L1 phonology. As for the control phonemic contrast /b/-/d/, there was a significant difference between the English+ and Arabic groups, which is unexpected since both phonemes exist in both English and Arabic. Again, the surprising results of /b/-/d/ contrast will be discussed later.

Table 12. Arabic and English+ Groups

Phonemic Contrasts	Groups' Medians		
	English+	Arabic	P value
/ʔ/-/ʕ/	1.64	2.00	< 0.001
/h/-/ħ/	1.30	2.00	< 0.001
/x/-/χ/	2.00	2.00	0.320
/b/-/d/	1.57	2.00	< 0.001
Identical Pairs	2.00	2.00	0.192

The final comparison is between the English and English+ groups. Table 13 below shows that the median score of the English+ group is significantly greater than that of the English group with respect to the experimental phonemic contrast /ʔ/-/ʕ/ ($p = 0.008$). This result in particular suggests that prior exposure to Arabic has played a positive role in the English+ group's perception of this non-native phonemic contrast, given the fact that they are distinguished by the feature [RTR], which is an absent feature in the English feature geometry. As for the rest of the phonemic contrasts there were no significant differences. Nevertheless, the English+ group outperformed the English group as predicted earlier in all the experimental phonemic contrasts. Once again, these differences, although not significant, might be attributed to the English+ group' prior exposure to Arabic. That is, it shows that there is a considerable difference between the accurate L2 perception of the L2 learners at first exposure and L2 learners with prior exposure to L2. Thus, the present study shows that first exposure studies could shed light on the differences between the L2 accurate perception of L2 learners at first exposure and L2 learners with prior exposure to L2 and also support the notion that L1 phonology may be the only knowledge contributing to L2 phonological perception at first exposure. This is because the accurate knowledge of L2 sounds can only emerge from the learner's ability to perceive such sounds correctly and to form appropriate representations of them after exposure (Brown 1998; Gullberg et al. 2010).

Table 13. English and English+ Groups

Phonemic Contrasts	Groups' Medians		
	English	English+	P value
/ʔ/-/ʕ/	1.36	1.64	0.008
/h/-/ħ/	1.15	1.30	0.116
/x/-/χ/	1.80	2.00	0.094
/b/-/d/	1.36	1.57	0.259
Identical Pairs	2.00	2.00	0.304

4.1.4. T Test

As mentioned in the previous chapter, participants were asked in the biographical data questionnaire to indicate (by choosing Yes or No) if they had studied linguistics to check for variables in their responses in comparison to those who reported no prior study of linguistics. This control measure was included to rule out the possibility that the participants' results were influenced by studying Linguistics. Those who had studied Linguistics before may have an advantage over those who had not, which may lead the participants to be able to identify linguistic properties better than those who had not studied it before. The results of this variable were found to be normally distributed in the normality test. Therefore, T test was utilized to find out if there was any significant difference between the means of 'Yes' and 'No'. Table 14 below shows that there was no significant difference between the means of the two sub-groups (p value = 0.455). This result suggests that studying Linguistics did not influence participants' responses³.

Table 14. T Test Results of Studying Linguistics Before

Have you studied Linguistics before?		No.	Mean	Std. Deviation	P value
Total	No	19	1.4811	0.14532	0.455
	Yes	11	1.5202	0.11846	

³ The Arabic group were not included because Arabic is their mother language and studying Linguistics would have no effect in their perception of Arabic phonemes.

Chapter Five

5. Discussion and Conclusion

5.1. General Discussion

In summary, the present results revealed that there were significant differences between the performances of the three speaker groups within the four different phonemic contrasts (see Figure 1 below). The performance of the English group was the worst in the perception of the non-native phonemic contrasts in comparison with the English+ group. Figure 2 below shows that the English+ group outperformed the English group in all four phonemic contrasts, however, the only significant difference between the two groups appears to be in the /ʔ/-/ʕ/ contrast, which suggests that previous exposure to Arabic as an L2 facilitated the accurate perception of the contrasts in question. In comparison, the Arabic group significantly outperformed the English group across all phonemic contrasts (see Figure 3 below). Moreover, the Arabic group significantly outperformed the English+ group across all phonemic contrasts except for the /x/-/χ/ contrast (see Figure 4 below). Thus, the hypothesis of this present study that L1 feature geometry alters L2 perception accuracy of non-native phonemes leading to inaccurate L2 perception of the non-native phonemic contrasts is supported. Additionally, the results of this study provide further support to the findings of Brown (1998) and Matthews & Brown (1998) that Japanese speakers learning English were unable to accurately discriminate between the contrasts /l/-/ɾ/ and /s/-/θ/ which are distinguished by the features [coronal] and [distributed], respectively, both of which are absent in the Japanese feature geometry. As mentioned in the literature review, Brown hypothesized that ‘speakers of a given L1 are only able to perceive those non-native contrasts which are distinguished by a feature present in their L1 grammar’ (1998: 170). So far,

the results of the present study support Brown's hypothesis and present an answer to this study's research questions.

The first research question in this study sought to determine which novel Arabic phonemes will be the least/most problematic to be perceived by adult native speakers of English after first exposure to Arabic. The results of this study suggest that the least problematic L2 non-native Arabic phonemes to perceive are the phonemes /x/ and /ɣ/. This is because despite the fact that they do not exist in English, they are distinguished by the features [dorsal, voice, continuant], all of which are present in the English feature geometry. On the other hand, the most problematic phonemes are /ʕ/ and /ħ/. This is due to the fact that these phonemes are distinguished by the feature [RTR], which is an absent feature in the English feature geometry.

* = the difference between the three groups in each contrast is significant

Figure 1. Significant Differences between the Medians of the Three Speaker Groups (Kruskal-Wallis)

* = significantly different from those columns which lack an asterisk

Figure 2. The English Group and the English+ Group Results

* = significant difference

Figure 3. The English Group and the Arabic Group Results

Figure 4. The Arabic Group and the English+ Group Results

The second research question that was presented by this study was whether the phonological properties that distinguish languages act as a perceptual filter affecting the perceptual capacities of L2 learners. On the basis of the present results, it appears that L1 English phonological properties do act as a perceptual filter that filters the Arabic L2 input causing the Arabic L2 learners to perceive only those sounds that are distinguished by phonological features that are present in English. This perceptual filter seems to be most present at first exposure to L2 Arabic, which is evident in the results of the English group with no prior exposure to Arabic in comparison to the results of the English+ group, who had some exposure to Arabic. Also, the English group poor performance is suggested to be caused by perceiving the non-native contrasts as the most similar L1 sounds (Rochet 1995). Specifically, the participants in the English group appear to perceive the Arabic phoneme /ʕ/ as its closest English counterpart /ʔ/, whereas the Arabic phoneme /ħ/ is perceived as its closest English counterpart /h/.

Once again, the present results are supported by Brown's study of the perception of the English /r-/l/ contrast by Japanese and Chinese listeners (1998). According to Brown, the Chinese learners were able to accurately perceive the English contrast /r-/l/ whereas the Japanese learners were not. This due to the fact that Chinese has the feature [coronal] in the Chinese feature geometry, which is necessary to support this contrast, whereas the Japanese feature geometry does not.

Now we turn to discuss the irregularities that were found in the results regarding the perception accuracy of the /b-/d/ contrast. As mentioned from the beginning of this study, this contrast was included as a control phonemic contrast because both phonemes exist in the phonemic inventory of both English and Arabic. As a result, all the participants across the three different groups were expected to perceive them accurately. Contrary to expectations, however, the English group and the English+ group unexpectedly performed poorly in the /b-/d/ contrast in comparison to the other non-native phonemic contrasts, whereas the Arabic group performed successfully as expected. As can be seen from Table 10 above repeated below as Table 15, while the Arabic group had a perfect median score of 2.00 in the control phonemic contrast /b-/d/ (as well as in the other experimental phonemic contrasts), the English group had a median score of only 1.36, whereas the English+ group was slightly better with a median score of 1.57. Table 15 also shows that the differences between the three groups with respect to the /b-/d/ contrast is significant ($p < 0.001$).

Table 15. Significant Differences between the Medians of the Three Speaker Groups

Phonemic Contrasts	Groups' Medians			
	English	English+	Arabic	P value
/ʔ/-/ʕ/	1.36	1.64	2.00	< 0.001
/h/-/ħ/	1.15	1.30	2.00	< 0.001
/x/-/χ/	1.80	2.00	2.00	0.006
/b/-/d/	1.36	1.57	2.00	< 0.001

It is unclear at this point why the participants in the English and English+ groups performed poorly in the control contrast /b/-/d/. If all the participants in all three groups performed equally poorly in the control contrast /b/-/d/, then one might argue that there was a problem with the experiment itself. Nevertheless, the fact that the performance of the participants in the Arabic group was perfect in the control contrast /b/-/d/ (and for that matter in all of the three experimental contrasts) is a strong indication that the experiment in and of itself was not flawed. Thus, the unexpected poor performance of the English group and the slightly better performance of the English+ group cannot be attributed to a flaw or weakness in the experiment itself (Figure 5 below).

Figure 5. The Results of /b/-/d/ Contrast

A possible explanation for this might be that although /b/ and /d/ exist in the phonemic inventory of both English and Arabic, however, it is conceivable that there may be some fine or subtle phonetic/acoustic differences between these phonemes in each language which caused the English and English+ groups to perform poorly since all of the test items were produced by a native speaker of Arabic. This explanation is supported by the fact that the English+ group performed better in the control /b/-/d/ contrast (and in all of the three experimental contrasts as well) compared to the English group, which is a strong indication that prior exposure to Arabic played a positive role in the perception of both the control contrast and the experimental contrasts. This rather unexpected finding is one of the advantages of comparing first exposure learners with learners with prior exposure in a first exposure study.

It must be noted, however, that this remains inconclusive at this point and requires further research and analysis. Specifically, further research should be undertaken to investigate the differences between /b/ and /d/ in English and Arabic. The investigation may also be extended to cover all the phonemes that are shared between the two languages. This may shed some light on what phonemes may be used as a control contrast in future studies.

5.2. Conclusion

The present study was an attempt to replicate Brown (1998) and Matthews and Brown's study (1998) of Japanese and Chinese speakers' perception of selected L2 English sounds in an AX discrimination task. The key strengths of the present study are twofold. Firstly, eight Arabic phonemes (/b, d, x, ɣ, ʔ, ʕ, h, and ħ/) were carefully selected to test for the effects of English L1 feature geometry on the perception of Arabic L2 phonemes. These Arabic sounds were divided into three groups. The first group consisted of phonemes that exist in English and Arabic, i.e., /b/-/d/. The second group consisted of

phonemes that do not exist in English but are distinguished by features that are present in English, i.e., /x/-/ɣ/. The third group consisted of the phonemic contrasts /ʔ/-/ʕ/ and /h/-/ħ/ that are distinguished by an absent feature in English [RTR], even though /ʔ/ and /h/ are present in English as phonemes.

The second strength of this study is that it compared the perception of native speakers of English who have never been exposed to Arabic with that of native speakers of English who reported prior exposure to Arabic in a first exposure study. The purpose of this is to compare the results of the two groups at L2 Arabic initial exposure. As previously mentioned, there is no study so far that has attempted such a comparison of L1 and L2 feature geometries and L2 perception of non-native sounds in a first exposure study. Thus, it is hoped that this study contributes to our knowledge of this essential aspect of L2 acquisition and serves as a base for future studies.

Overall, the results obtained have reaffirmed Brown's model of L2 speech perception and L1 feature geometry (1998). That is, the perception of L2 non-native contrasts is constrained by the phonological features present in the learners' L1 feature geometry. The Arabic control group, as expected, demonstrated the highest level of success in identifying all of the selected eight Arabic phonemes in the AX discrimination tasks. Additionally, the results of the English+ group (with prior exposure to Arabic) revealed a level of awareness of the target sounds as compared to the results of the English group. This seems to support Brown's argument for the establishment of a new feature geometry of the L2 as learners are trained to distinguish the phonemic features that are distinctive in the L2. According to Brown (1998), high-level learners can be taught to discriminate and distinguish sounds in the L2 category where, over time, a new feature geometry for the L2 sounds will be established within the learners' linguistic system. As for the English group (with no prior exposure to Arabic), their performance was the worst in the

perception of the non-native phonemic contrasts in comparison with the English+ group. Once again, this confirms Brown's (1998) argument that L1 feature geometry filters the L2 input and eliminates the ability to perceive cues in the acoustic signal, and that the L2 initial state is the L1 phonological structure. That is, L1 feature geometry is the starting point of L2 acquisition.

As mentioned in the literature review, L2 perception at first exposure is equal to that of L1 (Escudero 2005) and that the perception of L2 non-native contrasts is constrained by the phonological features of L1. The present study revealed that English learners of Arabic as L2 at first exposure to Arabic were constrained by English L1 feature geometry, which acted as the initial L2 phonological system. Moreover, they were able to accurately perceive the /x/-/ɣ/ contrast more than the /ʔ/-/ʕ/ and /h/-/ħ/ contrasts because the former contrast is differentiated by a feature present in the English feature geometry, i.e., [dorsal, voice, continuant]. On the other hand, the /ʔ/-/ʕ/ and /h/-/ħ/ contrasts were not accurately perceived by the English learners of Arabic because of the absence of the relevant necessary phonological feature in English, i.e., retracted tongue root [RTR].

The results of the AX discrimination task of the phonemic contrasts /ʔ/-/ʕ/ and /h/-/ħ/ obtained from the three speaker groups (English, English+, and Arabic) confirmed the hypothesis of this study that native English speakers do in fact find the most difficulty in perceiving novel Arabic sounds which consist of feature(s) absent in the feature geometry of the L1 English, viz., [RTR]. Likewise, the results obtained from the three speaker groups with respect to the phonemic contrast /x/-/ɣ/ confirmed the hypothesis of this study that native English speakers do not encounter difficulties in perceiving novel Arabic sounds which consist of feature(s) present in the feature geometry of the L1 English, viz., [dorsal, voice, continuant].

It must be noted also that the significant difference between the performance of the English and English+ groups in this first exposure study suggests that the L2 perception of adult learners gradually adjust to match that of the targeted L2 (Escudero 2005). These results generally suggest that adult learners with no prior exposure to L2 could acquire some of the L2 phonological representation, which is consistent with the results of other studies of first exposure studies such as Gullberg et al. (2010). The present results are also consistent with the findings of Onishi et al. (2002) who tested whether phonotactic regularities that are not present in English could be acquired by adult English speakers after first exposure. Their findings demonstrated that phonotactic constraints are rapidly learned from brief auditory experience and that some constraints are more easily learned than others.

As previously mentioned, there are two opposing point of views regarding the perception of L2 sounds. On the one hand, Best (1995), Kuhl (2000), Lado (1957), and Brown (1998, 2000) argue that difficulties in learning a novel L2 phoneme is linked to the absence of this phoneme in the learners' L1. Flege (1995), on the other hand, argues that novel phonemes can be easily acquired while similar phonemes are difficult to be acquired. The findings of the present study are consistent with the first view, particularly Brown's PIM and L1 feature geometry (1998, 2000).

Given the different point of views of L2 perception and their findings, it is clear that adult L2 learners, constrained by their language-specific perception, encounter significant L2 perceptual difficulties and that some of these difficulties may persist over a period of time (Strange & Shafer 2008). Nevertheless, understanding the nature of such L2 perceptual difficulties at first exposure and predicting which L2 sounds will be the least/most difficult to be perceived in comparison with a given L1 are key to provide insight on

the nature of L2 acquisition, and also on adult L2 learners' performance difficulties and the factors that influence the degree of L2 foreign accents. Identifying such problems is equally appreciated by L2 teachers and learners as it opens new opportunities in designing L2 learning experiences that are specifically tailored to a particular L2 learners of a given L1, which in turn facilitates L2 acquisition (Piske, MacKay and Flege 2001). Clearly, this has implications on the pedagogical approaches of language teaching methodologies depending on the difference between different L1s and L2s. It is, therefore, hoped that this study will provide some insight into the initial state of Arabic L2 learning by English native speakers.

5.2.1. Limitations and Future Recommendations

One source of weakness of this study which might have affected the results is the small sample size of participants. That is, a larger sample size may have produced different and more statistically representative results. An additional weakness of this study is the fact that the testing conditions were uncontrolled for as participants took the test online at their own convenience. Thus, there might be some external factors (such as noise, sound quality, etc.) which might have affected their performance.

In light of the weaknesses of this study, it is, thus, recommended that future studies should take into account including a larger sample size. In addition, it is recommended that testing be carried out in a controlled computer lab environment to eliminate any factors that might affect the performance of the participants. In addition, future studies are recommended to design experiments which incorporate speech production tasks. This might yield invaluable data which may further reaffirm Brown's hypothesis. It might also be interesting for future research to conduct longitudinal studies to investigate

and document the progress of English learners of Arabic from the L2 initial state to L2 ultimate attainment.

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Appendices

Appendix 1: Standard Arabic Phonemic Inventory (Consonants)

	Stop	Affricate	Nasal	Fricative	Trill	Approximant
Bilabial	b		m			w
Labiodental				f		
Interdental				θ	ð	
				<u>ð</u>		
Dental	t d					
	<u>t</u> <u>d</u>					
Alveolar			n	s	z	r
				<u>s</u>		
Palatoalveolar		dʒ		ʃ		
Palatal						j
Velar	k					
Uvular	q			χ	ʁ	
Pharyngeal				ħ	ʕ	
Glottal	ʔ			h		

Note. Underlining represents emphatic consonants. Phonemes to the left in pairs are voiceless.

Adapted from: Ingham (1994) and Watson (2007)

Appendix 2: English Phonemic Inventory (Consonants)

	Stop	Affricate	Nasal	Fricative	Central approximant	Lateral approximant
Bilabial	p b		m		w	
Labiodental				f v		
Dental				θ ð		
Alveolar	t d		n	s z		l
Palatoalveolar		tʃ dʒ		ʃ ʒ		
Retroflex					ɻ	
Palatal					j	
Velar	k g		ŋ			
Glottal				h		

Note. Phonemes to the left in pairs are voiceless.

Adapted from: Ladefoged (2001)

Appendix 3: Minimal Pairs

Table 1. /b/ and /d / Minimal Pairs

Item No. in Test	IPA of Test Pair	Gloss	Arabic Pair	Correct answer
2	baab/daab	door/snake	باب/داب	Different
8	baar/daar	obedient/house	بار/دار	Different
15	baan/daan	occur/near	بان/دان	Different
19	biir/diir	well/town	بير/دير	Different
25	buur/duur	heath/houses	بور/دور	Different
31	balal/dalal	wet/pamper	بلل/دلل	Different
35	ball/dall	wet/lead	بل/دل	Different

Table 2. /x/ and /y/ Minimal Pairs

Item No. in Test	IPA of Test Pair	Gloss	Arabic Pair	Correct answer
5	xaab/yaab	disappoint/absent	خاب/غاب	Different
10	xadar/yadar	dizzy/betray	خدر/غدر	Different
14	xaali/yaali	empty/expensive	خالي/غالي	Different
17	xeer/yeer	goodness/other	خير/غير	Different
24	xaliil/yaliil	friend/thirst	خليل/غليل	Different
27	xalal/yalal	malfunction/cuffs	خلل/غلل	Different
29	xilaal/yilaal	through/crops	خلال/غلل	Different
38	xaar/yaar	weaken/attack	خار/غار	Different
43	xafiir/yafiir	soldiers/numerous	خفير/غفير	Different
44	xuus/yuus	bamboo/dive	خوص/غوص	Different

Table 3. /h/ and /h/ Minimal Pairs

Item No. in Test	IPA of Test Pair	Gloss	Arabic Pair	Correct answer
4	haal/haal	cardamom/condition	هال/حال	Different
9	haan/haan	to ease/due time	هان/حان	Different
12	hadzar/hadzar	to desert/rock	هجر/حجر	Different
16	haram/haram	pyramid/campus	هرم/حرم	Different
20	haadi/haadi	quiet/one	هادي/حادي	Different
22	hazam/hazam	defeated/decided	هزم/حزم	Different
33	haam/haam	wander/hover	هام/حام	Different
36	habb/habb	blow/seed	هب/حب	Different
39	hala/hala	proper noun/dessert	هالا/حالا	Different
42	haamil/haamil	cast off/pregnant	هامل/حامل	Different
45	huruub/huruub	escape/wars	هروب/حروب	Different

Table 4. /ʔ/ and /ʕ/ Minimal Pairs

Item No. in Test	IPA of Test Pair	Gloss	Arabic Pair	Correct answer
1	ʔeeʃ/ʕeeʃ	what/rice	ايش / عيش	Different
3	ʔamr/ʕamr	order/proper noun	أمر / عمرو	Different
7	ʔadʒal/ʕadʒal	destiny/rush	أجل/عجل	Different
11	ʔaθar/ʕaθar	trail/found	أثر/عثر	Different
18	ʔayn/ʕayn	where/eye	أين/عين	Different
23	ʔuufi/ʕuufi	paid/healed	أوفي/عوفي	Different
26	ʔibar/ʕibar	needles/examples	إبر/عبر	Different
30	ʔalam/ʕalam	pain/flag	ألم/علم	Different
34	ʔamad/ʕamad	duration/pillar	أمد/عمد	Different
37	ʔamal/ʕamad	hope/work	أمل/عمل	Different
40	ʔasaf/ʕasaf	regret/tamed	أسف/عسف	Different

Table 5. Identical Pairs

Item No. in Test	IPA of Test Pair	Gloss	Arabic Pair	Correct answer
6	baan/baan	occur/occur	بان/بان	Same
13	duus/duus	stump/stump	دوس/دوس	Same
21	ʕamad/ʕamad	pillar/pillar	عمد/عمد	Same
28	huruub/huruub	escape/escape	هروب/هروب	Same
32	ʔafiir/ʔafiir	numerous/numerous	غفير/غفير	Same
41	ʔajn/ʔajn	where/where	أين/أين	Same

Appendix 4: IPA Transcription of the Arabic Weather Report

1. أعزائي مشاهدي طقس العرب
1. ʔaʕizzaʔi muʕaahidi ʔaqs alʕarab
2. أسعد الله أوقاتكم بكل خير
2. ʔasʕad allahu ʔawqaatakum bikulli xajr
3. نتابع معكم آخر التطورات حول العاصفة الإستوائية أشوبا
3. nutaabiʕ maʕakum ʔaaxir attaʔawuraat hawl alʕaaʕifa lʔistiwaawʔijja ʔaʕuuba
4. حيث نلاحظ من خلال صور الغيوم الملتقطة والمستلمة نهار اليوم الثلاثاء لدى طقس العرب
4. hayθ nulaaħið min xilaal ʕuwar alyujuum almultaqaʔa wa lmustalama nahaar alyawm aθθulaθaaʔ lada ʔaqs alʕarab
5. استمرار تواجد هذه العاصفة التي باتت الغيوم المرافقة لها تغطي أجزاء واسعة وكبيرة من بحر العرب
5. istimraar tawaadzud haaðihi lʕaaʕifa llati baatat alyujuum almuraafiqa laha tuyatʔi ʔadzʕaaʔ waasiʕa wa kabiira min baħr alʕarab
6. ونلاحظ أيضاً أن بعض السحب العالية التي تدور حول هذه العاصفة ظهرت في أجواء سلطنة عمان وبعض مناطق الإمارات
6. wa nulaaħið ʔajðan ʔanna baʕð assuħub alʕaalija allati taduur hawl haaðihi lʕaaʕifa ðaharat fi ʔadzʕaaʔ salʕanat ʕumaan wa baʕð manaaʔiq alʔimaraat
7. ولكنها سحب غير ماطرة وهي بعيدة عن ما يحدث في قلب حالياً فوق بحر العرب في قلب العاصفة

7. wa laakinnaha suhub yajr maatira wa hja bafiida fan ma jahduθ fi qalb
haalijjan fawq baħr alṣarab fi qalb ilṣaaṣifa

8. أما بالنسبة لمسار العاصفة أشوبا فنلاحظ أو المناطق أيضاً المحتمل أن تتأثر بها حسب آخر
التحديثات

8. ʔamma binnisba limasaar ilṣaaṣifa ʔafuuba fanulaahið ʔaw almanaatiq
ʔajdan almuħtamal ʔann tataʔaθθar biha ḥasab ʔaaxir attaħdiiθaat

9. نلاحظ أن العاصفة قد تحركت خلال الأربع وعشرين ساعة الماضية باتجاه الشمال الغربي

9. nulaahið ʔann alṣaaṣifa qadd taħarrakat xilaal alʔarbaṣ wa ṣifriin saaṣa
lmaaḏija bittidzaah affjamaal alyarbi

10. أي مابين يوم الإثنين واليوم الثلاثاء تحركت باتجاه الشمال الغربي

10. ʔaj ma bajn jawm alʔiθnayn wa ljawm aθθulaθaaʔ taħarrakat bittidzaah
affjamaal alyarbi

11. ويتوقع حسب بيانات وخرائط النماذج العددية المشغلة لدى طقس العرب استمرار حركتها
بنفس الإتجاه أي باتجاه الغرب والشمال الغربي

11. wa jutawaqaṣ ḥasab bajanaat wa xaraaʔiṭ annamaaḏidz alṣadadija
almuḥayyala lada ṭaqs alṣarab istimraar ḥarakatha binafs alʔittidzaah ʔaj
bittidzaah alyarb wa affjamaal alyarbi

12. حيث تقترب أكثر من السواحل العمانية يومي الأربعاء والخميس

12. ḥajθ taqtarib ʔakθar min assawaahil alṣumaanijja jawmaj alʔarbiṣaaʔ
wa alxamiis

13. ونلاحظ من خلال الخارطة أن أغلب التأثيرات الرئيسية التي تنتج عن هذه الحالة الجوية
ستؤثر على أجزاء من سلطنة عمان بمشيئة الله

13. wa nulaahið min xilaal alxaarta ?ann ?aylab atta?ðiiraat arra?iisijja allati tantud? ?an haaðihi lhaala ldzawwijja satu?a00ir ?ala ?adzxaa? min sal?anat ?umaan bima?i?at illah

14. حيث يُتوقع أن تتكاثر السحب يومي الأربعاء والخميس

14. haj0 jutawaqqa? ?ann tatakaa0ar assuhub jawmaj al?arbi?aa? wa alxamiis

15. وأن تزداد فرصة هطول الأمطار

15. wa ?ann tazdaad fur?at hu?uul al?am?aar

16. الأمطار ستكون متفاوتة الغزارة والشدة على الأجزاء الجنوبية والشرقية من سلطنة عمان

16. ?al?am?aar satakuun mutafaawitat alyazaara wa f?idda ?ala l?adzxaa? aljanuubijja wa ffarqijja min sal?anat ?umaan

17. كما يُتوقع حدوث نشاط على الرياح

17. kama jutawaqqa? huduu0 nafaat ?ala rriyaah

18. وحدث أيضاً اضطراب في البحر

18. wa huduu0 ?ajdan id?iraab fi lbahar

19. وارتفاع للأمواج على طول سواحل سلطنة عمان

19. wa rtifaa? lil?amwaad? ?ala ?uul sawaahil sal?anat ?umaan

20. وأيضاً ارتفاع الأمواج في منطقة السواحل الإماراتية المطلة على بحر عمان

20. wa ?ajdan irtifaa? al?amwaad? fi mantiqat assawaahil al?imaaraatijja almu?illa ?ala ba?r ?umaan

21. ويظهر من خلال آخر التحديثات أن دولة الإمارات ستكون بعيدة عموماً عن التأثيرات المباشرة لهذه العاصفة

21. wa yaðhar min xilaal ʔaaxir attahdiiθaat ʔann dawlat alʔimaaraat
satakuun baʕiida ʕumuuman ʕan attaʔθiiraat almubaafira lihaaðihi lʕaaʕifa

22. وسيُقتصر تأثيرها على شكل اضطراب البحر

22. wa sajuqtaʕar taʔθiiraha ʕala ʕakal idʔraab albaħar

23. وارتفاع الأمواج على السواحل الشرقية المطلة على بحر عمان

23. wa rtifaaʕ alʔamwaadʕ ʕala ssawaahil aʕʕarqijja almuṭilla ʕala baħar
ʕumaan

24. ونشاط الرياح وأيضاً إثارة الأتربة والغبار مما يؤدي إلى تدني الرؤية

24. wa naʕaaṭ arrijaah wa ʔajḍan ʔiθaarat alʔatriba wa lyubaar mimma
juʔaddi ʔila tadanni rruʔja

25. وأيضاً تزايد فرصة تشكل سحب ركامية على الجبال الشرقية وبعض المناطق الصحراوية
الداخلية

25. wa ʔajḍan tazaajid furʕat tafakkul suħub rukaamijja ʕala ldʕibaal
aʕʕarqijja wa baʕḏ almanaatiq aʕʕaħraawijja addaaxilijja

26. هذه الحالة الجوية تستدعي إطلاق سلسلة من التحذيرات لسلطنة عمان

26. haaðihi lhaala ldʕawwijja tastadʕi ʔiṭlaaq silsila min attahðiiraat
lisaltanat ʕumaan

27. من هذه التحذيرات أول شيء

27. min haaðihi ttahðiiraat ʔawal ʕay

28. من خطر تشكل السيول وحدوث الفيضانات نتيجة لشدة الهطول في الأجزاء الجنوبية
والشرقية من السلطنة

28. min xaṭar tafakul assuyuul wa ħuduuθ alfajaðaanaat natiidʕa lijiddat
alhuṭuul fi lʔadʕzaaʔ aldʕanuubijja wa ʕʕarqijja min assaltana

29. إثنين من خطر شدة سرعة الرياح وما قد ينتج عنها من أضرار
29. ʔiθnajn min xaṭar ʃiddat surʕat arrijaah wa maa qadd jantudʒ ʕanha min ʔaḏraar
30. الخطر الثالث خطر ارتداد البحر نتيجة لارتفاع الأمواج الناجمة عن الرياح القوية
30. ʔalxaṭar aθθaaliθ xaṭar irtijaad albaḥar natiidʒa lirtifaaʕ alʔamwaaḏʒ annaadʒima ʕan arrijaah alqawijja
31. والخطر الرابع هو تدني مدى الرؤية الأفقية نتيجة الغبار والأتربة المثار
31. ʔalxatar arraabiʕ huwa tadanni mada rruʔja lʔufuqijja natiidʒat alyubaar wa lʔatriba lmuḥaara
32. هذه الحالة الجوية وبناءً على ما تقدم ننصح جميع الجهات المعنية أخذ الإجراءات اللازمة مبكراً
32. haaḏihi lḥaala lḏawwijja wa binaaʔan ʕala ma taqaddam nanṣaḥ ḏʒamiiʕ aldʒihaat almaʕnijja ʔaxḏ alʔidʒraaʔaat allaazima mubakkiran
33. أعزائي المشاهدين بإمكانكم متابعة آخر التحديثات عبر موقعنا الإلكتروني ArabiaWeather.com
33. ʔaʕizzaʔi lmuʕaahidiin biʔimkaanikum mutaabʕat ʔaaxir attahdiiḥaat ʕabr mawqiʕina lʔilikuruuni ʔarajbija waḏar dot kom
34. بالإضافة لتطبيق طقس العرب الخاص بالهواتف الذكية
34. bilʔiḏaafa litatʔbiq ʔaqs alʕarab alxaaʕ bilhawaatif aḏḏakijja
35. وصفحاتنا على مواقع التواصل الاجتماعي
35. wa ʕafaḥaatina ʕala mawaaqiʕ attawaaʕul alʔidʒtimaaʕi
36. دمت في أمان الله وشكراً لكم
36. dumtum fi ʔamaan illah wa ʔukran lakum

Appendix 5: Occurrences of the investigated phonemes in the input

Phoneme	No. of Occurrences	Phoneme	No. of Occurrences
/ʔ/	94	/ʕ/	73
/h/	40	/ħ/	51
/x/	21	/y/	14
/b/	72	/d/	45

Appendix 6: English translation of the Arabic weather report

1. Dear viewers of Arab weather
2. May God bless your day.
3. Together we will follow on the Latest developments of the tropical storm Ashoba.
4. As can be seen from the images captured and received today at Arab Weather of the gathering clouds;
5. The storm continues as the accompanying clouds cover most of the Arabian Sea.
6. Moreover, most of these high clouds, which circle around the storm, have been seen in the Sultanate of Oman and some areas of the United Arab of Emirates.
7. However, these clouds are unlikely to carry rain, as they are far away from the heart of the storm over the Arabian Sea.
8. As the for the path of the storm, it is expected that the areas that are likely to be affected by the storm according to the latest updates;
9. we can see that the storm has moved during the past 24 hours towards the northwest
10. That is between Monday and Tuesday it moved toward the northwest.
11. and it is expected, according to data and numerical maps models powered by Arab weather, that the storm will continue to move in the same direction, towards the west and northwest
12. It is expected to reach the Omani coast on Wednesday and Thursday
13. where the most impacts from this weather condition will affect parts of the Sultanate of Oman, God's willing.
14. more clouds are expected to gather on Wednesday and Thursday
15. increasing the chances of rainfall.

16. rainfall intensity will vary on the southern and eastern parts of the Sultanate of Oman.
17. Also wind speed is going to be over the standard speed.
18. also sea level is expected to rise
19. with higher waves along the coasts of Sultanate of Oman
20. and along the Emirates coast and the Sea of Oman
21. The latest updates show that the Emirates will generally be far from the immediate effects of this storm.
22. the impact would be limited to higher sea level and higher waves
23. on the east coast.
24. However, wind speed will cause dust storms that will lead to as low visibility
25. which will increase the possibility of forming more clouds over the eastern mountains and some of the desert areas.
26. This weather condition calls for launching a series of warnings over the Sultanate of Oman. The first warning is
27. the danger of the rains and floods as a result of heavy precipitation in the southern and eastern parts of the Sultanate
28. Second: the danger of the intensity of the wind speed and the damages that may result from it.
29. The third: from going to the sea as it will be a dangerous as result of high waves and strong wind
30. and the forth is; low visibility as a result of the dust and dirt.
31. we advise all concerned to take precautions measures
32. Dear viewers, you can follow-up on the latest updates via our website arabiaweather.com
33. Also the Arab's weather app for smartphones.
34. And our pages in social media.
35. May God keep you all safe and thank you.

Appendix 7: Consent Form, Biographical Data, and Testing (items 1 and 2 are examples)

Dear participants,

This questionnaire forms part of an MA study of Second Language Acquisition. Your participation is greatly appreciated and your anonymity and confidentiality is assured.

*** Required**

Consent *

I agree that the answers I submit to this questionnaire as well as any information I provide about my age group, gender and locality can be used for an MA student project conducted in the School of English Literature, Language and Linguistics at Newcastle University. I understand that my participation is anonymous and voluntary, and that I receive no payment for my participation.

☐ I agree

Personal Data

1. Gender *

- ☐ Male
- ☐ Female

2. Age *

- ☐ 18-24
- ☐ 25-34
- ☐ 35-44
- ☐ 45-60

3. What is your first language? *

☐ English

☐ Arabic

☐ Urdu

☐ Other:

4. Do you speak or have knowledge of any of the following languages as your second language?

☐ Arabic

☐ Urdu

☐ English

5. Please rate your proficiency in the language you have chosen.

☐ Pre-beginner level

☐ Beginner level

☐ Intermediate level

☐ High level

Have you studied Linguistics before? *

☐ Yes

☐ No

Video

Please make sure that your speakers are working properly and that you are in a quiet place before watching the following weather report then answer the following.

...عاصفة اشوبيا الاستوائية

6. How many times did you watch this report? *

☐ 1

☐ 2

☐ Other:

Test

1. Please play the clip once only and decide if the two words you hear are the same or different. *

☐ Same

☐ Different

1

2. Please play the clip once only and decide if the two words you hear are the same or different. *

☐ Same

☐ Different

2

Appendix 8: Normality Distribution Test

Table 1. Normality Distribution Test for /ʔ/ and /ʕ/

		Group	Shapiro-Wilk		
			Statistic	Degree Of Freedom	P value
1.	/ʔ/ and /ʕ/	English	0.923	20	0.114
		English+	0.850	10	0.058
		Arabic	0.311	13	< 0.001

Table 2. Normality Distribution Test for /h/ and /ħ/

		Group	Shapiro-Wilk		
			Statistic	Degree Of Freedom	P value
2.	/h/ and /ħ/	English	0.876	20	0.015
		English+	0.880	10	0.132
		Arabic	0.592	13	< 0.001

Table 3. Normality Distribution Test for /x/ and /χ/

		Group	Shapiro-Wilk		
			Statistic	Degree Of Freedom	P value
3.	/x/ and /χ/	English	0.916	20	0.082
		English+	0.649	10	< 0.001
		Arabic	0.524	13	< 0.001

Table 4. Normality Distribution Test for /b/ and /d/

		Group	Shapiro-Wilk		
			Statistic	Degree Of Freedom	P value
4.	/b/ and /d/	English	0.851	20	0.006
		English+	0.773	10	0.007
		Arabic	0.311	13	< 0.001

Table 5. Normality Distribution Test for the Identical Pairs

		Group	Shapiro-Wilk		
			Statistic	Degree Of Freedom	P value
5.	Identical Pairs	English	0.522	20	< 0.001
		English+	0.640	10	< 0.001
		Arabic	0.446	13	< 0.001