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FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

PERCEPTUAL TRAINING OF ARABIC CONSONANTS IN ENGLISH-SPEAKING QURAN LEARNERS

A thesis submitted in partial fulfillment of

the requirements for the degree of

MASTER OF SCIENCE

in

SPEECH LANGUAGE PATHOLOGY

by

Amanda Smith

2021

To: Dean Ora Strickland
College of Nursing and Health Sciences

This thesis, written by Amanda Smith and entitled Perceptual Training of Arabic Consonants in English-Speaking Quran Learners, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this thesis and recommend that it be approved.

_____
Balaji Rangarathnam

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Iqbal Akhtar

_____
Angela M. Medina, Major Professor

Date of Defense: June 23, 2021

The thesis of Amanda Smith is approved.

_____
Dean Ora Strickland
College of Nursing and Health Sciences

_____
Andrés G. Gil
Vice President for Research and Economic Development
and Dean of the University Graduate School

Florida International University, 2021

DEDICATION

بسم الله الرحمن الرحيم

In the name of God, the Compassionate, the Merciful

This work is dedicated to the one God. May the efforts of all the lovers of the Holy Quran be accepted.

ACKNOWLEDGMENTS

I bear witness that there is no god but God and the Muhammad is his messenger. This work would not have been possible without blessings and permission of God, and I am humbled to be in His service.

I would like to extend my appreciation to Dr. Mohiaddin Mesbahi, the director of the Mohsin and Fauzia Jaffer Center for Muslim World Studies for supporting this project. His efforts to secure funding and share this study throughout the South Florida Muslim community made this effort possible. I would also like to extend thanks to the Islamic Jaffaria Association of Miami for their support in funding the project and assistance in finding participants for this study. Their support greatly impacted the overall quality and outcomes of this research.

To the members of my committee, I appreciate their support not only while writing this thesis, but throughout my 0entire graduate program. Their guidance has enabled me to grow as an intellectual and a professional.

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I have grown both personally and professionally while conducting this study, and in sha Allah, I hope to continue to serve learners of the Quran through speech language pathology.

ABSTRACT OF THE THESIS

PERCEPTUAL TRAINING OF ARABIC CONSONANTS IN ENGLISH-SPEAKING QURAN LEARNERS

by

Amanda Smith

Florida International University, 2021

Miami, Florida

Professor Angela M. Medina, Major Professor

In the Muslim community, accurate perception of classical Arabic phones is of importance in order to understand and recite the Quran, which is read, studied, and recited in its original language. High variability phonetic training (HVPT) develops new phonemic categories by exposing learners to a variety of productions of new phonemes. In this study, HVPT therapy was used to train accurate perception of Arabic consonants that do not exist in English. Results indicated significant improvement in perception of Arabic consonants (pretest mean = 58.5%, posttest mean = 64.8%, difference = 6.3%, w-value = 11, z = -1.36). Improvements were specifically seen for the contrasts /d-ḍ/, /k-q/, and /h/ħ/. No significant relationship between HVPT outcomes and language learning variables was found. Overall results of the study indicate the effectiveness of training perception of Arabic contrasts in English-speaking Quran learners.

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I. INTRODUCTION

Quranic Arabic

In the United States, approximately 3.45 million people identify as Muslim. More than half of that population are immigrants, and, aside from English, the most commonly spoken languages within the community are Arabic, Urdu and Farsi (Lipka, 2017). As a small religious community primarily composed of a diaspora, Muslims in the United States are in the process of developing institutions that have existed in Muslim majority regions for centuries such as Islamic educational institutions, where Quranic Arabic and recitation are taught (Khan & Siddiqui, 2017).

Arabic is commonly understood to be the language spoken by Arabs, the dominant ethnic group in the Middle East and North Africa. It is recognized as an official language in twenty different countries, but the reality is that Arabic is not spoken by one ethnic group nor is it truly one language (Holes, 2004). Arabic exists in many forms, some of which may be mutually intelligible and some of which may not. Furthermore, Arabic is spoken, written, and read far beyond the Arab world, functioning as the theological language of Islam (Holes, 2004), a religion practiced by 1.8 billion people globally, comprising nearly one fourth of the world's population (Lipka, 2017).

Arabic, as it is used in the world today, exists in three distinct varieties: colloquial or spoken Arabic, Modern Standard Arabic, and classical or Quranic Arabic. Colloquial Arabic refers to the varieties of Arabic spoken on a daily basis by Arabs. These varieties of Arabic are commonly referred to as dialects of Arabic; however, these varieties may not be mutually intelligible. They are commonly understood to be dialects of the same language due to their similarity in origin as well as a shared cultural foundation between those who speak them. Colloquial Arabic is a spoken language and is

rarely written. To communicate in writing, Arabs utilize Modern Standard Arabic (MSA) (Holes, 2004). MSA functions as a written lingua franca. It unifies the Arab world through writing despite the many variations of spoken dialect. MSA is used in formal contexts such as government speeches, university lectures, and news broadcasts (Holes, 2004). Classical Arabic refers to older varieties of Arabic that constitute the foundation of Arabic literature, the most influential of which is the Holy Quran, the holy book of Islam. In Islamic theology, the Quran was gradually revealed in the dialect of Arabic spoken by the people of Mecca from 610-632 CE. The Quran is considered to be the highest form of Arabic literature and it functions as a religious and spiritual text for Muslims worldwide regardless of their ethnicity or language (Aslan, 2005). This thesis will focus on Quranic Arabic, and the remainder of this paper will use term "Arabic" to refer to classical Arabic.

Preservation of the text has a great deal of significance in Islamic theology. Though many Muslims do not speak any form of Arabic for daily communication and may read translations of the Quran in the language they do speak, it is commonly understood that even the best translations will fail to fully convey the original meaning. Therefore, many Muslims around the world will study Arabic in order to directly access the meaning. This emphasis is not limited to the lexicon or syntax of the text, but also extends to the phonemic system (Boyle, 2004). As a form of worship, Muslims will often recite the Quran out loud using melodic tones. When reciting, maintaining even the phonemic system is considered an important element of preservation of the text and necessary to convey the correct meaning to the listener (Al-Qarashi, 1999). Furthermore, the sound of the Quran itself is believed to have spiritual benefits for both the reciter and

the listener. The Quran is believed to be the exact words of God, and through listening to and reciting the Quran, a Muslim can connect with the divine and earn heavenly rewards (Al-Qarashi, 1999).

All three categories of Arabic, colloquial, MSA, and classical, differ not only in their primary function, but also in lexicon, syntax, and even phonology. Focusing on the differences in phonology, many forms of colloquial Arabic have replaced or lost the phonemes of classical Arabic. For example, spoken Egyptian Arabic has replaced the voiced interdental fricative, /ð/, which exists in classical Arabic, with /z/. Other varieties of spoken Arabic have added phonemes, such as the addition of /p/ in the eastern dialect of Iraqi Arabic. In fact, not a single variety of colloquial Arabic uses the same phonemic inventory as classical Arabic, though they may be very similar (Watson, 2002).

Therefore, the phonemic inventory of Arabic is unique as it is not learned in the same manner as the phonemic inventories of the rest of the world's languages. Typically, the phonemic inventory of classical Arabic is taught in a classroom setting, particularly in Quran classes, as the theological importance of preserving of the text extends not only to syntax and lexicon, but to pronunciation (Boyle, 2004). Many Muslims will choose to undergo courses to improve their pronunciation, often before undergoing study in Arabic grammar or vocabulary (Boyle, 2004). One of the foundational works of Arabic grammar, *Al-Kitaab,* written in the eighth century by the Persian linguist Sibawahi, was specifically written in part to for preserve and teach the Quranic phonemic system. Details on the manner, place, and distinctive features of each phoneme are described in *Al-Kitaab*, explicitly teaching proper articulation (Al Nasser, 1985). Modern Quran teachers will still use the method of explicit articulation instruction (Yahya, 2013). Other

common pedagogical methods include instructing a student to listen to a professional reciter and attempting to imitate them, and having a student recite out loud while the teacher provides active feedback on their production (Boyle, 2004). Though not represented in the literature, the use of robust auditory discrimination training is not a common practice.

Arabic Phonology

The phonemic inventory of Arabic contains eight vowels and 28 consonants. The vowel inventory of Arabic is relatively much smaller than that of English and does not contain productions that vary extensively from English. Arabic has four short vowels and four long vowels, wherein the long vowels differ from the short vowels only in the duration of production: /i, iː, u, uː, a, aː, ɑ, ɑː/. The vowels /ɑ/ and /ɑː/ are used to replace /a/ and /aː/ after the consonants /X, r, ṣ, ḍ, ṭ, ð̣, ʁ, q/ (Tench, 1992; Yahya, 2013).

The consonantal inventory of Arabic (Appendix A) differs from the consonantal inventory of English far more. Arabic utilizes many of the same manners of articulation, containing stops, fricatives, affricates, nasals, laterals and glides. It also utilizes many of the same places of articulation, including labial, labiodental, interdental, alveolar, palatal, velar, and glottal. However, classical Arabic contains several additional consonants that may share places of articulation with English, but vary in manner, as well as entirely different places of articulation such as the uvula and the pharynx (Watson, 1985). Therefore, the Arabic consonantal repertoire has several consonants that do not exist English, whereas English only has two consonants that do not exist in Arabic, /p/ and /v/ (Brustad, et al., 2004). In addition to the places of articulation that exist in Arabic and not English, several Arabic consonants are emphatic. Emphatic consonants are produced in a

place and manner similar to their non-emphatic counterparts: however, the edges of the tongue are raised and articulated with the hard palate (Yahya, 2013) and the pharynx is partially constricted (Scott, 2018). For example, /t/ in Arabic is produced as a voiceless alveolar stop, but the emphatic /ṭ/ is produced with the sides of the tongue on the hard palate and the pharynx partially constricted, creating a more "emphatic" sound (Yahya, 2013; Scott, 2018). A particularly unique consonant of Arabic is the phoneme /ḍ/, an emphatic voiceless alveolar stop, represented by the Arabic letter *ḍaad* (ض). While other Semitic languages, such as Hebrew and Amharic, also utilize emphatic consonants, Arabic is the only language with this phoneme, giving it the name *lughat aḍ-ḍaad*, the language of *ḍaad* (Versteegh, 2001).

Arabic is also unique in its high consonant to vowel ratio (Newman, n.d.). This is hardly surprising considering the morphological structure of Arabic. Words in Arabic are constructed using a root system where three consonants typically compose one root. Roots are generally associated with meaning and are given a specific meaning by inserting the root into predefined morphological patterns. For example, the word "to write" in Arabic is *kataba* and the word for "book" is *kitab*. Both words utilize the same root, /k/-/t/-/b/; therefore, they are related in meaning. However, their specific meaning is derived from the morphological pattern in which the root appears. The word *darasa*, meaning "to study," uses the same morphological pattern as "to write." Each letter of the root in both words is followed by the vowel /a/. By inserting the roots associated with "writing" and "studying" into this form, the verbs "to write" and "to study" are made (Brustad, et al., 2004). The morphological system of Arabic is, in part, why preservation of the phonemic system of the Quran is of such great importance. An error in one speech

sound has the potential to cause a drastic change in meaning. For example, if the pharyngealized consonant in the word /ṭi:n/ were to be replaced by its unpharyngealized counterpart, /ti:n/, the word “clay” would be changed to “fig,” drastically changing the meaning of a verse (Brustad et al., 2004).

Native (L1) English-speaking learners of Arabic will often struggle to produce the speech sounds in Arabic that do not exist in English, but will often misperceive several Arabic phones as well, causing difficulties in both comprehension and in production. This phenomenon is typical in second language (L2) learners past the critical period for language learning (Miyawaki et al., 1975).L1 English-speaking Arabic learners will typically misperceive consonants specific to Arabic, such as misperceiving the pharyngealized consonants as their unpharyngealized counterparts or one speech sound with a similar place or manner of articulation. The most commonly misperceived contrasts are depicted in table 1:

Table 1

Commonly Misperceived Contrasts by L1 English-Speaking Learners of Arabic

International Phonetic Alphabet	Target	ðˤ	dˤ	tˤ	sˤ	Q	ʁ	ħ	ʕ
	Contrast	ð	d	t	s	K	X	h	ʔ
Arabic Alphabet	Target	ظ	ض	ط	ص	ق	غ	ح	ع
	Contrast	ذ	د	ت	س	ك	خ	ه	ء

(Al-Mahmoud, 2013; Hussein, 2007)

L2 Speech Learning and Perception

The speech learning model (Fledge, 1995) addresses problem of second language speech learning past the critical period by considering both production and perception as essential components of the learning process. Speech production is a sensorimotor

process in that phones are produced using articulators within the laryngeal, pharyngeal, and oral cavities. However, if accurate L2 speech production was simply a matter of correct articulatory movements, learners of an L2 would have the capacity to produce native-like speech if their anatomy was typical. Therefore, the speech learning model argues that accurate auditory perception can guide sensorimotor learning needed to produce L2 sounds. Accurate auditory perception is not the only factor in correct articulation, but it does play an important role in the L2 speech learning process (Fledge, 1995).

The sounds of the world's languages are classified into two categories, phones and phonemes. Phones are the sounds physically produced by speakers, whereas phonemes are the psychological representations of sound that serve contrastive functions, differentiating one phone from another to create meaning. For example, in English, the voiceless bilabial stop, /p/, can be produced in an aspirated form, [p^h], as in *pin* or in an unaspirated form, [p], as in the word *spin*. Thus, [p] and [p^h] are phonetic realiations of the phoneme /p/.. If a speaker were to produce *pin* with an unaspirated bilabial stop, or *spin* with one, it would not result in the listener failing to comprehend the message (McGregor, 2009) because the listener comprehends that these productions represent the phoneme /p/. However, the classification of phones and phonemes varies from language to language. Though English classifies both [p] and [p^h] as allophones (variations) of one phoneme, Thai classifies these as two entirely different phonemes. In this case, if a speaker were to produce the unaspirated form in place of the aspirated form, it would result in an entirely different contrast and change the meaning of the word (McGregor, 2009).

Beyond the classification of phonemes and phones, productions of speech sounds vary from speaker to speaker. Though two speakers may speak the same language, their productions will vary. For example, men, women, and children speak at different frequencies with men usually using low frequencies and children using high frequencies - . So, even though a man, woman, and child may speak the same language, their productions will not be the same acoustically (Peterson & Barney, 1952). Peterson and Barney (1952) measured the English vowel productions of 76 speakers(33 adult men, 28 women and 15 children) and found that the frequencies of each production did not remain constant, rather they changed based on age, gender, language background and phonemic context. In addition to frequency, productions can vary due to factors such as voice onset time (Caramazza et al., 1973), nasality, or rate of speech (Small, 2012). However, despite acoustic variation, speakers of the same language are able to consistently perceive each other's speech and comprehend the intended message (Shankwiler et al., 1977). On the surface, this seems counterintuitive. How can listeners perceive a wide variety of acoustic signals as one phoneme? Liberman et al. (1957) theorized that phonemes are not directly related to one acoustic signal, rather, they exist as categories with clear boundaries. Listeners are able to clearly identify differences between /b/, /d/, and /g/, despite variance in acoustic signal, but cannot clearly identify differences in acoustic signals that fall within a phonemic category. Therefore, phonemes are not understood on a continuum of fronted-ness to back-ness, or voiced to voiceless, instead, they are clearly delineated categories of sound (Liberman et al., 1957).

Though native speakers of a language are able to perceive and comprehend a variety of phones and acoustic productions as the phonemes of their L1, nonnative

speakers will often struggle to perceive phonemes that do not exist in their phonemic repertoire when learning a new language after the critical period (Miyawaki et al., 1975). For example, native speakers of English will easily be able to differentiate between /l/ and /ɹ/, but native speakers of Japanese who are learning English as an L2, will frequently struggle to do so as /l/ and /ɹ/ do not exist as distinct phonemes in Japanese. Consequently, both English phonemes would be processed through the perceptual categories of Japanese and as a result be incorrectly perceived (Miyawaki et al., 1975).

High Variability Phonetic Training

Logan, et al. (1991) addressed the problem of acquiring L2 phonemes by developing high variability phonemic training (HVPT). HVPT training is designed to expand phonemic inventories through exposure to variable productions of the target phonemes. This variance in exposure enables a listener to develop a more detailed phonemic category for the target and thereby would enable them to more accurately perceive and comprehend speech sounds that do not exist in their L1.

HVPT was first tested on the /ɹ/- /l/ contrast in Japanese speakers (Logan, et al., 1991). Six Japanese students who lived in the United States between six months and three years were exposed to recordings of different words containing /ɹ/ or /l/ produced by six different speakers, three male and three female. All words were minimal pairs with a target phoneme in a variety of contexts: initial singleton, initial cluster, intervocalic, final singleton and final cluster. Each participant was administered a pretest to determine their baseline discrimination ability. Participants completed fifteen training sessions over the course of three weeks. During each training session, participants listened to recordings of 136 words produced by one of the speakers and was asked to determine if they heard /ɹ/

or /l/ by pressing a response button. Session content included one set of productions by one speaker twice, for a total of 272 trials per training. Participants were exposed to a new set of productions by a new speaker and cycled through five of the six sets of recordings three times during each session. After completing the training, participants were administered one of two posttests using words that had not been tested during training. Three participants were tested using productions by the sixth speaker whom they had not been exposed to during training, and the three other participants were exposed to productions by one speaker whom they had heard during training. Results of the study showed a significant increase in the ability to correctly perceive /ɹ/ and /l/, particularly in initial clusters and in the intervocalic position. Furthermore, participants who were administered the posttest utilizing productions of a speaker whom they had been exposed to during training only performed marginally better than those tested using new productions. The pretest mean of percentage of correct discriminations in all positions was 78.1% and the posttest mean was 85.9% ($F= 38.47$, $p < .005$). In initial clusters, the pretest mean was 58.3% and the posttest mean was 78.1%, and in the intervocalic position the pretest mean was 78.6% and the posttest mean was 87.5% (Logan, et al., 1991).

Logan et al. (1994) further replicated their study; however, they divided their participants into two different groups. One group was exposed to variable productions of the /l/ - /ɹ/ contrast by multiple speakers, and the second group was exposed to only one speaker. Upon administering the posttest, both groups showed improvement in discrimination between the sounds when exposed to a familiar speaker, but the group that was exposed to only one speaker during training was not able to generalize their abilities

to a new speaker. Thus, Logan et al. (1994) determined that exposure to variable productions of a phoneme enabled participants to develop more robust phonemic categories than the participants who were trained with sounds produced by only one speaker .

This study has since been replicated by many researchers using a variety of phonemes from many languages and with many different types of participants. For example, Iverson and Evans (2009) used HVPT to expand the English vowel inventory of Spanish and German L1 speakers, rather than testing a single contrast. Five sessions of HVPT were administered, training 14 vowels and consisting of 225 trials per session. The results of their study showed that German L1 speakers showed more significant improvement in discriminating English vowels after training than Spanish speakers. Iverson and Evans (2009) theorized that it was due to the German vowel inventory being closer in similarity to the English vowel inventory than Spanish. However, both German and Spanish L1 speakers showed improvement after completing HVPT program, as well as retention of the skills they had acquired.

While much of HVPT research has been confined to a laboratory environment. Some researchers aimed to transition HVPT from theory to practice by testing its use as a supplement to an L2 learning classroom. Thomson (2011) developed and an HVPT software for Windows and successfully trained Canadian-English vowels with 22 L1 Mandarin speakers studying English in Canada. He later launched his program as a web based HVPT software, called English Accent Coach (Thomson, 2012).

Burnham (2013) tested the use of HVPT to train the /ħ/-/h/ contrast in L1 English-speaking learners of Modern Standard Arabic. Twenty-four students participated in the

study, with 10 in the test group and 14 in the control. All participants completed a pre and posttest, consisting of 108 stimuli recorded by a male and female speaker. The control group completed an HVPT session consisting of 100 modules over the course of four weeks. Each module tested 12 minimal pairs twice, providing a total of 2,400 trials over the course of the program. Participants who completed the training demonstrated significant gains in the perception of the /ħ/-/h/ contrast.

While Burnham (2013) demonstrated the effectiveness of this method in training the the /ħ/-/h/ contrast in L1 English speakers, HVPT has not been used to train other Arabic contrasts. Similarly, it has not been used specifically to train the consonantal inventory of Quranic Arabic which, though quite similar to Modern Standard Arabic, does contain some differences. Therefore, the purpose of this study is to determine if HVPT successfully trains L1 English-speaking Quran learners to perceive the consonants of Classical Arabic that do not exist in English. Working within the speech learning model, this study would potentially provide the needed auditory discrimination ability needed to succeed in pronunciation training. This study differs from earlier research in that it trains all of the phoneme pairs English-speaking Quran students typically experience difficulty perceiving (Hussein, 2007). Furthermore, it tests the use of the tool in the L1 English-speaking Quran learning population, where there is demand for such a tool due to the theological importance preserving the phonemic system of the Quran.

Research Questions

This study investigates the following research questions and proposes the following hypotheses for each question:

1. In English-speaking Quran learners, is HVPT more effective in training auditory perception of Quranic Arabic consonants than no intervention?

   Hypothesis: HVPT will result in a statistically significant improvement in auditory perception of Quran Arabic consonants in English-speaking Quran learners.

2. Do English-speaking Quran learners more effectively perceive certain phonemic contrasts after undergoing HVPT than others (such as stop consonants compared to fricatives)?

   Hypothesis: There will be a statistically significant difference in perception of certain phonemic contrasts in English-speaking Quran learners after undergoing HVPT.

3. Is there a statistically significant positive correlation between learning language variables (age of first exposure to Arabic, simultaneous bilingualism of English and another non-Arabic second language, etc.) and HVPT training outcomes?

   Hypothesis: There will be a statistically significant positive correlation between learning language variables (simultaneous bilingualism of English and another non-Arabic second language, years learning Arabic, age of first exposure to Arabic, and listening skills) and HVPT training outcomes.

II. METHODS

Research Design

This quantitative study tests the efficacy of an HVPT program designed to improve the perception of Quranic Arabic consonants in L1 English-speaking Quran

students. Pretest and posttest data were collected before and after completion of the training program. The control group did not participate in the HVPT program.

HVPT Program

The pretest (Appendix B) was administered online using Boom cards. Each slide had three audio icons, a target word and two isolated phonemes. The recordings were made by two Quran teachers, one male and one female. 24 minimal pairs or near minimal pairs were tested twice, once using male stimuli and once using female, for a total of 96 trials. Each contrast was tested in CVC, VCV, and VCC syllables and each pair only used the target Arabic phoneme once. No pair included any of the targeted Arabic phonemes except for the intended target.

The HVPT program (Appendix C) was also administered online using Boom cards. Each slide had three audio icons, one recording of a word containing a target phoneme and two recordings of isolated phoneme, one the target and one the contrast. The stimuli were be recorded from five Quran teachers, 2 females and 3 males to create variability. The training consisted of ten sessions, completed within 2 weeks. Each training session used the stimuli from one speaker. Stimuli from each speaker was presented twice, once each week. Each session trained each phoneme in the CVC, VCC, and VCC phonemic environments 4 times each, and only contained one of the Arabic target phonemes, for a total of 192 trials each session and 1,920 total trials.

Participants

20 participants completed the study, 11 in the control group and 9 in the study group. Inclusion criteria for participants was aged 18+, Quran learner, and learned English as a first language the US before the age of 12, and no history of a speech,

language or hearing impairment or disorder. Participants were recruited via word of mouth and a flyer that was shared via email and social media. Potential participants completed an online eligibility screener (Appendix D) and were prompted to provide their email address if interested in participating. Individuals who provided their contact information were provided with a link to an online consent form (Appendix E) and details about the study. Those who consented were directed to complete a language history questionnaire (Li, Sepanski, & Zhao, 2006) and were then sorted into test and control groups. The language history questionnaire collected qualitative data on each participant's language learning background. Participants self-reported if they were monolingual or bilingual and provided details about the context and age at which they learned the languages they know. The time spent listening to the Quran daily was collected using an interval scale, and each participant rated their listening ability in Arabic using a Likert scale where 1 indicated poor listening ability and 7 indicated native or native-like listening ability.

Participants in the control and test groups were matched for age and gender. Participants' ages ranged from 21-52 with a mean age of 34. 16 participants were female and 4 were male. Seven participants reported having learned another language other than Arabic to a native or native-like level before the age of twelve. Three participants reported being fluent in Urdu, one in both Bangla and Hindi, one in Gujarati, one in Farsi and one in Spanish. The consonantal inventories of each of these languages utilize consonants not present in English (Table 2).

Table 2

Non-English Consonants Represented in the Phonemic Inventories of Participants

Language	Consonants not present in English or Arabic
Urdu/Hindi	/pʰ, bʰ, ʈ, ʈʰ, ɖ, ɖʰ , ʈ, ʈʰ ,ɖ, ɖʰ, kʰ, gʰ, mʰ, nʰ ɳ, ɲ, rʰ, ɽ, ɽʰ, ʂ, ɣ, x, ɣʰ, dʒʰ, lʰ, ʋ/
Bangala	/pʰ, bʰ, tʰ, dʰ, ʈ, ʈʰ, ɖ, ɖʰ, c, cʰ, ɟ, ɟʰ, kʰ, gʰ/
Gujrati	/ pʰ, bʰ, tʰ, dʰ, ʈ, ʈʰ, c, cʰ, kʰ, ɖ, ɖʰ, dʒʰ, gʰ, nʰ, ɳ, ɭ/
Farsi	/c, ɟ, G, x/
Spanish	/ɲ, r, x/

(Gorman, n.d.; Barman, 2009; Mistry, 1997; Anousha & Shabani-Jadidi, 2018; American Speech-Language-Hearing Association, n.d.).

Participants reported the years spent learning Arabic between 1-20 years, for a mean of 9.25 years. The ages they started learning Arabic were between 4-49, with a mean age of 22 years. Participants self-rated their listening ability in Arabic on a scale of 1-7, one being low ability and 7 being native-like, between 1 and 3. The mean self-rating was 1.88.

Procedures

Upon being assigned to either the test or control group, participants completed the pretest. Participants were instructed to listen to all three audio files on each slide, then to type which of the two isolated phonemes was represented in the target word. Participants in the test group were then given access to the HVPT. Participants in the test group were instructed to complete only one session over the course of 14 days, allowing four days off. Participants were instructed to listen to all three audio files on each slide of the

HVPT, then to click which phoneme corresponded with the sound depicted in the word. Test-group participants were then asked to complete the posttest 1 day after completing their final HVPT session, while the participants in the control group completed it 15 weeks after taking the pretest. The posttest was administered in the same manner as the pretest. The pre and posttest generated true interval scores, where 0 correlated with 0 answers correct and 96 correlated with 96 answers correct.

Data Analysis

A Wilcoxon signed-rank test was conducted to compare pretest and posttest data. The significance level for all tests conducted in this study was $\alpha = .05$. To determine the relationship between HVPT outcomes and language learning variables, several statistical procedures were conducted. To determine if there was any significant difference in the performance of monolingual participants and participants who were simultaneous bilinguals, the Mann-Whitney U test was conducted. To determine if there was any correlation between the difference in pre and posttest scores and the years spent learning Arabic a least squares regression line test was conducted. A least squares regression line was also conducted to determine if a correlation between the age participants started learning Arabic and the difference between the pre and posttest.

Possible correlation between the time spent listening to the Quran daily was converted to an interval scale, and the difference between the pre and posttest scores, as well as each participant's self-rated listening ability in Arabic, was determined using the Spearman rank correlation coefficient.

III. RESULTS

Results of the pretest indicated high existing ability to perceive the /X-ʁ/ contrast (test group average = 87.01%; control group average = 87.1%). Only two participants of twenty scored substantially below the mean, therefore the /X-ʁ/ contrast data was removed from the results.

Results of a Wilcoxon signed-rank test on pretest and posttest data showed statistically significant improvement in the test group (Table 3) and no significant improvement in the control group, indicating HVPT significantly improved the perceptual abilities of participants and no significant influence of test-retest effects.

Table 3

HVPT Results

	Pretest mean	Posttest mean	Difference	Critical Value	w-value	z-value
Control group	54.5%	56.7%	2.2%	8	11	-1.36
Test group	58.5%	64.8%	6.3%	5	1.5	-2.31

Further analysis of the pre and posttest data indicated significant improvement for certain contrasts and no significant improvement for others. The control group showed no significant improvement in any contrast. Test group results indicated improvement in three contrasts: /ħ-h/, /ḍ-d/ and /q-k/. No statistically significant improvement was indicated in any other contrast. Results for each contrast are depicted in table 4.

The relationship between language learning variables and HVPT outcomes yielded no statistically significant results. Monolingual and bilingual test group

participants had no statistically significant difference in the mean of the difference between their pre and posttest scores (table 5).

No statistically significant relationship between years spent learning Arabic and the difference between pre and posttest scores of the test group was found (table 6). No statistically significant relationship between the age each participant started learning and the difference between their pre and posttest scores was found (table 7). Each participant's self-rated listening skills and difference between pre and posttest scores did not have a statistically significant relationship (table 8). These results indicate no significant relationship between language learning variables and the outcomes of HVPT training. Results for the contrast group were calculated using 10 degrees of freedom, and for the test group 8 degrees of freedom.

Table 4

Results by Contrast

		Pretest mean	Posttest mean	Difference	Critical Value	w-value	z-value
/ħ-h/	Control	48.5%	53%	4.5%	10	22	-.56
	Test	48.1%	56.7%	8.5%	3	1.5	-2.11
/ṣ-s/	Control	50%	49.24%	-0.76%	10	26.5	-0.1
	Test	53.7%	47.22%	-6.48%	8	12	-0.84
/ḍ-d/	Control	58.3%	67.4%	9.1%	9	10	-1.48
	Test	63.9%	76.9%	13%	8	2.5	-2.17
/ṭ-t/	Control	50.76%	59.85%	9.09%	8	9	-1.26
	Test	54.63%	58.33%	3.7%	5	6	-0.4

/ð-	Control	50%	44.70%	-5.30%	9	14	-1.01
ð/	Test	59.26%	62.04%	2.78%	7	11	-0.51
/q-	Control	71.2%	70.5%	-0.76%	8	16	-0.28
k/	Test	75.9%	87%	11.1%	8	2.5	-2.17
/ʕ-	Control	53%	52.3%	-0.8%	9	21.5	-0.12
ʔ/	Test	53.7%	59.3%	5.6%	2	6	-0.94

Table 5

Results in Bilinguals Compared to Monolinguals

	Bilingual difference mean	Monolingual difference mean	z-value	u-value	p-value
Control group	.05%	.01%	.52	15	.3
Test group	8.5%	3.6%	.99	14.5	.16

Table 6

Relationship between Years Learning Arabic and Test Score Difference

	Mean years	Mean score difference	Degrees of freedom	r-value	p-value
Control group	8.91	2.17%	9	.17	.62
Test group	9.67	5.3%	7	.21	.59

Table 7

Relationship between Age Started Learning Arabic and Test Score Difference

	Mean age	Mean score difference	Degrees of freedom	r-value	p-value
Control group	23	2.17%	9	-.07	.84
Test group	21	5.3%	7	-.29	.45

Table 8

Relationship between Self-Rated Listening Skills and Test Score Difference

	Mean self-rating	Mean score difference	Degrees of freedom	r_s-value	p-value
Control group	1.89	2.17%	9	-.83	.01
Test group	1.88	5.3%	6	.36	.38

IV. DISCUSSION

The results of the study indicate that HVPT effectively trained auditory perception of multiple Arabic contrasts in Quran learners. The results of this study are congruent with other HVPT studies, indicating that in addition to being an effective tool to teach contrasts of other languages, HVPT can effectively train Arabic contrasts. Overall improvement in perceptual abilities indicates that HVPT may serve as an effective pedagogical tool. This affirms the results of Thomson (2011) and Burham (2013) who both used HVPT as part of an L2 learning program. In keeping with the speech learning model, this tool can enable learners to develop the auditory discrimination abilities needed to later develop the sensorimotor skills required to

produce accurate Arabic speech sounds within a Quran learning environment. In addition to developing these skills, HVPT in this context may positively contribute to the spiritual experience of the user as well as improve their self-perception and motivation. In feedback to the researchers of this study, one participant expressed that she felt that the program had been beneficial for her and that she would want to undergo more training in the future.

The results also indicate that English-speaking Quran learners more effectively perceive certain phonemic contrasts than others, specifically /ħ-h/, /ḍ-d/, and /q-k/. Consonants from a broad range of places and manners of articulation in the vocal tract were successfully trained. Test group participants were able to accurately perceive the /ḍ-d/ contrast, near the front of the vocal tract, and /ħ-h/ and /q-k/, near the back. Stops, a fricative, and pharyngeal consonants were all successfully perceived post-training. The improvement in perception of the marked Arabic phoneme /ḍ/, indicates the effectiveness of this method even for sounds unique to one language. This study affirms and expands the findings of Burnham (2013), indicating that not only HVPT can successfully train the /ħ-h/ contrast, but that it can be trained in a variety of contexts, not only in the initial position.

Though this study used a similar number of trials as Iverson and Evans (2009), significant results were not seen for several of the contrasts. It is possible that training a wide array of contrasts could have results in more gains with more trials. A key difference between this study and the Iverson and Evans (2009) study was that this study focused entirely on consonants while the other focused on vowels. The wide range of placements and manner of production of the consonants trained in this study, as opposed

to the relatively smaller range of English vowels trained in the other, may require more trials to result in improvement.

No statistically significant correlation between language learning variables, such as bilingualism, first age of exposure to Arabic, or the years spent learning Arabic were indicated by the results of this study. These findings contradict the hypothesis of Iverson and Evans (2009) that learners with larger phonemic inventories than others may experience greater gains when undergoing the same number of HVPT sessions. All of the bilingual participants in this study spoke languages with between 3-27 consonants that do not exist in English. Though both bilinguals and monolinguals in this study improved, there was no significant difference in their overall level of improvement despite the larger consonantal inventory of bilinguals comparted to monolinguals. Greater gains in HVPT training may be more closely related to similarity of a speakers L1 than to the robustness of their phonemic inventory.

A limitation of this study was the variability in audio quality. Due to the Covid-19 pandemic, it was not possible to record the stimuli using tools implemented in other HVPT studies such as a sound-proof room. The Quran teachers who volunteered to record the stimuli did so using their personal devices, which may have resulted in variable audio quality. Furthermore, participants completed the study using their own devices, which may have also resulted in variable audio quality that could have impacted the ability of some participants to clearly perceive the contrasts.

Another limitation was the difficulty in producing consonants in isolation, particularly stop consonants. The volunteers were provided with examples of each phone in isolation prior to recording, however producing sounds in isolation, particularly

consonants, is not a common manner of speaking, and several of the volunteers had to record each phone multiple times. Variance in production of each phone in isolation and the unnaturalness of the production may have impacted the overall effectiveness of the tool for each contrast.

V. CONCLUSION

Overall, this tool successfully resulted in improved perception of Quranic Arabic speech sounds in L1 English-speaking Quran learners. Though improvement was not seen in each contrast trained, the results of this study indicate that this method is effective and reveal how the tool can be improved. Results of this study also indicate that despite the diversity of language learning variables in the Quran learning population, those variables do not confound the effectiveness of HVPT. This study indicates that a more robust consonantal inventory may not necessarily result greater gains from HVPT.

Future Research

Further exploration of the self-perception and motivation of Quran learners after the use of HVPT would be a worthwhile avenue of future research. A study using more advanced and consistent recording tools, increasing the number of trials, or utilizing alternative methods, such as matching target words to written stimuli rather than an isolated phone are also potential areas of future research.

Clinical Implications

This study indicates that HVPT would likely serve as a reliable pedagogical tool within a Quran learning environment. Considering the linguistic diversity of the American Muslim community, a tool such as this one, which has been shown to yield significant results in learners of many different linguistic backgrounds, can serve as a

helpful tool for both learners and Quran teachers. Additionally, HVPT may serve as a useful tool to provide auditory discrimination training as part of the treatment of speech sound disorders.

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Appendix A

	Labial	Labio-dental	Inter-dental		Dental-alveolar		Palatal		Velar	Uvular		Pharyn-geal		Glottal	
Stops	b ب				d د	t ت			k ك	q ق				ʔ ء	
Emphatic					ḍ ض	ṭ ط									
Fricatives		f ف	ð ذ	ɵ ث	z ز	s س	ʤ ج	ʃ ش		ʁ غ	X خ	ʕ ع	ħ ح		h ه
Emphatic			ð̣ ظ			ṣ ص									
Nasals	m م				n ن										
Laterals					r ر l ل										
Glides							j ي		w و						

Appendix B

Pretest/Posttest

Target contrast: h/ ħ

Male stimuli

1. Which sound is in this word?	جَهَدوا	/ʤahadu:/
A. /h/		
B. /ħ/		
2. Which sound is in this word?	حَمَدَ	/ħamada/
A. /ħ/		
B. /h/		
3. Which sound is in this word?	نَجْح	/naʤħ/
A. /h/		
B. /ħ/		
4. Which sound is in this word?	هَمَدَ	/hamada/
A. /ħ/		
B. /h/		
5. Which sound is in this word?	نَجْه	/naʤh/
A. /ħ/		
B. /h/		
6. Which sound is in this word?	جَحَدوا	/ʤaħadu:/
A. /ħ/		
B. /h/		

Female stimuli

7. Which sound is in this word?	جَحَدوا	/ʤaħadu;/
A. /ħ/		
B. /h/		

8. Which sound is in this word?	حَمَدَ	/ħamada/
A. /h/		
B. /ħ/		
9. Which sound is in this word?	نَجْه	/naʤh/
A. /ħ/		
B. /h/		
10. Which sound is in this word?	هَمَدَ	/hamada/
A. /h/		
B. /ħ/		
11. Which sound is in this word?	جَهَدوا	/ʤahadu:/
A. /h/		
B. /ħ/		
12. Which sound is in this word?	نَجْح	/naʤħ/
A. /h/		
B. /ħ/		

Target contrast: /X-ʁ/

Male stimuli

13. Which sound is in this word?	نُغَلّفَ	/nuʁɑllafa/
A. /X/		
B. /ʁ/		
14. Which sound is in this word?	نُسْغ	/nusʁ/
A. /X/		
B. /ʁ/		
15. Which sound is in this word?	نُخَلّفَ	/nuXɑllafa/
A. /X/		
B. /ʁ/		
16. Which sound is in this	غَليل	/ʁɑli:l/

word?

A. /X/

B. /ʁ/

17. Which sound is in this word? خَليل /Xɑlil/

A. /X/

B. /ʁ/

18. Which sound is in this word? نَسْخ /nasX/

A. /ʁ/

B. /X/

Female stimuli

19. Which sound is in this word? نُخَلّفَ /nuXɑllafa/

A. /ʁ/

B. /X/

20. Which sound is in this word? غَليل /ʁɑli:l/

A. /ʁ/

B. /X/

21. Which sound is in this word? نُسْغ /nusʁ/

A. /ʁ/

B. /X/

22. Which sound is in this word? نَسْخ /nasX/

A. /X/

B. /ʁ/

23. Which sound is in this word? خَليل /Xɑli:l/

A. /X/

B. /ʁ/

24. Which sound is in this word? نُغَلّفَ /nuʁɑllafa/

A. /ʁ/

B. /X/

Target contrast: /ṣ-s/

Male stimuli

25. Which sound is in this word?	سُدود	/sudu:d/
A. /s/		
B. /ṣ/		
26. Which sound is in this word?	يُسِرُّونَ	/jusirru:na/
A. /ṣ/		
B. /s/		
27. Which sound is in this word?	يُصِرُّونَ	/juṣirru:na/
A. /ṣ/		
B. /s/		
28. Which sound is in this word?	نَكْص	/nakṣ/
A. /s/		
B. /ṣ/		
29. Which sound is in this word?	مَكْس	/maks/
A. /ṣ/		
B. /s/		
30. Which sound is in this word?	صُدُود	/ṣudu:d/
A. /ṣ/		
B. /s/		

Female stimuli

31. Which sound is in this word?	صُدُود	/ṣudu:d/
A. /ṣ/		
B. /s/		
32. Which sound is in this word?	يُصِرُّونَ	/juṣirru:na/
A. /ṣ/		

B. /s/

33. Which sound is in this word?	نَكْص	/nakṣ/

A. /s/

B. /ṣ/

34. Which sound is in this word?	مَكْس	/maks/

A. /ṣ/

B. /s/

35. Which sound is in this word?	سُدود	/sudu:d/

A. /ṣ/

B. /s/

36. Which sound is in this word?	يُسِرُّونَ	/jusirru:na/

A. /s/

B. /ṣ/

Target contrast: /d-ḍ/

Male stimuli

37. Which sound is in this word?	دُهور	/duhu:r/

A. /ḍ/

B. /d/

38. Which sound is in this word?	مُضِلّ	/muḍill/

A. /ḍ/

B. /d/

39. Which sound is in this word?	ضُهور	/ḍuhu:r/

A. /ḍ/

B. /d/

40. Which sound is in this word?	مُدِلّ	/mudill/

A. /ḍ/

B. /d/

41. Which sound is in this word? فَرْد /fard/

A. /d/

B. /ḍ/

42. Which sound is in this word? فَرْض /farḍ/

A. /d/

B. /ḍ/

Female stimuli

43. Which sound is in this word? دُهور /duhu:r/

A. / ḍ/

B. /d/

44. Which sound is in this word? ضُهور /ḍuhu:r/

A. /d/

B. /ḍ/

45. Which sound is in this word? فَرْد /fard/

A. /ḍ/

B. /d/

46. Which sound is in this word? فَرْض /farḍ/

A. /ḍ/

B. /d/

47. Which sound is in this word? مُدِلّ /mudill/

A. /d/

B. /ḍ/

48. Which sound is in this word? مُضِلّ /muḍill/

A. /ḍ/

B. /d/

Target contrast: /t-ṭ/

Male stimuli

49. Which sound is in this word?	تين	/ti:n/
A. /ṭ/		
B. /t/		
50. Which sound is in this word?	رَبْط	/rɑbṭ/
A. /ṭ/		
B. /t/		
51. Which sound is in this word?	تَرتيب	/tarti:b/
A. /ṭ/		
B. /t/		
52. Which sound is in this word?	تَرطيب	/tarṭi:b/
A. /ṭ/		
B. /t/		
53. Which sound is in this word?	طين	/ṭi:n/
A. /ṭ/		
B. /t/		
54. Which sound is in this word?	رَبْت	/rɑbt/
A. /t/		
B. /ṭ/		

Female stimuli

55. Which sound is in this word?	تَرطيب	/tarṭi:b/
A. /ṭ/		
B. /t/		
56. Which sound is in this word?	تين	/ṭi:n/
A. /t/		
B. /ṭ/		
57. Which sound is in this word?	رَبْط	/rɑbṭ/

A. /t/

B. /ṭ/

58. Which sound is in this word?	رَبْت	/rɑbt/

A. /ṭ/

B. /t/

59. Which sound is in this word?	طين	/ṭi:n/

A. /t/

B. /ṭ/

60. Which sound is in this word?	تَرتيب	/tarti:b/

A. /t/

B. /ṭ/

Target contrast: /ð-ẓ/

Male stimuli

61. Which sound is in this word?	لَمْظ	/lamẓ/

A. /ð/

B. /ẓ/

62. Which sound is in this word?	ظِلّا	/ẓilla:/

A. /ẓ/

B. /ð/

63. Which sound is in this word?	ذِلّة	/ðillah/

A. /ẓ/

B. /ð/

64. Which sound is in this word?	نَبْذ	/nabð/

A. /ð/

B. /ẓ/

65. Which sound is in this word?	نُذِرَ	/nuðira/

A. /ð/

B. /ð/

66. Which sound is in this word? نُظِرَ /nuḍira/

A. /ð/

B. /ḍ/

Female stimuli

67. Which sound is in this word? نُذِرَ /nuðira/

A. /ð/

B. /ḍ/

68. Which sound is in this word? نُظِرَ /nuḍira/

A. /ð/

B. /ḍ/

69. Which sound is in this word? لَمْظ /lamḍ/

A. /ḍ/

B. /ð/

70. Which sound is in this word? ذِلّة /ðillah/

A. /ḍ/

B. /ð/

71. Which sound is in this word? ظِلًّا /nuḍira/

A. /ḍ/

B. /ð/

72. Which sound is in this word? نَبْذ /nabð/

A. /ḍ/

B. /ð/

Target contrast: /k-q/

Male stimuli

73. Which sound is in this word? رُكود /ruku:d/

A. /k/

B. /q/

74. Which sound is in this word?	رُقود	/ruqu:d/

A. /k/

B. /q/

75. Which sound is in this word?	كُرْبَة	/kurbah/

A. /k/

B. /q/

76. Which sound is in this word?	سَبْك	/sabk/

A. /k/

B. /q/

77. Which sound is in this word?	سَبْق	/sabq/

A. /k/

B. /q/

78. Which sound is in this word?	قُرْبَةٌ	/qurbah/

A. /k/

B. /q/

Female stimuli

79. Which sound is in this word?	رُكود	/ruku:d/

A. /q/

B. /k/

80. Which sound is in this word?	سَبْق	/sabq/

A. /k/

B. /q/

81. Which sound is in this word?	سَبْك	/sabk/

A. /k/

B. /q/

82. Which sound is in this	رُقود	/ruqu:d/

word?

A. /q/

B. /k/

83. Which sound is in this word?	قُرْبَةٌ	/qurbah/

A. /k/

B. /q/

84. Which sound is in this word?	كُرْبَة	/kurbah/

A. /q/

B. /k/

Target contrast: /ʕ-ʔ/

Male stimuli

85. Which sound is in this word?	بَدْع	/badʕ/

A. /ʕ/

B. /ʔ/

86. Which sound is in this word?	يُأَمِّلَ	/juʔammala/

A. /ʔ/

B. /ʕ/

87. Which sound is in this word?	بَدْء	/badʔ/

A. /ʕ/

B. /ʔ/

88. Which sound is in this word?	أَرَب	/ʔarab/

A. /ʔ/

B. /ʕ/

89. Which sound is in this word?	عَرَب	/ʕarɑb/

A. /ʔ/

B. /ʕ/

90. Which sound is in this word?	يُعَمِّلَ	/juʕammala/

A. /ʔ/

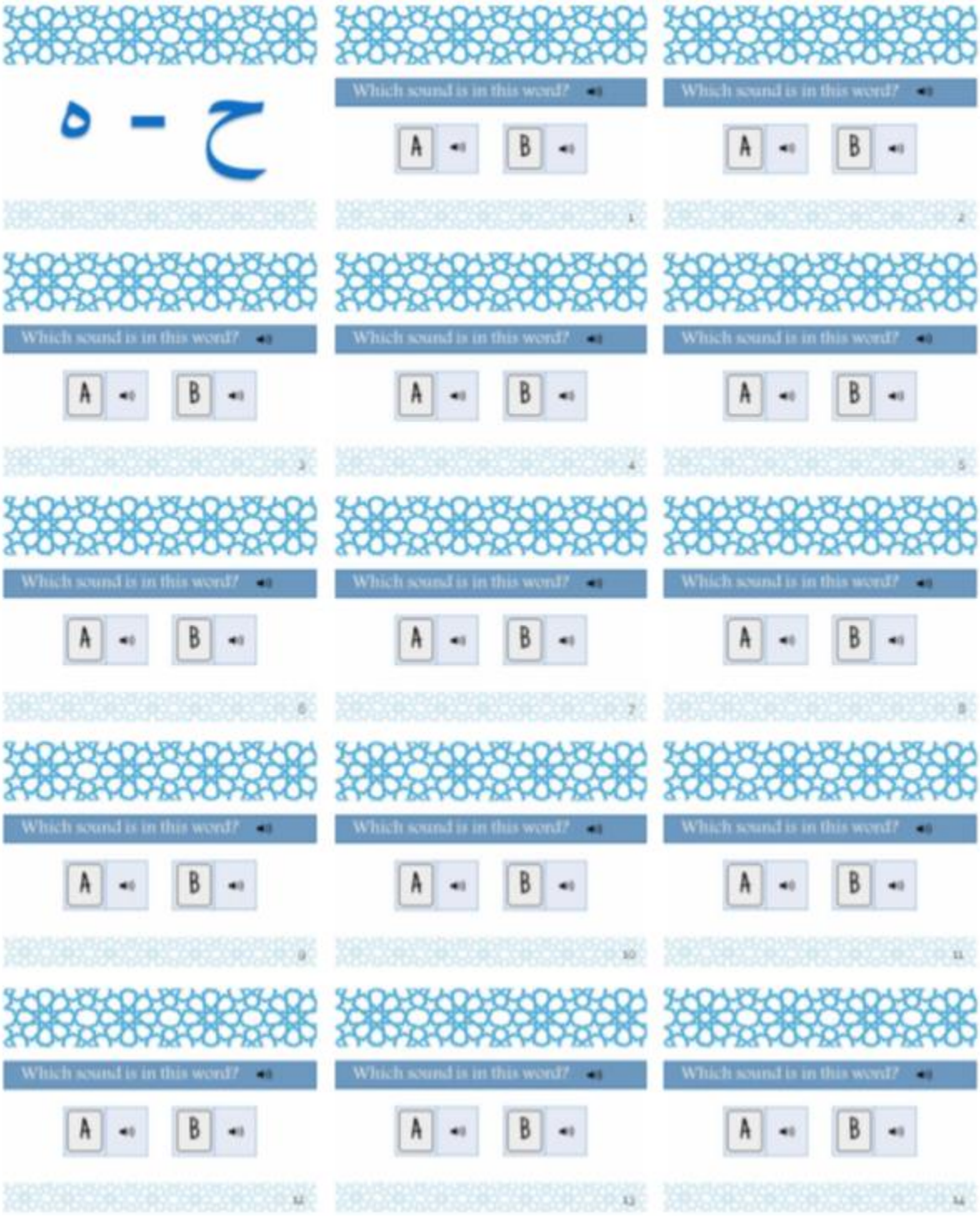
B. /ʕ/

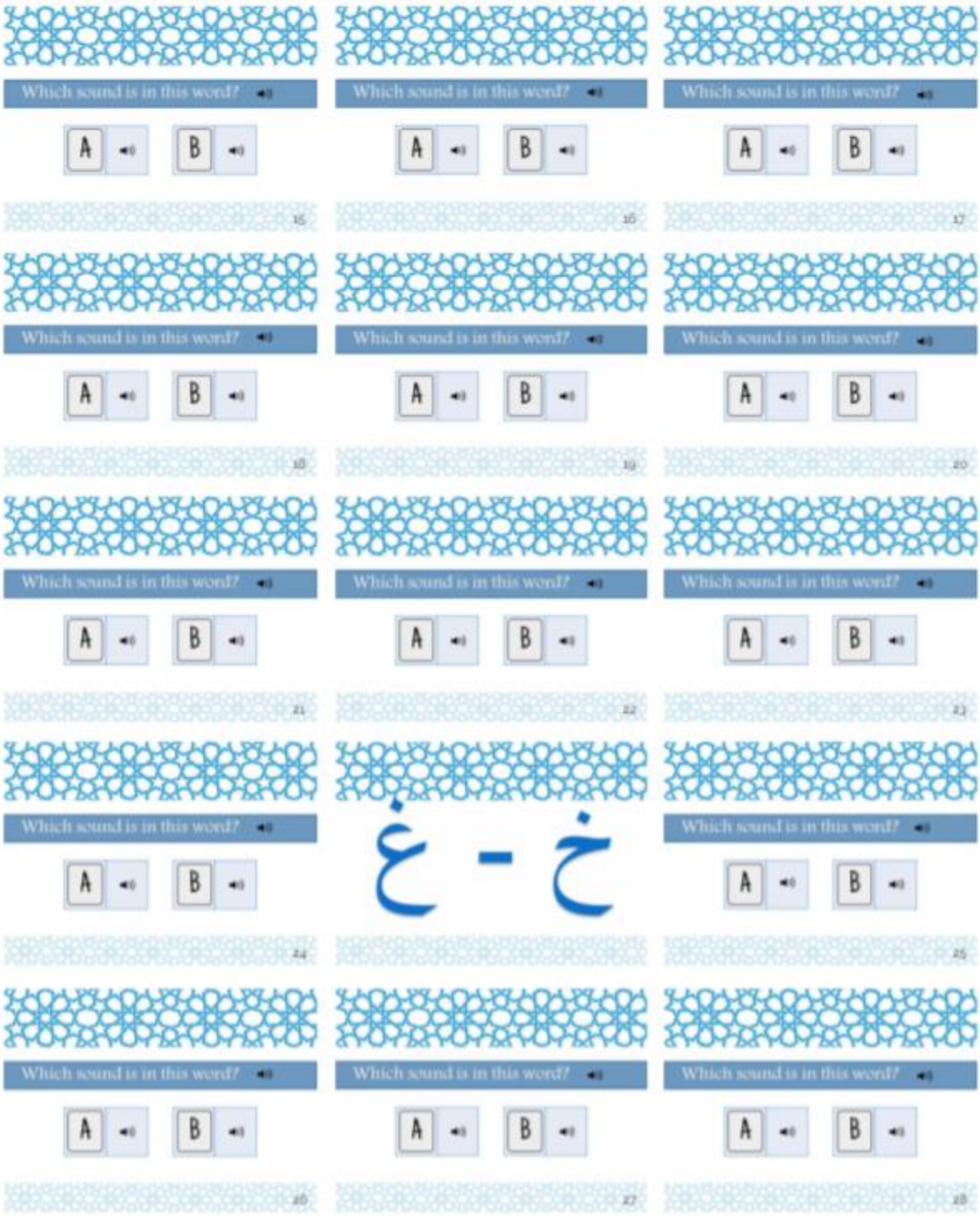
Female stimuli

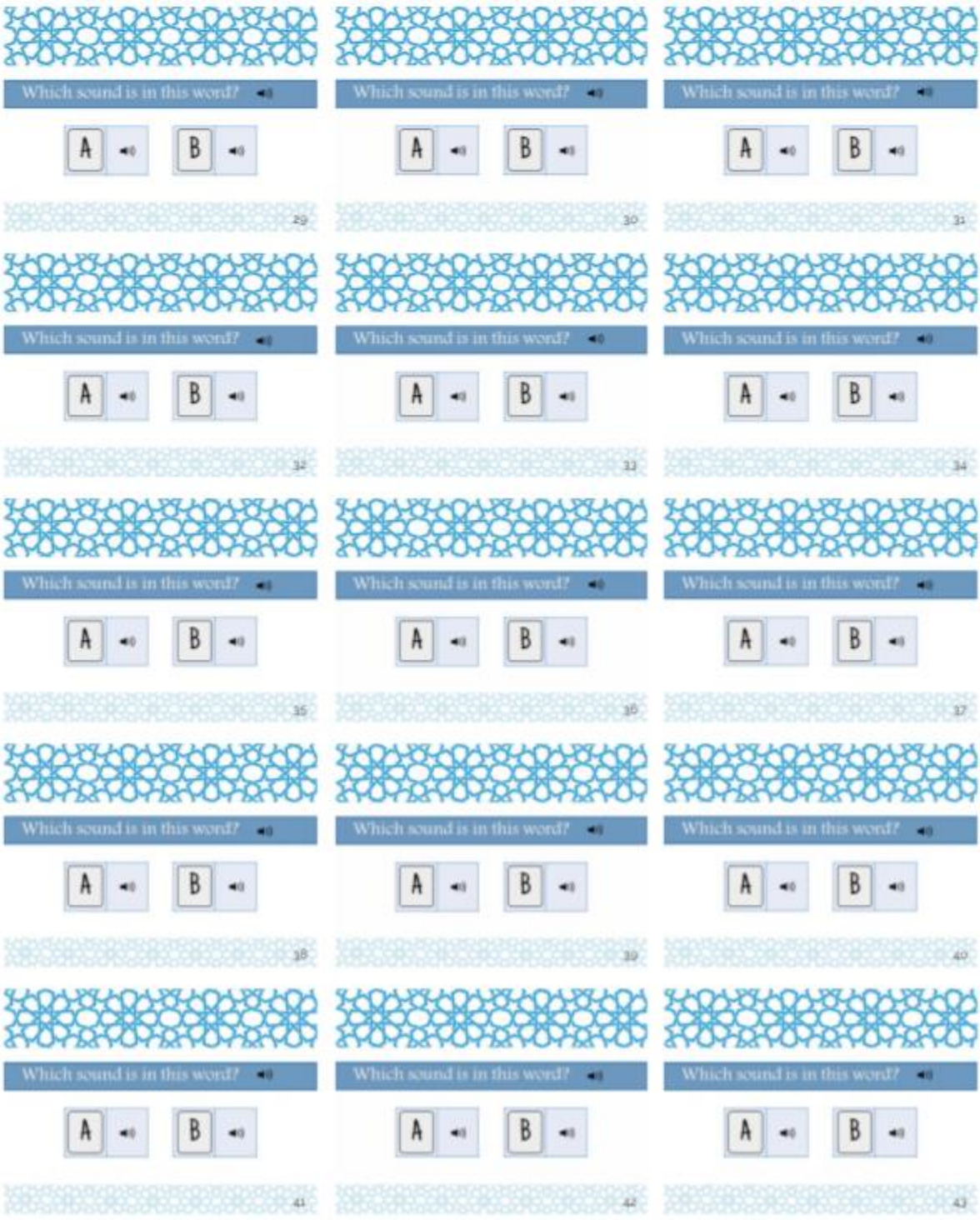
91. Which sound is in this word?	يُعَمَّلَ	/juʕammala/
A. /ʕ/		
B. /ʔ/		
92. Which sound is in this word?	أَرَب	/ʔarab/
A. /ʔ/		
B. /ʕ/		
93. Which sound is in this word?	يُأَمَّلَ	/juʔammala/
A. /ʕ/		
B. /ʔ/		
94. Which sound is in this word?	بَدْع	/badʕ/
A. /ʕ/		
B. /ʔ/		
95. Which sound is in this word?	بَدْء	/badʔ/
A. /ʕ/		
B. /ʔ/		
96. Which sound is in this word?	عَرَب	/ʕaraɓ/
A. /ʔ/		
B. /ʕ/		

Appendix C

Sample of the HVPT program




Which sound is in this word?
A
B
15
16
17
18
19
20
21
22
23
خ - غ
24
25
26
27
28


Which sound is in this word?
A
B
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43

Appendix D

Eligibility Screening

1. Are you 18 or over?
    A. Yes
    B. No (Skip logic: Thank you. You do not qualify to participate in this study.)

2. Are you learning how to pronounce Quranic Arabic correctly?
    A. Yes
    B. No (Skip logic: Thank you. You do not qualify to participate in this study.)

3. Were you born in the US?
    A. Yes (Skip logic: Answer question 5.)
    B. No

4. Did you immigrate to the US before the age of 12?
    A. Yes
    B. No (Skip logic: Thank you. You do not qualify to participate in this study.)

5. Is English your native language?
    A. Yes (Skip logic: Answer question 7.)
    B. No

6. Did you learn English before the age of 12?
    A. Yes
    B. No (Skip logic: Thank you. You do not qualify to participate in this study.)

7. How would you rate your fluency in Arabic? This includes any dialect of Arabic.
    A. Very Poor
    B. Poor
    C. Fair
    D. Functional
    E. Good
    F. Very Good
    G. Native/ Native-like (Skip logic: Thank you. You do not qualify to participate in this study.)

8. Do you have a speech, language or hearing impairment or disorder?
    A. Yes (Skip logic: Thank you. You do not qualify to participate in this study.)
    B. No

9. Do you have access to the internet and a computer/mobile device?
    A. Yes
    B. No (Skip logic: Thank you. You do not qualify to participate in this study.)

10. You meet the requirements to participate in this study! If you would like to participate, please provide your name and email below. Your name and email will be kept confidential and used only for the purpose of this study.

Name _____
Email Address _____

Appendix E

Consent Form

FIU | FLORIDA INTERNATIONAL UNIVERSITY

ADULT ONLINE CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Perceptual Training of Arabic Consonants in English-speaking Quran Learners

SUMMARY INFORMATION

Things you should know about this study:

- **Purpose:** The purpose of the study is to test an online tool to train native speakers of English to hear the difference between Quranic Arabic consonants.
- **Procedures**: If you choose to participate, you will be split into a control group and a test group. You will be asked to:
  1. Take a pretest. You will be required to complete the pretest if you are in the test or control group.
  2. Complete ten sessions on the training tool if you are in the test group. The sessions should be completed once a day, every weekday, for two weeks. If you are in the control group, you will not complete these sessions.
  3. Take a post test. You will be required to complete the pretest if you are in the test or control group.
- **Duration:** It will take approximately 30 minutes to complete the pre and posttests. The training sessions should take approximately 45 minutes each.
- **Risks**: The main risk or discomfort from this research is cognitive fatigue.
- **Benefits:** The main benefit to you from this research is learning how to perceive the difference between Quranic Arabic consonants.
- **Alternatives:** There are no known alternatives available to you other than not taking part in this study.
- **Participation:** Taking part in this research project is voluntary.

Please carefully read the entire document before agreeing to participate.

PURPOSE OF THE STUDY

The purpose of this study is to test an online tool to train native speakers of English to hear the difference between Quranic Arabic consonants.

NUMBER OF STUDY PARTICIPANTS

If you decide to be in this study, you will be one of 33 people in this research study.

DURATION OF THE STUDY

Your participation will involve two weeks of your time.

If you are in the test group, you will be required to take a pre and posttest, each approximately 30 minutes in length. You will be required to complete ten training sessions online, each approximately 45 minutes long. You will be required to complete each session every weekday for two weeks.

If you are in the control group, you will be required to take a pre and posttest, each approximately 30 minutes in length. You will be asked to take the posttest two weeks after completing the pretest.

PROCEDURES

If you agree to be in the study, we will ask you to do the following things:

1. Take a pretest.
    - If you are in the test group or control group, you will be asked to complete the pretest.
    - The pretest will be conducted online using the website Boom learning.
    - The pretest will consist of listening to an audio recording of an Arabic word and listening to two recordings of different Arabic consonants. You will be asked to click which consonant was in the word.
2. Complete the training.
    - If you are in the test group, you will be asked to complete the training.
    - The training be conducted online using the website Boom learning.
    - The training will consist of listening to an audio recording of an Arabic word and listening to two recordings of different Arabic consonants. You will be asked to click which consonant was in the word. This procedure is experimental.
3. Take a post test.
    - If you are in the test group or control group, you will be asked to complete the posttest.
    - The posttest will be conducted online using the website Boom learning.
    - The post test will consist of listening to an audio recording of an Arabic word and listening to two recordings of different Arabic consonants. You will be asked to click which consonant was in the word.

RISKS AND/OR DISCOMFORTS

The study has the following possible risks to you: First, fatigue. Completing the online sessions may cause you to experience cognitive fatigue. Looking at the screen for 30-45 minutes may also cause eye fatigue.

Second, false hope in the program. The purpose of this study is to test a tool to teach native English speakers to hear the difference between common Arabic consonants. This is experimental and may not be successful. You may experience false hope in the program.

BENEFITS

The study has the following possible benefits to you: First, the program will likely teach you to hear the difference between Arabic consonants.

Second, improvement in perception of Arabic consonants may improve your performance in Quranic Arabic studies.

Third, improvement in perception of Arabic consonants may improve your feelings about your performance in Quranic Arabic studies and Quran recitation.

Fourth, this study may be used to develop a tool which can be utilized in Quran recitation classes for native English speakers.

ALTERNATIVES

There are no known alternatives available to you other than not taking part in this study.

CONFIDENTIALITY

The records of this study will be kept private and will be protected to the fullest extent provided by law. In any sort of report we might publish, we will not include any information that will make it possible to identify you. Research records will be stored securely and only the research team will have access to the records. However, your records may be inspected by authorized University or other agents who will also keep the information confidential.

Any information you provide will be digitally stored and will be password protected.

USE OF YOUR INFORMATION

Identifiers about you might be removed from the identifiable private information and that, after such removal, the information could be used for future research studies or distributed to another investigator for future research studies without additional informed consent from you or your legally authorized representative.

COMPENSATION & COSTS

There are no costs to you for participating in this study.

RIGHT TO DECLINE OR WITHDRAW

Your participation in this study is voluntary. You are free to participate in the study or withdraw your consent at any time during the study. You will not lose any benefits if you decide not to participate or if you quit the study early. The investigator reserves the right to remove you without your consent at such time that he/she feels it is in the best interest.

RESEARCHER CONTACT INFORMATION

If you have any questions about the purpose, procedures, or any other issues relating to this research study you may contact Angela Medina at MedinaAM@fiu.edu or Amanda Smith at asmit364@fiu.edu.

IRB CONTACT INFORMATION

If you would like to talk with someone about your rights of being a subject in this research study or about ethical issues with this research study, you may contact the FIU Office of Research Integrity by phone at 305-348-2494 or by email at ori@fiu.edu.

PARTICIPANT AGREEMENT

I have read the information in this consent form and agree to participate in this study. I have had a chance to ask any questions I have about this study, and they have been answered for me. By clicking on the "consent to participate" button below I am providing my informed consent.

(Consent to participate button inserted here on Qualtrics)