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A SPANISH-LANGUAGE MODIFIED RHYME TEST FOR WORD RECOGNITION TESTING

by

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THESIS APPROVAL PAGE

This is to certify that the thesis prepared by Rita Irene Ball entitled: A Spanish-Language Modified Rhyme Test for Word Recognition Testing has been approved by her committee as satisfactory completion of the thesis requirement for the degree Doctor of Audiology.

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ABSTRACT

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FOR WORD RECOGNITION TESTING

Rita I. Ball

A Spanish-Language Modified Rhyme Test (MRT) for word recognition testing was developed using the original MRT structure by House et al. (1965) with modifications as specified by Aguilar (1991). The greatest modification to the Spanish-Language MRT originally proposed by Aguilar (1991) is the use of bisyllabic Spanish words instead of monosyllabic words. A total of six 50-word lists were developed and recorded onto a compact disk (CD). This study also included testing of the developed test material in order to collect normative data. Forty four (*N*=44) native Spanish-speaking participants (18 males, 26 females) with normal hearing were included in this study. Paired-samples t-tests showed no ear, age or gender effect between the mean scores. Individuals with normal hearing scored close to or equal to 100% correct on all lists. Further studies, which may include a larger sample size and the inclusion of Spanish-speaking participants with hearing loss, are necessary in order to further validate the materials.

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Chapter 1

Introduction

As of the most recent published report released by the United States (U.S.) Census Bureau in 2009, which details the Hispanic population of the U.S. between the years 2000 through 2006, the Hispanic population currently makes up a total of 14.8% of the nation's population (U. S. Census Bureau, 2009). It was reported that between 2000 and 2006, the Hispanic population accounted for almost half of the nation's overall growth (24.3%). The Hispanic population currently makes up approximately 6.8% of the nation's older population (ages 65 an over) and is additionally expected to reach 19.8% by 2050 (Administration on Aging [AOA], 2010). As of 2008, more than 70% of Hispanic persons 65 and older within the U.S. live in the states of California, Texas, New Mexico, Arizona, Florida and New York (AOA, 2010; U.S. Census Bureau, 2008). This growing trend will lead Hispanics to be the largest U.S. minority group in the population of persons 65 and older (AOA, 2010).

As the older Hispanic population steadily increases, as do the health concerns within this population (AOA, 2010). Due to the continuous growth of the aging Hispanic population in the U.S., considerations must be taken within the healthcare realm to provide adequate care that meets the diverse needs of the country's changing population. This paper will focus on the accessibility of adequate audiology services to meet the needs of the rapidly-growing Hispanic population in the U.S.

The traditional and comprehensive audiologic test battery includes the administration of pure tone and speech audiometry testing (Brandy, 2002; Konkle & Rintelmann, 1983). Air and bone conduction pure tone testing are conducted to obtain patient hearing thresholds at octave frequencies typically ranging from 250-8000 Hz. These frequencies are particularly important to the perception of speech sounds. A threshold for the selected stimulus is considered the lowest intensity level that elicits a designated response (such as a hand raise or push of a button) at least 50% of the time (Harrell, 2002). Pure tone testing provides an accurate and quantifiable measurement of auditory sensitivity across test frequencies.

In the audiologic test battery, speech audiometry characteristically follows pure tone testing. Speech audiometry, in addition to pure tone testing, provides further quantifiable information on patient auditory sensitivity to everyday conversational speech (Brandy, 2002). Speech audiometry measures the patient’s ability to perceive and recognize spoken stimuli. It can be administered to both children and adults, with variations in test methods. In the U.S., traditional speech audiometry tests (e.g., speech recognition thresholds, word recognition testing) are typically administered in English, the primary language of U.S. citizens (Brandy, 2002; Central Intelligence Agency [CIA], 2010).

Though the U.S. does not have an official language, English is the primary language spoken throughout the country (CIA, 2010). Therefore, speech audiometry test materials developed in the U.S. or for use in the U.S. are typically developed in English. However, difficulties arise when an audiologist needs to evaluate the word recognition skills of a non-English-speaking patient as a part of the standard audiologic evaluation (specifically in this case, Spanish-speaking patients). In these circumstances, the ability of audiologists to correctly administer and score a speech audiometry test in a language they are not fluent in can negatively impact the patient’s test results. On the other hand, if the test is administered in the audiologist's first language (and not the patient's first language) it can also negatively impact the accuracy of the patient's test results (Nelson et al., 2005). Because more than 14% of the nation's population is Hispanic, a language barrier related to test administration and scoring is prominent between English and Spanish speakers in the U.S. If presented with an English language speech audiometry word list, native Spanish speakers may perform poorly due to lack of familiarity with the language or the inability of audiologists to accurately score the test, rather than the representation of a true auditory deficit (Carhart, 1951; Gat & Keith, 1978; Weisleder & Hodgson, 1989). An objective, recorded, speech audiometry test that can be administered by non-Spanish-speaking audiologists is needed for accurate and objective testing of Spanish-speaking patients.

Chapter 2

Review of Literature

The Spanish Language Around the World

Spanish is the third most commonly spoken language in the world (Fernández & Roth, 2006). By rank, as of 2006, 14.52% of the world natively speaks Chinese, 6.25% speaks English, 5.68% speaks Spanish and 3.96% speaks Arabic. Spanish is currently the official language in 21 countries and territories around the world (Fernández & Roth, 2006).

The Spanish Language in the United States

A common language barrier in the U.S. exists between English speakers and native Spanish speakers who have come to the U.S. from Spanish-speaking countries. The U.S. Census Bureau reports that as of July 1, 2006, there were 44.3 million Hispanics in the U.S. (U.S. Census Bureau, 2009). The Hispanic population makes up 14.8% of the U.S. population of approximately 299 million people (U.S. Census Bureau, 2009). Though the newest data collected are not yet available to the public, projections for the 2010 census are estimated to increase to 47.8 million Hispanics, nationwide (U.S. Census Bureau, 2009). The growth in the Hispanic population in the U.S. will require more audiologic testing of native Spanish speakers as well as more audiologists with Spanish language skills. The American Speech-Language-Hearing Association (ASHA) estimated less than 1% of audiologists to be proficient in Spanish (Cole, 1990).

Developing a reliable way to accurately administer and score Spanish speech audiometry tests could have widespread application in other countries as well as the U.S.

In attempt to eliminate or reduce this language barrier, the audiologic test battery needs to be modified in order to accommodate Spanish speakers. Speech audiometry measures have demonstrated to be successfully used for testing in languages other than English (Cardenas & Marrero, 1994; Carhart, 1951; Ferrer, 1960; Martin & Hart, 1978). Speech audiometry tests developed to test Spanish-speaking patients need to be properly developed by taking into consideration the specific linguistic, phonetic and syntactic rules of the Spanish language (Carhart, 1951).

Testing Spanish speakers with English word lists developed for English speakers may produce inaccurate scores for several reasons. First, the patient may not be familiar with the stimulus words (Gat & Keith, 1978; Weisleder & Hodgson, 1989). Secondly, variations in speech and dialect of English stimulus words by the talker (i.e., audiologist) can also lead to inaccurate responses by the patient who may by unaware of these possible variations. Alternatively, testing in the patient's native language without the use of recorded material may also cause difficulties in presentation of the stimulus words and the interpretation of the verbal response due to the audiologist's unfamiliarity with the test language.

Introduction to Speech Audiometry

The field of audiology incorporates diagnosis, treatment and counseling in the area of hearing loss. Audiologists are trained specialists that work with patients and their families to assist them with their hearing needs. A common complaint of patients with hearing loss is a general difficulty in understanding speech in conversation (Brandy, 2002). Patients who perceive hearing difficulties may eventually wish to seek audiologic evaluation. A standard comprehensive audiologic evaluation includes air and bone conduction pure tone and speech audiometry testing (Konkle & Rintelmann, 1983). In audiologic testing, speech stimuli are used in conjunction with pure tone stimuli to gain further insight into each patient's communication needs. Speech audiometry evaluates each patient's ability to hear and discriminate spoken stimuli.

Speech audiometry has its roots in aural rehabilitation programs developed for soldiers after World War II (Silverman, 1983). Many speech audiometry tests developed following World War II are still used in standard testing today. These types of speech audiometry tests serve to: (a) verify the validity of pure tone testing, (b) quantify the effect of hearing loss on speech understanding, (c) determine a patient's candidacy for amplification and (d) help indicate the possibility of hearing loss due to medical pathology (ASHA, 1988; Ferrer, 1960; Gelfand, 2001; Mendel, 2008; Nelson et al., 2000; Silverman, 1983). The two most commonly used measures in speech audiometry are the speech recognition threshold (SRT) and word recognition score (WRS) (ASHA, 1998; Bess, 1983; Gelfand, 2001).

Speech Recognition Threshold (SRT)

A SRT indicates the lowest intensity level, in decibels hearing level (dB HL), at which 50% of the stimulus words presented are correctly recognized by the listener (ASHA, 1988; Wilson & Margolis, 1983). The SRT for the right and left ear is obtained individually via headphones or insert earphones (Ferrer, 1960). Children and adults who will not tolerate headphones can be tested via sound field (speakers) to obtain a SRT (Gelfand, 2001). The ASHA guidelines recommend the use of a closed-set spondee word list for SRT testing (ASHA, 1988). Spondee words are bisyllabic (two syllable) compound words with equal emphasis on each syllable (Ferrer, 1960; Gelfand, 2001). Spondee word lists include common words like “airplane” and “birthday.” Speech recognition threshold testing is done with a closed-set word list (with a limited number of options) and the patient can respond by saying, writing or pointing to the stimulus word (Brandy, 2002). Most frequently in clinical practice, an oral response to the stimulus words is used. The stimulus words are initially presented at an audible level for familiarization. Once the patient is familiarized with the word list, the words are presented randomly at softer levels (usually in 5 dB HL increments) multiple times until the patient responds correctly only 50% of the time at the same intensity level. This intensity level is recorded as the patient’s SRT for that ear. The same steps are then taken to obtain the SRT for the patient’s opposite ear.

Word Recognition Testing

Word recognition testing provides a Word Recognition Score (WRS). A WRS is a percentage of correct words out of a set number of stimulus words (Bess, 1983). The SRT is measured first and is then used to select a proper intensity level for word recognition test presentation. A WRS is obtained for each ear and is calculated as a percentage score of correctly recognized words at a fixed presentation level (Bess, 1983; Gelfand, 2001). This presentation level is usually 30 to 40 dB HL above SRT unless deemed uncomfortably loud by the listener, in which case it is presented at the patient’s most comfortable listening level (MCL) (Bess, 1983; Gelfand, 2001). In theory, a WRS represents the individual's best speech-perception performance in quiet, at a comfortable listening level (Ferrer, 1960).

Typically, a WRS is obtained using an open-set word list using phonetically-balanced monosyllabic words (Brandy, 2002). In an open-set word list the stimulus word is presented without specific choices (Mendel & Danhauer, 1997). Though traditionally called phonetically-balanced words, these words are technically phonemically-balanced words which proportionally represent each initial and final consonant by its frequency in the English language (Brandy, 2002; Gelfand, 2001). After presentation of the stimulus word, patients speak or write the word they perceived. The WRS is a percent correct score out of the total number of words presented (e.g., 100% at 60 dB using a 50 word list). Word lists can vary between 10 and 50 words in length per ear (Gelfand, 2001).

Word List Factors

Word recognition tests can vary in their format and presentation. They can vary in: (a) presentation format, (b) gender of the speaker, (c) carrier phrase, and (d) response format. Each of these variations has the potential to influence the WRS in a different manner.

Presentation Format. Word recognition test stimuli can be presented to the listener either via recorded material or monitored live voice (MLV). Monitored live voice involves the presentation of speech stimuli to the listener through the audiometer while monitoring speech intensity by volume unit (VU) meter (Carhart, 1946). In a survey conducted in 1998, 82% of practicing audiologists reported the use of MLV for speech recognition testing (Martin, Champlin, & Chambers, 1998). Reasons for the preferred use of MLV over recorded material may include the flexibility in presentation or lack of appropriate equipment to present the recorded material (Roeser, Valente, & Hosford-Dunn, 2000). Though the use of MLV is the presentation method most widely used in the clinical setting, the use of recorded material is recommended for speech audiometry by ASHA (1988). Recorded material helps to ensure an equal presentation level of all words and helps to maintain consistent presentation levels across patients and/or test sessions (Mendel & Danhauer, 1997). In addition, the use of recorded material limits variation among speakers (i.e., test administrators) such as accent, articulation pattern and gender speaking differences. These speaker differences cannot easily be controlled when using MLV because they are unique to the individual person. Using recorded material to control these variations helps to achieve consistency between patient scores and consistency within an individual patient's scores.

The hope for the future of speech audiometry testing is that recorded materials will become more widely used by audiologists (Mikolai & Mroz, 2010). The goal for the use of recorded materials is to provide uniformity in test presentation. Previously, recorded material was limited to the use of audio tapes which required the use of audio tape players as well as rewinding and fast-forwarding of the tapes (Wilson, Preece & Thornton, 1990). With the advent of the compact disc (CD) in the past two decades came the ability to present recorded material by digital track selection or randomization (Wilson et al., 1990). Compact disc players are now also relatively inexpensive and easy to acquire. As using recorded material for speech audiometry becomes more commonplace and regarded as best practice, the future of speech audiometry also looks at stimuli presentation via personal computer (PC)- based digital media players (Mikolai & Mroz, 2010).

The introduction of PC-based audiometers has allowed for the integration of digital media players and integrated PC-based speech audiometry materials into the audiometric set-up (Mikolai & Mroz, 2010). Recorded CD materials can be uploaded onto the PC hard drive for use with a digital media player or PC-based audiometer software (Mikolai & Mroz, 2010). Some recently-introduced PC-based audiometers even allow the user flexibility in word and track randomization for SRT and word recognition testing, respectively. Others also include scoring options such as whole word or phoneme -scoring which additionally include a visual display (Mikolai & Mroz, 2010). Personal computer-based speech audiometry materials reduce the need for paper-based copies, eliminate the need for external media players such as CD and tape players, and allow for a more flexible testing process.

Gender of the Speaker. Variations in speech are noticeable when comparing the voices and speech patterns of males and females. Males and females have different spectral variations in their voice quality (Brandy, 2002). In general, women tend to have softer and higher pitched voices and men tend to have louder and lower pitched voices (Mendel & Danhauer, 1997). In a study by Klatt and Klatt (1990) the spectral voice differences of six male and 10 female were analyzed. Each talker repeated two sentences which were later evaluated for vowel analysis. Overall, female voices were noted to have a higher fundamental frequency and to be of more breathy quality than male speakers. Due to these spectral differences, female voices may be more difficult to hear during conversational speech, especially to a patient with hearing loss (Mendel & Danhauer, 1997). Of note, male and female speaker variations should be taken into consideration when developing recorded materials and when comparing MLV word recognition scores across test sessions.

Carrier Phrase. Another variation in word recognition testing is the use of a carrier phrase when presenting stimulus words. A carrier phrase in word recognition testing is used to monitor speaking intensity and alert the listener (Brandy, 2002; Mendel & Danhauer, 1997). The carrier phrase comes before the stimulus word and includes those phrases such as, "Say the word…" and "You will say…" (Mendel & Danhauer, 1997). A carrier phrase is traditionally emphasized for use in MLV presentation of stimuli to assist in maintaining a natural speaking intensity, monitored by a VU meter (Brandy, 2002). A carrier phrase also helps to alert listeners that the stimulus word is going to be presented (Mendel & Danhauer, 1997). The use of a carrier phase has been demonstrated to produce higher performance scores when testing word recognition using MLV (Gelfand, 1975). Due to the prevalence of MLV use for word recognition stimuli presentation as discussed above, carrier phrase use is recommended during MLV in order to obtain more accurate scores and therefore more accurately identify those patients with hearing loss (Gelfand, 1975).

Response Format. Word recognition lists exist in either open-set or closed-set format. In open-set lists, the stimulus word is presented without specified choices or alternatives (Mendel & Danhauer, 1997). Therefore, the listener must verbally repeat or write a response word among an unlimited number of possible responses within the

English language (Roeser et al., 2000). In closed-set lists, however, the stimulus word is presented among a limited number of response alternatives. The listener must select the stimulus word among a set number of objects, pictures or printed words (Mendel & Danhauer, 1997). For this reason, closed-set lists are sometimes referred to as multiple-choice or forced-choice lists. The response format in closed-set lists is highly dependent on the abilities of the listener and familiarity with the vocabulary and language (Mendel & Danhauer, 1997). Closed-set lists may be an easier task to complete if the listener has poor vocabulary or language abilities.

Common Open-Set Word Recognition Tests

Examples of common word recognition lists used to test English-speaking adults are the Central Institute for the Deaf Auditory Test W-22 (W-22), developed by Hirsh et al. (1952) and the Northwestern University Auditory Test number 6 (NU-6), developed by Tillman and Carhart (1966). Both the W-22 and NU-6 word lists use monosyllabic (one syllable) words and are open-set lists. The open-set structure of these lists may cause difficulty for children or Spanish-speaking listeners due to lack of context or familiarity with the language (Cokely & Yager, 1993; Gelfand, 2001). The stimuli may be unknown to the child or Spanish-speaking listener or may be difficult to produce properly if the response is in the spoken format. Written responses in open-set testing yield more accurate results because the response is more clearly discernable by the tester (Roeser et al., 2000). Written responses, however, add time to the test battery and may be limited by the patient’s language, literacy, and spelling ability.

Common Closed-Set Word Recognition Tests

In contrast to open-set word recognition tests, closed-set tests are more commonly used when testing young children and adults with intellectual challenges (Gelfand, 2001). In the closed-set test format, the listener selects the stimulus word among a set number of pictures or objects. Young children are not commonly asked to verbally produce their response as they may not have refined expressive language skills, or may not have clear speech production. For pediatric speech audiometry, the Northwestern University Children’s Perception of Speech (NU-CHIPS) (Elliot & Katz, 1980) and the Word Intelligibility by Picture Identification (WIPI) (Ross & Lerman, 1971) are commonly used closed-set word recognition tests.

The NU-CHIPS can be used for children between the ages of 3-5 years and has four possible responses (Elliot & Katz, 1980). The WIPI can be used for children between the ages of 4-6 years and has six possible responses (Ross & Lerman, 1971). Though commonly used for testing children, closed-set tests can also be useful when testing certain adult populations that may have limited language or vocabulary skills (e.g., adults with intellectual challenges and adults who are not native English speakers). In contrast to using closed-set tests developed for use with children to tests these adult populations, the Modified Rhyme Test is an available closed-set test of word recognition which was developed for normally-functioning adults and may have application for non-native English speakers.

The Modified Rhyme Test

The Modified Rhyme Test is a print format closed-set word recognition list for adults with age-appropriate literacy skills. The concept for the Modified Rhyme Test was initially introduced by Fairbanks (1958) simply as the Rhyme Test. The Rhyme Test was developed as a test of phonemic discrimination at the Speech Research Laboratory at the University of Illinois (Fairbanks, 1958). The Rhyme Test consists of 50 sets of five rhyming words. Each stimulus word is monosyllabic and has a consonant-vowel-consonant (CVC) phoneme structure. Individual vowel phonemes and diphthongs are included in the criteria of vowel sounds. Every word in each rhyming set varies only in the initial consonant position but contains the same orthographic and phonologic "stem" or remainder of the word (e.g., male, tale, sale, pale, bale). Initial consonant phonemes with two letters (e.g., "th") are not included and word stems that have alternate pronunciations (e.g., comb, womb) are not used (Fairbanks, 1958).

For the Rhyme Test the stimulus word is presented via recorded material and the listener manually records their response on a response sheet (Fairbanks, 1958). The response sheet has a blank followed by the stem of the stimulus word (e.g., __ale). Listeners then fill-in the appropriate letter that completes the word they heard. The test is designed so that any of the five possible stimulus words in a rhyming set can be presented as a closed-set test because there are limited alternatives to the possible responses (Fairbanks, 1958).

Based on Fairbanks' Rhyme Test, the Modified Rhyme Test (MRT) was designed by House et al. (1965), using a similar test structure. Different from the Rhyme Test however, the stimulus words in the MRT vary in either the initial or final consonant. The MRT consists of 50 sets of six rhyming words. As with the Rhyme Test (Fairbanks, 1958), each stimulus word in the MRT is monosyllabic and has strictly CVC phoneme structure. In the MRT, the rhyming words vary in either the initial consonant phoneme (e.g., fang, bang, rang, hang, gang, sang) or final consonant phoneme (e.g., fizz, fit, fill, fib, fig, fin). Unlike the original Rhyme Test, in the MRT, double letter phonemes and words with alternate pronunciations are included. Like the original Rhyme Test, responses for the MRT are also recorded on a response sheet (House et al., 1965). However, the response sheet uses a multiple choice list. There are six lists; each word in a set is only presented in one of the lists. The stimulus word is presented after the carrier phrase, "Number __. The word is __." and the listener marks the stimulus word among six possible rhyming words. The MRT has less phonological focus than the Rhyme Test because it was developed to evaluate the performance of military speech-communication systems, not for use as a test of phonemic differentiation (House et al., 1965). These military speech-communication systems were developed prior to World War II for military telecommunications (Ericson, Simpson, & McKinley, 2005).

The MRT was adapted and recorded for clinical application by Kreul et al. (1968). Kreul et al. (1968) coined this test as the Modified Rhyme Hearing Test (MRHT). Essentially the same word lists developed by House et al. (1965) were used in these recordings, with a few changes made to avoid repeated words or to eliminate words considered to be ill-fitting. The recordings included three versions of all six lists using one male and two female talkers (Kreul et al., 1968). Broadband noise at different intensities was added to the recorded lists to create different signal-to-noise ratios (SNR) intended to yield approximately a 96%, 83%, and 75% correct score on each of the three versions, respectively.

The MRT allows for a reliable assessment of word recognition. Testing of 18 U.S. Air Force personnel over a period of 30 days demonstrated that the MRT can be administered to untrained listeners without the need for prior word familiarization (House et al., 1965). Not having to familiarize patients helps save time during testing. The same study also demonstrated the MRT's reliability. Although the MRT is a closed-set test, the tested Air Force personnel exhibited no improvement in scores regardless of repeated exposure to the same test materials (House et al., 1965). In other words, no learning effect was present.

Though the MRT is not as commonly used as other tests of word recognition such as the W-22 (Hirsh et al., 1952), it has been shown to be a comparable test of word recognition testing (Stark & Hagness, 1972). Stark and Hagness (1972) used 10 participants (five males and five females) with hearing within normal limits to compare the variability and reliability of the MRT against the W-22. Performance on List 4 of the W-22 was compared to the male voice recording of lists B (designed to yield 96% performance), D (designed to yield 75% performance), and F (designed to yield 83% performance) of the MRT. The authors of the study indicate that a male recording of the MRT lists was used because the W-22 recording uses a male speaker as well (Stark & Hagness, 1972). The study consisted of two test sessions, seven days apart. During session one, normal hearing was established through pure tone testing and SRT was established for each participant. The W-22 and MRT lists were administered in either the right or left ear of the participants (randomized selection) at 10, 20, 30, 40, and 50 dB above the SRT for that ear in that respective order. During session two, SRT was reestablished for each participant and again the W-22 and MRT lists were administered in the same test ear as in session one at 10, 20, 30, 40, and 50 dB above SRT (Stark & Hagness, 1972).

In the Stark and Hagness (1972) study, mean scores for the W-22 were generally higher than those for the MRT. However, the W-22 recording has no competing noise whereas the MRT recordings were modified with noise in order to achieve the expected performance levels. When comparing List B of the MRT (which has minimal competing noise added) and List 4 of the W-22 (designed to yield 96% performance) at a presentation level of 50 dB above SRT, the mean scores and ranges were similar (Stark & Hagness, 1972). During session one at 50 dB above SRT, the range for MRT List B was 90-98% and the range for W-22 List 4 was 96-100%. During session two at 50 dB above SRT, the range for MRT List B was 86-100% and the range for W-22 List 4 is 94-100%. Scores for the W-22 and MRT were comparable when testing listeners with hearing within normal limits. Additionally, discrimination scores between test sessions differed by less than 2% for the majority of participants between test and retest scores (Stark & Hagness, 1972).

The MRT has also been proven to be statistically reliable because of its repeatable means and standard deviations throughout repeated testing (Bell, Kreul, & Nixon, 1972; Elkins et al., 1971). In a study by Elkins et al. (1971) four of the six possible MRT word lists were selected for presentation. The lists were presented to nine listeners with hearing within normal limits and 50 listeners with hearing loss. As also done by Kreul et al. (1968), the recordings of the word lists were designed to yield 96%, 83%, and 75% accurate scores by listeners with hearing within normal limits by changing the signal to noise ratio to yield the desired score. The purpose of the Elkins et al. (1971) study was to evaluate the reliability of the MRT as a test of word discrimination for listeners with hearing loss. This was evaluated by comparing the scores of listeners with hearing loss to those with hearing within normal limits (Elkins et al., 1971).

The MRT word lists that were selected and their respective designated scores were list B (96%), list F (83%), list D (75%) and list E (96%) (Elkins et al., 1971). Air and bone conduction pure tone threshold testing was first performed to establish hearing levels and the four MRT lists were presented in each listener’s better ear at 40 dB above their SRT using insert earphones. Listeners with hearing within normal limits obtained the expected correct response percentages. Listeners with hearing loss performed equally for the tests designed to yield 96% and showed an average 16% decrease in performance for the 83% accuracy list (Elkins et al., 1971). However, listeners with hearing loss did not show the expected proportional decrease in scores for the 75% condition, rather their performance showed a plateau earlier than expected. The researchers reported this as evidence that the presence of high levels of background noise affects speech understanding for listeners with hearing loss more than those with hearing within normal limits (Elkins et al., 1971). These results indicate that the MRT effectively identifies listeners with hearing loss as the expected relationship among MRT conditions is not maintained (Elkins et al., 1971).

The validity of the use of the MRT for use with patients with hearing loss was further examined in a study by Bell, Kreul, and Nixon (1972) which follows similar format to that of Elkins et al. (1971). In the Bell at al. (1972) study all six MRT lists were administered to two participants with hearing within normal limits and participants with sensorineural hearing loss above 3000 Hz and positive history of noise exposure (Bell et al., 1972). Fourteen (male and female) college students with hearing within normal limits and 12 male participants with hearing loss above 3000 Hz were presented the six lists of the MRT in three different conditions (18 MRT lists total) and then again in a separate session two weeks later. The order of list presentation was counterbalanced by assigning each participant to a group number with a different presentation order for each group (Bell et al., 1972). The recordings of the MRT, developed for clinical use by Kreul et al., (1968) were used in the Bell et al. (1972) study. The lists were administered at 40 dB above the three-frequency pure tone average of the better ear with effective contralateral masking. Both listener groups had repeatable means and standard deviations between sessions and among test conditions. This study, however, demonstrated that the MRT was not a reliable test of word recognition for listeners with hearing within normal limits due to a lack of range of scores among participants. In contrast, it was demonstrated that the MRT is considered reliable as a test of word recognition for listeners with high frequency noise induced hearing loss (Bell et al., 1972).

Spanish Speech Audiometry

Available Materials in the U.S. Currently, an open-set word list recording for Spanish SRT and word recognition testing is available through the Auditec of St. Louis

Company (Auditec of St. Louis Company, n.d.). Unlike the English version, the Spanish SRT list is composed of trisyllabic (three syllable) Spanish words because there are no true spondee words in the Spanish language (Tato, 1949). Also, unlike the monosyllabic words used in English word recognition testing, the Spanish word recognition test list is composed of bisyllabic words, which are more appropriate for Spanish language testing due to the prevalence of bisyllabic words in the Spanish language. In Spanish, bisyllabic words have more stress on one of the two syllables and are called paroxytone words (Cancel, 1968). However, the Auditec of St. Louis Company Spanish word recognition test list is an open-set word list and typically requires a verbal or written response.

Scoring Spanish Speech Audiometry. Due to the limitation of available materials, there is a need for a word recognition test for non-Spanish speakers that may help eliminate the language barrier. Though many studies have proven the reliability of English language speech audiometry materials to test English speakers, not much research exists on the validity of using English language material to test Spanish speakers. As previously stated, less than 1% of practicing audiologists in the U.S. are fluent in Spanish (Cole, 1990). Therefore, it is safe to assume that if recorded Spanish language speech audiometry materials were readily available for in-office use, the majority of administering audiologists would be responsible for judging the accuracy of Spanish speech audiometry tests without proper knowledge of the language. This brings to question the accuracy of Spanish speech audiometry scoring of oral responses by English speaking audiologists. Despite hypothesized testing dilemmas, one relatively recent study has demonstrated that English speakers with and without knowledge of the

Spanish language perform equally in scoring oral Spanish word recognition responses by Spanish speakers (Cokely & Yager, 1993).

Cokely and Yager (1993) presented four recorded 50 word Auditec of St. Luis Company lists of bisyllabic Spanish words to 10 Spanish speakers with hearing within normal limits (25 dB or less from 250-8000 Hz). The 10 Spanish speakers had an average time of six months living in the United States (Cokely & Yager, 1993). These four specific word lists were previously found to be comparable in scores to monosyllabic English word lists (Cokely & Yager, 1993; Weisleder & Hodgson, 1989). In this study, the 10 native Spanish speakers presented oral as well as written responses to each of the four word lists (Cokely & Yager, 1993). The oral responses were recorded via audio tape for future scoring and comparison. The word lists were scored by 30 English speakers with hearing within normal limits (10 dB or less from 250-8000 Hz). These English speakers were divided into two groups of 15 judges: (a) those with no reported knowledge of Spanish and (b) those with two to three years of reported college level Spanish courses. The English speakers listened to the recordings of the oral responses by the Spanish speakers and marked them as correct or incorrect in comparison to the stimulus word list. This study was conducted in an attempt to demonstrate the validity of English listeners scoring Spanish speaker word recognition responses (Cokely & Yager, 1993).

In the Cokely and Yager (1993) study, the overall mean WRS for the oral response was 59.8% for the judges with Spanish language knowledge and 60.2% for those without Spanish language knowledge. At the conclusion of the testing the written responses were also calculated. The oral response scores as calculated by each of the judges were subtracted from the written WRS of each of the Spanish speakers. The oral responses scored by the judges with Spanish knowledge differed by two percentage points when compared to the written scores. The oral responses scored by the judges without Spanish knowledge differed by two percentage points when compared to the written scores. Additionally, examination of the data revealed that oral and written scores differed by more than 10 percentage points in 1% of the cases where the oral responses were scored by English speakers with Spanish knowledge. Oral and written scores differed by more than 10 percentage points in 3% of the cases where the oral responses were scored by judges without Spanish knowledge (Cokely & Yager, 1993). The researchers therefore concluded that Spanish word recognition scores from oral responses were comparable when scored by English-speaking persons with and without knowledge of Spanish.

Cokely and Yager (1993) claimed their study demonstrated that oral responses as interpreted by English speakers were comparable in percentage scores when compared to the actual written responses of Spanish speakers. However, the authors did not analyze how accurately the two English speaking groups judged the oral responses of the Spanish speakers. In other words, the verbal response words were simply marked as correct or incorrect but were not judged on a phonemic level for whole word accuracy. Though the comparison of English speakers scoring verbal responses to written responses was examined, the accuracy at which the English-speakers scored the oral responses of Spanish-speakers was not examined. Cokely and Yager’s (1993) study did not demonstrate the need for examination on a phonemic level due to the similarity in mean scores of both written and oral responses. However, the individual data did show a small percentage of cases in which the oral and written scores differed by more than 10% between verbal and written scores when the two groups were scoring the oral responses (Cokely & Yager, 1993).

It is also noted that the Cokely and Yager (1993) study was based out of Baylor University in Waco, Texas. Due to the proximity of Texas to Mexico it could be speculated that regardless of each English speaker's level of formal higher-level Spanish education or lack thereof, the judges may have had more informal exposure to the Spanish language on a more regular basis than other locations within the U.S. This may have been a factor in individual judge performance on the scoring task. This study still leaves the accuracy of English speakers scoring Spanish word recognition tests as well as the ethical aspect of doing so in question.

Nelson et al. (2000) further studied the difference between Spanish and non-Spanish-speaking listeners scoring Spanish word recognition responses. The oral responses of four Spanish speaking speakers were evaluated by 30 English-speaking individuals with varying levels of Spanish language exposure. Of these 30 listeners, four were also fluent Spanish speakers. The Auditec of St. Lewis Company Spanish word recognition lists A and B were used as stimulus word lists. Among the words, two specific types of changes were intentionally made by each speaker as foils. The two changes made were key changes and gross changes. Key changes included consonant errors (e.g., /p/ in place of /b/ and /t/ in place of /k/) and medial and final vowel changes (e.g., /o/ for /a/ and /e/ for /a/). In the key changes, each change altered the word to be another Spanish word. In gross changes, the entire word was substituted for a similar word. Word lists were modified to range between 78-92% correct score and were randomized to reduce order and learning effect.

The purpose of the Nelson et al. (2000) study was to assess the accuracy of both Spanish and non-Spanish-speaking listeners in their ability to judge oral Spanish word recognition test responses. This study resulted in comparable percent scoring of both groups (Nelson et al., 2000). Though some differences in percentage scores did exist, none were clinically significant. Across the judges, results showed that 283 out of the 300 tests were scored with 90% accuracy or higher (Nelson et al., 2000). Though these differences may not be considered clinically significant, there were statistically significant differences in the accuracy of the scoring between both judging groups. Despite lack of clinically significant differences in scoring, it was noted that the fluent Spanish speakers scored the words with greater accuracy. However, due to the small group of fluent Spanish speaking judges, the validity of these differences remains uncertain. It is possible that a more significant difference could exist when using a larger group of fluent Spanish speakers as judges (Nelson et al., 2000). It is apparent that regardless of the demonstrated ability of English speakers to score Spanish word recognition tests, a more objective method of doing so without the potential interference of a language barrier would be best practice.

Ethics in Scoring Spanish Word Recognition Tests. The ethical nature of performing the task of scoring an oral response in a foreign language can be disputed despite the previous studies that have concluded it can successfully be accomplished. The capacity of audiologists who are not fluent or formally trained in the Spanish language to accurately score Spanish language word recognition responses is a strong argument against doing so. The demonstration that English speakers with little or no knowledge of the Spanish language can effectively score Spanish tests of word recognition does not indicate that all English speaking audiologists will perform the task successfully. Nelson et al. (2000) argued that English speakers who are not familiar with the Spanish language may simply lack the linguistic competence to accurately score Spanish word recognition tests. Due to lack of proper training, some audiologists may also feel uncomfortable or unwilling to perform the task of scoring a test in another language (McCullough & Wilson, 2001). Error in scoring due improper familiarity with the test language could result in inaccurate and unreliable scores which may falsely indicate auditory deficit (Weisleder & Hodgson, 1989). These errors, in turn, could lead to improper diagnosis and patient care. This argument demonstrates need for a more objective Spanish word recognition test.

Spanish Modified Rhyme Test

One way to avoid the potentially negative effects of the language barrier between patients and audiologists is to use a Spanish Modified Rhyme Test. The development of a Spanish version of the MRT was proposed by Aguilar (1991). Following the same structure as the MRT, the test was proposed to be designed using sets of six monosyllabic CVC Spanish words. Word recognition tests in other languages such as English, German, Danish, Swedish, Hebrew, Italian, French, Finnish, and Portuguese exist which also followed the same criteria of monosyllabic stimuli structure (Ferrer, 1960). However, Aguilar's use of the monosyllabic test design of the MRT was ineffective for the use of Spanish word recognition testing (Aguilar, 1991). This design caused Aguilar to have some sets with less than six options within a rhyming set. As stated by Tato (1949), the phonetic composition of the Spanish language is mostly bisyllabic. Only approximately 7.48% of Spanish words are monosyllabic, but 61.16% are bisyllabic (Aguilar, 1991). Clearly, the Spanish language has few monosyllabic words from which to draw. Therefore it was difficult for Aguilar (1991) to construct six word lists of monosyllabic words due to the lack of useful monosyllabic words. This lack of monosyllabic words also made it more difficult to compile rhyming word sets with sufficient foils.

To meet the format and rhyming scheme of the original MRT, the list developed by Aguilar (1991) used Spanish monosyllabic words which were structured by consonant-vowel-consonant (CVC), consonant-vowel (CV), or vowel-consonant (CV). However, due to limited rhyming alternatives, the format required the use of many nonsense monosyllabic words which were unfamiliar to the listener (e.g. rob, rol, ros or coz, foz, hoz).

Strict adherence to the English model of the MRT led to the restriction of using monosyllabic words for the Spanish MRT by Aguilar (1991). Due to this restriction, the size of the test was reduced from 50 sets of five rhyming words to 40 sets of four rhyming words. Aguilar (1991) stated several disadvantages of her proposed Spanish MRT: (a) the test only evaluated consonants within the words and excluded evaluation of vowels, (b) only words with CVC, CV, and VC structure were evaluated which excluded words with consonant clusters, (c) due to the exclusion of words with consonant clusters consonants were only evaluated in the initial and final position of the word, (d) phonetic and spelling differences existed within stimulus words (e) only a limited vocabulary was evaluated, and (f) the task was fairly easy to be open to chance (Aguilar,1991).

In addition to the limitations stated above, the prevalent use of nonsense syllables within a Spanish language word recognition test may additionally be detrimental to patient performance. Nonsense syllables have proven to be a difficult identification task for Spanish speakers (Danhauer, Crawford, & Edgerton, 1984). Danhauer, Crawford, and Edgerton (1984) performed a nonsense syllable test (NST) of speech sound discrimination using, 10 English speaking, 10 Spanish speaking, and nine bilingual (English and Spanish speaking) participants. The NST, developed by Edgerton and Danhauer (Auditec of St. Louis Company, 1979), consists of 25 CVCV bisyllabic nonsense words. This test was developed using English language phonemes. Though certain test items may have meaning in other languages or may include phonemes that are not used in other languages, it was determined useful for use in the study as a screening tool to determine how each group of participants performed on the task (Danhauer et al., 1984). Each participant was administered 25 NST words at five ascending levels (25, 35, 45, 55, 65 dB) above SRT in the participant's better ear. List A of the NST was used in every presentation. List A was shown to have no learning effect even when presented 15 times in a single session (Danhauer et al., 1984). Results of the study showed that English and Bilingual listeners performed equally well at the vowel, phoneme, and consonant level at 35 dB above SRT and higher; a plateau was reached in both groups at 45 dB SL. However, the Spanish speaking group performed significantly lower ($p < 0.05$) than the other two groups at all intensity levels and among vowel, phoneme, and consonant scoring methods (Danhauer et al., 1984).

As a solution to the problems demonstrated by the application of a monosyllabic Spanish MRT, a functional bisyllabic Spanish-language adaptation of the MRT was designed by Cardenas and Marrero (1994) as the “Test de Rasgos Distintivos” (TRD), translated as the “Test of Distinctive Traits.” The TRD is a recorded test that consists of 58 sets of two bisyllabic rhyming words. Every word pair varies in only one phoneme (e.g., fila, pila or pierna, tierna). Pairs of words are grouped according to their distinctive traits (e.g., voicing, nasality, fricative). Each distinctive trait is also grouped by the critical speech frequencies which are affected (i.e., nasality: 472 Hz) (Cardenas & Marrero, 1994).

In the presentation of the TRD, no carrier phrase is used; the words are presented in isolation (Salesa et al., 2005). The word list is strategically designed to represent all the acoustic variations in the Spanish language, hence the term “distinctive traits.” These words use CVCV structure or CVCCV structure, which also allow for the evaluation of consonant clusters. The TRD not only serves as a method to determine WRS, it also serves as a way of measuring specific phonemes and frequency bands which may present hearing difficulties to the listener. Like the English MRT, the listener marks the stimulus word they heard among the rhyming word sets on a closed-set response sheet (Salesa et al., 2005).

In a clinical trial, the TRD was presented monaurally to 57 Spanish-speaking listeners with hearing within normal limits at an intensity level of 50 dB HL (Salesa et al., 2005). Results showed minimal errors among listeners (maximum two errors per person). Common errors included misinterpretation of /p/ and /t/ sounds and /m/ and /n/ (Salesa et al., 2005). Errors were most commonly found in the initial syllable position of the word. However, though the TRD uses natural language variations, there are only two options per stimulus word, meaning the listener has a 50% change of guessing the correct answer (Salesa et al., 2005).

Statement of Purpose

A word recognition test is needed for non-Spanish-speaking audiologists to administer to Spanish speakers which will allow the tester to objectively administer and score the test. Ideally, this test would provide more choices than the TRD (Salesa et al., 2005) while at the same time using common Spanish words, unlike the Spanish MRT proposed by Aguilar (1991).The purpose of this project is to develop a Spanish-language closed-set test of word recognition testing to be administered by non-Spanish-speaking audiologists to Spanish speakers. In order to make this test a reliable, objective method of testing word recognition, the stimuli will be recorded and the responses will be paper-based and include an answer key for the test administrator. The purpose of developing this test is to create an easy-to-administer Spanish word recognition test with useful clinical audiology application.

Chapter 3

Methods

This study was reviewed and approved by the Towson University Institutional Review Board for the Protection of Human Subjects (IRB). The approval letters are provided in Appendix A.

Participants

Inclusion criteria for this study consisted of Spanish speakers, ages 18 and over, with hearing within normal limits who were born in Spanish-speaking countries. Air conduction audiometry was performed to screen hearing from 250 through 8000 Hz with a cut-off of 20 dB or better. Tympanometric testing was also conducted. Participants who did not have Jerger (1970) Type A tympanograms (excluding Type B) but passed the air conduction hearing screening were additionally screened via bone conduction audiometry to rule out a conductive component to their hearing. Qualifying participants reported no significant otologic history and denied history of learning, language, or speech disorders. Participants were recruited through fliers, email, and personal contact through the Towson University community and in the surrounding Baltimore County and Baltimore City areas. Participants were required to read and sign an informed consent form approved by the Towson University IRB. See Appendix B.

A total of 49 participants were recruited for this study. Four participants were not tested with the developed materials due to hearing loss or participant noncompliance. One participant was excluded from the data set post-data collection due to patient fatigue during testing. Forty four (*N*=44) participants met the inclusion criteria of hearing within normal limits with no conductive component and successfully completed the study. The age range of the participants was 19-56 years (*M*=32.98, *SD*=10.09). Participants consisted of 18 males and 26 females. All participants were born in Spanish-speaking countries and reported fluency in the Spanish language. The countries of origin and the number of participants per country were: Mexico, nine; Peru, eight; Argentina, five; Spain, four; Puerto Rico, three; Venezuela, two; Paraguay, two; Nicaragua, two; Dominican Republic, two; Costa Rica, two; Colombia, one; Chile, two; Panama, one; Ecuador, one. Summary of the participant characteristics can be seen in Appendix F.

Stimulus Material

A Spanish-Language Modified Rhyme Test was developed following the test structure used by House et al. (1965) and also incorporating the suggestions for Spanish speech audiometry test development by Tato (1949) and development of a Spanish-language MRT by Aguilar (1991). This Spanish-language MRT consists of 50 sets of six rhyming, Spanish bisyllabic words.

The test developer is a Mexican-born, bilingual (English and Spanish) Doctor of Audiology candidate at Towson University. Word lists were compiled using several materials: *A Dictionary in Spanish: The cat in the hat beginner book* by Eastman (1994), *My First Spanish Word Book* by Wilkes (1999) and bisyllabic words selected from the top 175 Spanish words in order by frequency of use as listed in *Frecuencias del Español: Diccionario y Estudios Léxicos y Morfológicos* by Almela, Cantos, Sanchez, Sarmiento & Almela (2005). Words were selected from these sources to ensure listener familiarity with the stimulus words. Additionally, the test developer included supplemental words, not found in the sources listed above, which were considered to be common words within the rhyming sets.

The selected stimulus words were organized and grouped by the rhyming of their first syllable (e.g., *to*po, *to*do, *to*mo, *to*co, *to*no, *to*ro) or last syllable (e.g., an*cho*, bi*cho*, di*cho*, he*cho*, o*cho*, te*cho*). Words were allowed to be used multiple times if they met criteria for multiple rhyming sets. Groups of matching syllables that did not have enough rhyming words to complete the set of six words were thrown out. In the final product, 16 sets of rhyming words were first syllable rhymes and 34 sets were last syllable rhymes were compiled.

To randomize the lists a traditional six-sided die was rolled for each word in the 50 sets to number them one through six. If a number was rolled that had already been assigned to a word in that group the die was rolled until an unassigned number was rolled. Each numbered word then was assigned to the list pertaining to its assigned number (List 1 through List 6). This resulted in six lists of 50 words each. The lists were cross-checked for repeated stimulus words within the same list. Repeated words were switched for another word in the same position in one of the other randomly selected lists. This process was repeated until no repeat words were found within one same list. The six finalized lists are provided in Appendix C.

The six word lists were audio recorded in a sound treated booth using a DPA 4006-TL 15 - 20,000 Hz omnidirectional Phantom P48 powered (DIN 45 596) microphone and Pro Tools LE 7 version 7.3 software. A male native Spanish speaker was recruited via an internet classified advertisement. He was born, raised, and educated in

Argentina and came to the U.S. as an adult. As explained in further detail in Chapter 2, a male speaker was selected for the recording of the material due to the greater ease of understanding male voices over female voices (Mendel & Danhauer, 1997). He was required to sign a release form prior to recording. This release form can be found in Appendix D. Each stimulus word was repeated five times by the speaker in order to later select the best recorded sample of each word. Separate from the stimulus words, the word “numero”, the phrase “circule la palabra” and the numbers one through 50 in Spanish were also recorded five times each.

The recordings were edited with Adobe Audition 1.5 software. The editor listened to every presentation of each recorded word or phrase and selected the best quality and most accurate recording. Each selection was converted into an individual sound file. Prior to editing, each sound file was equalized to the same root-mean-squared (RMS) amplitude (loudness level). The final product resulted in the carrier phrase followed by the stimulus word: “Numero __. Circule la palabra __,” which in English means, “Number __. Circle the word __.” Although the recordings were equalized, a carrier phrase was included to alert the listener. Prior to audio recording, during the process of word list compilation, words that were repeated among the six lists were noted for future reference during sound editing.

There were some words within the six words lists which were used in multiple lists (but never more than once within each list). For example, the words “pasa” is Item 8 in List 1 (rhyming set: pasa, pata, papa, pala, para, paja) and Item 30 in List 4 (rhyming set: casa, grasa, tasa, pasa, masa, asa). During editing and compilation of the lists onto a

CD, only one single sound clip of any repeated word was used across the individual lists. This was to ensure stimuli uniformity. Similarly, the same selection of the carrier phrase and numbers was replicated and used for each presentation of that specific item. For example, every time the listener heard the carrier phrase "Circula la palabra" it was the same sound clip used each time.

There were a total of seven tracks for this project: one calibration tone track and six word lists. A 1000 Hz pure tone of equal RMS to the stimulus words was designated as Track 1 to serve as a calibration tone. Lists 1 through 6 were then assigned as Track 2 through 7. Each audio track is preceded by a spoken prompt identifying the list number in English (e.g., "List one"). The seven tracks were copied onto a two channel compact disk.

Procedures

Participant testing began with an otoscopic examination and diagnostic tympanometric testing. Tympanometry was conducted at 226 Hz using a GN Otometrics Madsen OTOflex 100 middle ear analyzer. Tympanograms were categorized according to the Jerger classification of 226 Hz tympanograms (Jerger, 1970). Pure tone and word recognition testing was the performed for qualifying participants. Audiologic testing was performed in a sound-treated booth using equipment calibrated in compliance with American National Standards Institute (ANSI) S3.39-1987 standards (ANSI, 1987). Air conduction pure tone screening and list presentation was completed using a Grason-Stadler GSI 61clinical audiometer with E.A.R.Tone 3A insert earphones. Pure tone screening was performed utilizing the Modified Hughson Westlake method (Carhart &

Jerger, 1959). Initial pure tone presentation level for each test frequency was 20 dB HL. Consistent participant response to two presentations of a test frequency at the intensity of 20 dB HL or better was considered a pass for that test frequency. After audiometric testing determined hearing to be within normal limits, each participant was administered all six Spanish MRT lists in randomized order in each ear individually at 60 dB HL (comfortable listening level). Recorded materials were presented via a Sony CDP-CE375 five disk CD player through the same Grason-Stadler GSI 61 audiometer. All participants were given the same instructions as follows, spoken by the fluent Spanish- speaking tester:

> Por favor mire la hoja de respuestas. Usted verá que hay 50 bloques numerados con seis palabras cada uno. Cada vez que oiga una palabra debe elegir una palabra del bloque apropiado. Usted oirá el numero seguido por la frase “circule la palabra”. Por favor escuche con atención y circule la palabra que oiga. Si usted no está seguro de la palabra, por favor intente de adivinar.

English translation:

> Please look at the response page. You will see that there are 50 numbered squares with six words each. Every time you hear a word you must select a word in the appropriate square. You will hear the number followed by the phrase “circle the word”. Please pay close attention and circle the word that you hear. If you are not sure of the word, please make an effort to guess.

Full lists (50 words) were used for each list presentation. The first ear to be tested was randomized. Twenty participants were tested beginning with right ear presentation first and 24 participants were tested beginning with left ear presentation first. Each listener was instructed to circle their responses on the response sheet provided for each of the lists. As per the directions given in Spanish prior to testing, participants were asked to leave no blank answers and encouraged to guess if they were unsure of the correct stimulus word. The sample response sheet is provided in Appendix E. Responses were scored on a correct or incorrect basis and each list was scored out of a total of 50 possible points (one point for each correct answer). All lists were scored using an answer key.

A transparency marked with the correct responses for each list was overlaid on top of each corresponding response sheet and compared to the marks made by the participant. This method was employed to ensure consistency in scoring and to avoid human scoring error. Scores were recorded for each participant for each individual ear and analyzed using descriptive statistics and paired-samples t-tests in Chapter 4.

Chapter 4

Results

Mean Scores

Mean scores (out of a possible 50 correct) for the right and left ear were calculated separately for each list. Mean scores for the right ear were as follows: List 1 (*M* = 49.84, *SD* = 0.43); List 2 (*M* = 49.58, *SD* = 0.76); List 3 (*M* = 49.75, *SD* = 0.49); List 4 (*M* = 49.98, *SD* = 0.15); List 5 (*M* = 49.80, *SD* = 0.46); List 6 (*M* = 49.80, *SD* = 0.46). Mean scores for the left ear were as follows: List 1 (*M* = 49.80, *SD* = 0.51); List 2 (*M* = 49.70, *SD* = 0.59); List 3 (*M* = 49.73, *SD* = 0.82); List 4 (*M* = 49.89, *SD* = 0.32); List 5 (*M* = 49.93, *SD* = 0.25); List 6 (*M* = 49.75, *SD* = 0.53). The range of scores was 47-50 correct points in the right ear and 45-50 correct points in the left ear. Table 1 displays a summary of the minimum, maximum, mean and total scores of each list presentation per ear.

There was little variance in individual participant scores (45-50) and overall list scores when scores for each ear were combined (93-100), leading to a lack of a normal distribution of scores. Because the assumption of normal distribution, as required to conduct repeated-measures analysis of variance (ANOVA) was violated, data were compared via paired-samples t-tests. Specifically, ear effect, age effect, gender effect and list equivalency were analyzed. Statistical significance was computed using an $\alpha = 0.01$ confidence level. A more conservative confidence level of $\alpha = 0.01$ was selected for use instead if the more conventional $\alpha = 0.05$ to reduce the risk of committing a type one error (incorrectly rejecting the hypothesis) during collection of the pilot data (Downing &

Clark, 1997). This smaller value is considered to provide stronger evidence against the null hypothesis (Sterne & Smith, 2001). Individual participant scores can be found in Appendix F.

Ear Effect

Paired-samples t-tests were used to analyze results and compare mean performance on each list for the right and left ear. Total mean data for right and left ear performance were also compared. Comparisons of mean scores for the right and left ear suggested no significant difference between ears, within each list or for the overall means. Specifically, results indicated no significant differences between ears for List 1, $t(43) = 0.53$, $p = 0.60$; List 2, $t(43) = -1.03$, $p = 0.31$; List 3, $t(43) = 0.24$, $p = 0.81$.; List 4, $t(43) = 1.67$, $p = 0.10$; List 5, $t(43) = -1.96$, $p = 0.06$.; or List 6, $t(43) = 0.63$, $p = 0.53$. The overall mean for the right and left ears also showed no significant difference, $t(43) = -0.25$, $p = 0.81$. Table 2 shows a summary of the comparison of mean scores between ears for each list. Because no ear effects were found, these data were combined for all further analyses.

Age Effect

A paired-samples t-test was used to compare performance across lists (i.e., the cumulative scores in the right and left ears for Lists 1 through 6) between two age groups. Participant data were evenly divided in half to create a younger group (ages 19-36) and an older group (ages 37-56). Twenty two participants were between 19 and 36 years of age and 22 participants were between 35 and 56 years of age. Results indicated no significant difference in score performance $t(1) = 0.33$, $p =0.57$ when groups were compared based on age. However, it is interesting to note that six of the 11 participants who received perfect scores were ages 37 and over.

Gender Effect

A paired-samples t-test was used to compare the performance across lists between males and females in the study. Data were divided in to two groups for the 18 participating males and 26 participating females. Results indicated no significant difference in score performance, $t(1) = 0.49$, $p = 0.49$. Additionally, of the 11 perfect scores, five were female and six were male.

List Equivalency

List scores were obtained by adding each participant's score on each list for both right and left ear. Inter-list equivalency was analyzed by comparing each combination of paired lists using paired-samples t-tests. A statistically-significant difference was found between List 2 and List 4 $t(43) = -3.69$, $p < 0.001$). No other statistically-significant differences were found between lists. Table 3 shows a summary of inter-list equivalency data. Table 4 displays a ranked summary of incorrectly-identified words in each list, regardless of order of presentation, ear presentation, participant age, and participant gender. Table 4 also shows the number of people who made each of the common errors. Error on right and left ear presentation of the stimulus word was committed at least once for the following items: List 1 Item 39, List 2 Item 26, List 2 Item 2, List 2 Item 20, List 3 Item 30, List 3 Item 18, List 5 Item 35, and List 6 Item 30. List 2 had the most number of error items committed twice by participants while List 4 had none.

Based on these descriptive data, it can be concluded that the majority of errors committed were the same substitution errors for that particular item. List 2 had the most total errors (32 errors), followed by List 3 (22 errors), List 6 (20 errors), List 1 (15 errors), List 5 (12 errors) and lastly, List 4 (5 errors).

Table 1
Minimum Score, Maximum Score, Mean Score and Standard Deviations for the Six Lists for the Right and Left Ear

Ear & List Number	Minimum Score	Maximum Score	Mean Score	Standard Deviation (SD)
Right Ear				
List 1	48	50	49.84	0.43
List 2	47	50	49.57	0.76
List 3	48	50	49.75	0.49
List 4	49	50	49.98	0.15
List 5	48	50	49.80	0.46
List 6	48	50	49.80	0.46
Total	292	300	298.73	1.56
Left Ear				
List 1	48	50	49.80	0.51
List 2	48	50	49.70	0.59
List 3	45	50	49.73	0.82
List 4	49	50	49.89	0.32
List 5	49	50	49.93	0.25
List 6	48	50	49.75	0.53
Total	292	300	298.80	1.71

Table 2
Comparison of Mean Scores for the Right and Left Ear

Measure (Ear and List #)	*t*	*df*	*p*
R1-L1	0.53	43	0.60
R2-L2	-1.03	43	0.31
R3-L3	0.24	43	0.81
R4-L4	1.67	43	0.10
R5-L5	-1.96	43	0.06
R6-L6	0.63	43	0.53
Right Total-Left Total	-0.25	43	0.81

Note. $p<0.01$ confidence level.

Table 3
Comparison of Mean Scores Between List Pairs

List Pair	*t*	*df*	*p*
List 1-List 2	2.33	43	0.02
List 1-List 3	0.76	43	0.45
List 1- List 4	-2.12	43	0.04
List 1-List 5	-0.70	43	0.49
List 1-List 6	0.63	43	0.53
List 2-List 3	-0.94	43	0.35
List 2-List 4	-3.69	43	0.00[a]
List 2-List 5	-2.49	43	0.02
List 2-List 6	-1.70	43	0.10
List 3-List 4	-2.13	43	0.04
List 3-List 5	-1.23	43	0.23
List 3-List 6	-0.33	43	0.74
List 4-List 5	1.35	43	0.18
List 4-List 6	2.32	43	0.03
List 5-List 6	1.14	43	0.26

Note. [a]Statistically significant at the $p < 0.01$ level.

Table 4
List Items with Two or More Errors, Ranked by Number of Errors and Number of People Committing Errors

List	Item Number	Times Missed	Target Word	Substitutions (Times Used)	Right Ear	Left Ear	Number of People
List 1	39	8	poca	boca (8)	5	3	7
List 2	26	10	pino	vino (10)	4	6	9
	25	4	bebe	debe (4)	4	0	4
	2	3	patio	pato (3)	2	1	2
	16	3	rollo	rojo (3)	3	0	3
	20	2	fuente	puente (2)	1	1	1
	28	2	dicho	bicho (2)	1	1	2
	29	2	dardo	cerdo (2)	1	1	2
	47	2	paja	baja (2)	2	0	2
List 3	30	10	tasa	casa (10)	4	6	7
	18	2	gallo	cuello (2)	1	1	1
List 4	40	2	pago	hago (1), vago (1)	0	2	2
List 5	35	8	perro	carro (8)	4	4	6
List 6	30	5	asa	tasa (5)	1	4	4
	36	3	bajo	ajo (3)	2	2	3
	40	3	hago	pago (2), mago (1)	1	2	3
	47	3	baja	paja (3)	2	1	3
	16	2	rojo	rosa (1), rollo (1)	0	2	2
	17	2	secar	sacar (2)	2	0	2

Chapter 5

Discussion

The Modified Rhyme Test for word recognition testing used monosyllabic rhyming English words (House et al., 1965). The use of monosyllabic words for the purpose of a Spanish-language MRT was difficult to successfully apply because the Spanish language has few monosyllabic words (Aguilar, 1991). Assembling a functional Spanish-language MRT comprised of monosyllabic words required the use of many nonsense syllables due to the lack of monosyllabic words in Spanish (Aguilar, 1991) However, the abundance of bisyllabic words in the Spanish language makes their use preferable for compiling a more complete test (Aguilar, 1991). The purpose of this study was to develop Spanish-language MRT word recognition test material that could be used clinically in audiologic assessments. A six list, Spanish-language MRT was developed using Spanish bisyllabic words. In order to develop normative data for the test, each list was administered to each ear of 44 Spanish-speaking participants with normal hearing.

Findings

Previous Research. A previous study by Cokely and Yager (1993) stated that English speakers with no prior knowledge of the Spanish language can effectively score word recognition responses by Spanish speakers. Though Cokely and Yager (1993) demonstrated that Spanish and English speakers can accurately score oral word recognition responses of native Spanish speakers, there may be a strong argument against the ethics of audiologists scoring tests in a language of which they are unfamiliar. This study was designed despite findings reported by Cokely and Yager (1993). In addition, it could be argued that, based on the location of this study (Texas), more of the scorers had been exposed to at least some Spanish throughout their lifetime. There were additionally apparent gaps in the research to further support Cokely and Yager's (1993) claims. For this reason, the development of an objective Spanish language word recognition test and developing normative date for this test seemed essential. This project was based on the original MRT as developed by House et al. (1965) and constructed based on a Spanish MRT developed by Aguilar (1991).

A Spanish language version of the MRT was proposed by Aguilar in 1991. Aguilar (1991) reported that her test had some design flaws which limited the development and eventual implementation of the test. These design flaws included the inability to assemble 50 rhyming sets with six words each. The test was reduced from six lists to five lists, therefore also reducing the number of foils per item from six to five. By following the monosyllabic structure of the original English-language MRT, Aguilar was limited by the phonetic composition of the Spanish language (Aguilar, 1991). Due to the limited number of monosyllabic words in Spanish, Aguilar (1991) used nonsense syllables to complete many of the rhyme sets. Changing the parameters of the original MRT structure also changed its validity, as stated by Bell, Kreul and Nixon (1972).

The present study took into consideration the critiques mentioned by Aguilar (1991) and Tato (1949) regarding Spanish speech audiometry. Based on these studies, bisyllabic words were selected as stimuli. The materials developed included six complete lists of 50 words each. Recorded material was used to ensure uniformity of list presentation between participants, versus the use of monitored live voice presentation.

This study collected normative data for all six lists using 44 normal hearing participants. The data collected in this study suggest that the method of test development was an improvement over the previous attempt of Aguilar (1991), while avoiding the potential ethical dilemma that the Cokely and Yager (1993) study attempted to prove was minimal.

List Equivalency. Paired-samples t-tests suggested statistically significant differences between List 2 and List 4. The lowest overall mean scores were achieved on Lists 2 and 3. However, statistically-significant differences between lists did not show clinical significance in the differences of percentage scores. Individual list scores ranged from 45-50 points out of a total of 50 points (90-100%). All 44 participants had individual list scores of 90% accuracy or higher. Mean right and left ear combined scores ranged between 99.27-99.86 points out of 100 points. In word recognition testing, scores between 90-100% are normally considered to be excellent (Goetzinger, 1978). Because all scores on all lists were 90% or better for each ear, clinical significance between the lists was not demonstrated. In addition, List 2 and List 3 had participants who responded incorrectly on both presentations of various stimuli 3 and 4 times, respectively. This contributed to a higher number of overall errors for these lists.

Item Errors. Specific list items (as previously displayed in Table 4) with two or more errors were further examined. A closer listening inspection of the stimuli suggested that the errors committed were not specifically due to sound editing errors; rather, errors appeared to be due to listener error between words with phonemes pronounced with similar place (e.g., poca and boca) or orthographic errors between similarly spelled words (e.g., pato and patio). List 1 Item 39, List 2 Item 26, List 3 Item 30 and List 6 Item

30 were the items with the most errors (five or more). For these items, all participants marked the same incorrect word in place of the stimulus word. Often times, the same participant committed the same error on both presentations of an item. Table 5 shows a summary of items with errors on both presentations of the stimulus word.

Study Limitations

Sample Size. This study had a relatively small participant sample size for the purpose of normative data collection. The purpose of this study was to develop normative data on the lists which were developed. All 44 participants had mean right and left ear combined scores ranging between 49 points and 50 points across all lists. Variance between mean scores differed by only fractions of one point for all 44 participants. Results from these 44 participants suggested negligible variance between scores overall, and no differences between ears, gender, or age.

Speaker Dialect. Of note, the speaker in the recorded material is from Buenos Aires, Argentina. The Argentinean accent of Buenos Aires has distinguishing pronunciation of the “ll”, “y” and post-nuclear “s” phoneme (Moreno & Mariño, 1998). The “ll” is most typically pronounced in other Spanish speaking countries similarly to the English “y”. However, the Buenos Aires dialect pronounces “ll” and “y” more similarly to the English “sh” (e.g., pollo becomes po-sho) (Moreno & Mariño, 1998). The post-nuclear “s” becomes an “h” sound as long as it not at the end of the word or before a vowel (e.g., mosca becomes moh-ca). The Spanish in Buenos Aires can additionally be generalized to the Spanish dialect spoken throughout Argentina and its eastern neighbor, Uruguay (Moreno & Mariño, 1998). During recording of the lists, the speaker had to make an effort to intentionally neutralize these aspects of his accent.

The speaker's pronunciation modifications did not seem to have affected listener perceptions or overall results. Of the 11 participants with perfect scores, three participants were from Argentina (regions unspecified). Two of the five participants from Argentina did not receive perfect scores. However, neither of these two listeners committed errors on words with "ll" or post-nuclear "s" sounds. The scores of the Argentinean listeners did not seem to particularly favor the Argentinean speaker. Three participants from Argentina, three participants from Mexico, two from Puerto Rico, one from Nicaragua, one from Peru and one from Venezuela received perfect scores on all six lists presented in each ear. The details of specific errors (if two or more errors were present across participants) are shown in Table 6. This table demonstrates the few (10 total) errors made on "ll" and post-nuclear "s" words across all 44 participants in each presentation of the list (right and left ear). Of note, no stimulus words had the letter "y" for comparison. There seems to be no correlation between a particular country and number of errors relative to the overall population of the test group. These data suggest that those words which may have been pronounced with a more traditional regional Argentinian accent had no effect on performance for speakers of other Spanish dialects.

Participant Acclimatization. Statistical analysis suggested that there were no statistically significant ear effects between ears, regardless of initial ear of presentation. These results suggest that participant acclimatization to the speaker's voice was not a factor in participant performance.

Test Duration. Testing sessions lasted about 1 hour and 10 minutes to 1 hour and 30 minutes. During testing some participants expressed that they had become tired or felt sleepy. Despite test duration or participant restlessness, all participants included in the final analysis performed well throughout the testing session. The one person who was excluded from the data set post-data collection was due to excessive exhaustion during the test session.

Future Research

Further validation of the study materials needs to be conducted to determine normative data for clinical significance. Additionally, once normative data are collected, testing on participants with varying degrees of hearing loss is likely to show a greater distribution of scores. Developing distribution data for this test using participants with hearing loss would be the final step in further validation of the study materials. In order for the test materials to be valid, scores for participants with hearing loss would need to show a more normal distribution of scores and possibly be correlated to degree or configuration of hearing loss.

It is recommended that list items be reorganized in future validation of the materials. In this recording of the test material, the first 16 sets of rhyming words are first-syllable rhymes and the following 34 sets are last-syllable rhymes. Reorganizing the lists so that the two rhyme types are intermingled will distribute the rhyme types more evenly. If statistically significant differences continue to be shown between lists, difficult list items may need to be completely removed from the lists or evenly distributed throughout the remaining five lists for a more even spread of difficult words within each list. This step would ensure list equivalency.

Conclusion

The methods used to create the test materials resulted in a successful Spanish-language version of the MRT. Scores for the recorded materials showed no ear, age or gender effect. Inter-list equivalency, however, was not definitively established. Two of the six lists were shown to have more errors than the rest. Further studies involving Spanish-speaking participants with hearing loss are necessary in order to establish clinical significance of the new test. This study demonstrated that the development of a Spanish-language MRT could be effectively achieved.

Table 5

Summary of Number of Participants Who Marked the Same Incorrect Item on Both Presentations of a Stimulus Word

List Number, Item Number	Total Number of Errors	Number of Participants Who Marked Item Incorrect on Both Presentations of the Word
List 1 Item 39	8	1
List 2 Item 26	10	1
List 3 Item 30	10	3
List 5 Item 35	8	1
List 6 Item 30	5	1

Table 6
Errors on Words Which May Have Stronger Argentinian Accent Relative to Country of Origin of Participants Who Committed Errors

List Number	Item Number	Stimulus Word	Total Number of Errors on Item	Countries and Number of Participants Who Committed Error From That Country
1	1	olla	1	Dominican Republic (1)
	13	ella	1	Mexico (1)
	17	rascar	0	
	18	sello	0	
	44	rosca	0	
	48	llave	0	
2	16	pollo	3	Chile (1), Puerto Rico (1), Venezuela (1)
	17	pescar	0	
	18	pollo	0	
	44	rasca	1	Peru (1)[a]
3	18	gallo	2	Mexico (1)
	44	tosca	1	Peru (1)[a]
4	18	brillo	0	
	44	busca	0	
5	18	bello	0	
	44	pesca	0	
6	18	cuello	0	
	44	mosca	0	

Note. [a]Same participant.

APPENDICES

APPENDIX A

TOWSON UNIVERSITY

APPROVAL NUMBER: 10-A068

Office of University Research Services
Towson University
8000 York Road
Towson, MD 21252-0001
t. 410 704-2236
f. 410 704-4494

To: Rita Ball
10032 Hillgreen Circle, Apt. L
Cockeysville MD 21030

From: Institutional Review Board for the Proctection of Human Subjects Melissa Osborne Groves, Member

Date: Tuesday, April 27, 2010

RE: Application for Approval of Research Involving the Use of Human Participants

APPROVED APR 27 2010 MOG/WRP TOWSON IRB

Thank you for submitting an Application for Approval of Research Involving the Use of Human Participants to the Institutional Review Board for the Protection of Human Participants (IRB) at Towson University. The IRB hereby approves your proposal titled:

Developing a Spanish-Language Modified Rhyme Test of Word Recognition Testing

If you should encounter any new risks, reactions, or injuries while conducting your research, please notify the IRB. Should your research extend beyond one year in duration, or should there be substantive changes in your research protocol, you will need to submit another application for approval at that time.
We wish you every success in your research project. If you have any questions, please call me at (410) 704-2236.

CC: Brian Kreisman
File

APPENDIX A (continued)

TOWSON UNIVERSITY

Date: Tuesday, April 27, 2010

NOTICE OF APPROVAL

TO: Rita Ball **DEPT:** ASLD

PROJECT TITLE: *Developing a Spanish-Language Modified Rhyme Test of Word Recognition Testing*

SPONSORING AGENCY:

APPROVAL NUMBER: 10-A068

The Institutional Review Board for the Protection of Human Participants has approved the project described above. Approval was based on the descriptive material and procedures you submitted for review. Should any changes be made in your procedures, or if you should encounter any new risks, reactions, injuries, or deaths of persons as participants, you must notify the Board.

A consent form: [✓] is [ ] is not required of each participant

Assent: [ ] is [ ] is not required of each participant

This protocol was first approved on: 27-Apr-2010

This research will be reviewed every year from the date of first approval.

Melissa Osborne Groves

Melissa Osborne Groves, Member WRP

Towson University Institutional Review Board

APPENDIX B

FORMULARIO DE CONSENTIMIENTO INFORMADO

El departamento de Audiología está tratando de validar una prueba de reconocimiento de palabras en español. Estamos tratando de averiguar qué tan bien funciona con hablantes nativos de español con audición normal. Su papel en este proyecto consistirá en asistir a una sesión de aproximadamente 1 hora y media. La sesión constará en una prueba de audición y su participación en escuchar e identificar varias palabras en español. Los resultados serán utilizados para recolectar datos normativos sobre la prueba y para validar o invalidar la prueba. Su trabajo consiste en circular las palabras que escucha entre seis opciones posibles. No hay riesgos ni molestias asociadas con este procedimiento. Sin embargo, si usted decide no participar en este proyecto, todavía será elegible para la rifa de tarjetas de regalo.

Su participación en este estudio es voluntaria. Toda la información se mantendrá estrictamente confidencial. Aunque las descripciones y los resultados pueden ser publicados, en ningún momento se utilizará su nombre. Usted está en libertad de retirar su consentimiento para el experimento e interrumpir su participación en cualquier momento sin prejuicios. Si usted tiene alguna pregunta después de hoy, por favor siéntase libre de llamar a 410-704-3620 y pregunte por el Dr. Brian Kreisman, o contactar a la Dra. Debi Gartland, Presidenta de la Junta de Revisión Institucional para la Protección de los Participantes Humanos en la Universidad de Towson a 410 -704-2236.

Yo, ___________________________________, afirmo que he leído y entendido la declaración anterior y que se han contestado todas mis preguntas.

Fecha: ____________________

Firma: ____

Testigo: ____

ESTE PROYECTO HA SIDO REVISADO POR LA JUNTA DE REVISIÓN INSTITUCIONAL PARA LA PROTECCIÓN DE LOS PARTICIPANTES HUMANOS DE LA UNIVERSIDAD DE TOWSON. IRB# 10-A068.

APPENDIX C

List 1	List 2	List 3	List 4	List 5	List 6
1. olla	1. ola	1. ojo	1. otra	1. oso	1. otro
2. papa	2. patio	2. pato	2. pata	2. pala	2. para
3. abril	3. aquí	3. apio	3. agua	3. así	3. azul
4. tomo	4. topo	4. toro	4. tono	4. topo	4. toco
5. alma	5. algo	5. alto	5. alta	5. alguien	5. ala
6. bala	6. bajo	6. baño	6. bata	6. baja	6. base
7. cada	7. capa	7. caja	7. cara	7. casa	7. cama
8. pasa	8. pata	8. papa	8. pala	8. para	8. paja
9. corre	9. como	9. cono	9. cola	9. codo	9. cosa
10. bote	10. botón	10. boda	10. bota	10. bola	10. boca
11. cara	11. carro	11. cama	11. casa	11. cabra	11. cada
12. como	12. cosa	12. codo	12. copa	12. cola	12. coche
13. ella	13. eso	13. ése	13. éste	13. era	13. ésta
14. lejos	14. león	14. letra	14. leche	14. legal	14. leve
15. hora	15. hoja	15. hotel	15. hogar	15. olor	15. odio
16. rosa	16. rollo	16. roca	16. roto	16. ropa	16. rojo
17. rascar	17. pescar	17. brincar	17. sacar	17. tocar	17. secar
18. sello	18. pollo	18. gallo	18. brillo	18. bello	18. cuello
19. pluma	19. palma	19. tema	19. broma	19. lima	19. crema
20. gente	20. fuente	20. diente	20. frente	20. puente	20. siente
21. fresa	21. casa	21. risa	21. besa	21. rosa	21. cosa
22. fruta	22. cinta	22. ruta	22. pinta	22. gota	22. gusta
23. falta	23. venta	23. canta	23. salta	23. pata	23. lata
24. plato	24. lento	24. moto	24. gato	24. alto	24. pato
25. nube	25. bebe	25. sube	25. sabe	25. debe	25. cabe
26. cono	26. pino	26. mano	26. fino	26. vino	26. freno
27. pera	27. llora	27. mira	27. tira	27. cara	27. hora
28. bicho	28. dicho	28. hecho	28. techo	28. ocho	28. ancho
29. todo	29. dardo	29. cerdo	29. dedo	29. dado	29. codo
30. casa	30. grasa	30. tasa	30. pasa	30. masa	30. asa
31. arde	31. tarde	31. guarde	31. verde	31. grande	31. pierde
32. zurdo	32. codo	32. pudo	32. cerdo	32. gordo	32. dardo
33. algo	33. hongo	33. pego	33. jugo	33. mango	33. lago
34. cierra	34. barra	34. tierra	34. garra	34. jarra	34. gorra
35. gorro	35. chorro	35. cerro	35. zorro	35. perro	35. carro
36. ojo	36. viejo	36. ajo	36. fijo	36. rojo	36. bajo
37. ala	37. isla	37. pila	37. vela	37. tela	37. pala
38. carne	38. cine	38. gane	38. pone	38. peine	38. tiene
39. poca	39. boca	39. cerca	39. toca	39. busca	39. brinca
40. vago	40. lago	40. mago	40. pago	40. trago	40. hago
41. cama	41. ama	41. rama	41. dama	41. drama	41. fama
42. vuelta	42. alta	42. puerta	42. multa	42. salta	42. falta
43. coche	43. eche	43. leche	43. noche	43. luche	43. broche
44. rosca	44. rasca	44. tosca	44. busca	44. pesca	44. mosca
45. charco	45. tronco	45. cinco	45. circo	45. blanco	45. banco
46. fines	46. tienes	46. ganes	46. cisnes	46. lunes	46. viernes
47. ceja	47. paja	47. hija	47. hoja	47. bruja	47. baja
48. llave	48. tuve	48. nueve	48. breve	48. vuelve	48. nieve
49. polvo	49. nuevo	49. pavo	49. lavo	49. huevo	49. clavo
50. salvo	50. vivo	50. cuervo	50. calvo	50. tuvo	50. sirvo

APPENDIX D

With cooperation from:

CIAT Center for Instructional Advancement and Technology

TOWSON UNIVERSITY

RELEASE FOR THE USE OF RECORDED IMAGE OR SOUND ON VIDEOTAPE, FILM, PHOTOGRAPH, AUDIOTAPE OR LIVE TRANSMISSION

Participant's Name: ______________________________

Program: ____________________ Production Date: ______________

I acknowledge that I am over the age of eighteen, and that I am voluntarily participating in the production of the above-named program by Towson University (TU).

I agree that my participation in the above-named program confers upon me no rights of ownership whatsoever. I authorize Towson University, its affiliates, employees and assigns, to use in any manner and without restrictions, all materials produced pursuant to this release, including but not limited to any photograph or recorded image of either me or property belonging to me, any recording of my voice or statements made by me for any purpose, and any use of my name during the process of such recordings, in whole or in part, without inspection or further consent or approval by me or by my parent or guardian (if applicable) of the finished product or any use which may be made of it. I further agree that TU may copyright, modify, alter, duplicate, broadcast and/or distributed any or all such materials without limitation, through any means whatsoever.

In consideration for being allowed to participate in this production, I hereby release TU, its agents, employees, officers, directors and assigns, from liability for any claims by me or by any third party in connection with the aforementioned materials and/or my participation in the above-named program. This voluntary grant and release will not be made the basis of any future claim of any kind against TU, the University System of Maryland, or the State of Maryland.

I confirm that any and all material furnished by me for this program is either my own or otherwise authorized for such use without obligation to me or to any third party. I also agree to the use of voice for program publicity and organizational promotional purposes.

PARTICIPANT

____
Signature

Date: ________________

____
Street Address

____
City State Zip

WITNESS

____
Signature

Date: ________________

Parent or Guardian Consent: I, as (father, mother, guardian) of the person named above, do hereby consent to the release of the material described above.

Name: ______________________

Signature: ______________________ Date: ______________

APPENDIX E

No.						
1.	ojo	oso	ola	otro	olla	otra
2.	papa	pala	pato	pata	para	patio
3.	abril	apio	agua	aquí	azul	así
4.	topo	toco	todo	tono	tomo	toro
5.	ala	alma	algo	alta	alto	alguien
6.	baja	baño	bajo	bata	base	bala
7.	casa	capa	cama	cada	cara	caja
8.	pala	pasa	pata	para	paja	papa
9.	cosa	cola	codo	cono	como	corre
10.	boca	bola	bota	botón	boda	bote
11.	cabra	cara	cada	carro	cama	casa
12.	como	cola	coche	cosa	codo	copa
13.	ella	éste	era	eso	ése	ésta
14.	leche	leve	legal	león	lejos	letra
15.	hoja	hora	hotel	odio	olor	hogar
16.	rojo	rollo	rosa	roca	roto	ropa
17.	pescar	secar	brincar	tocar	sacar	rascar
18.	pollo	gallo	bello	sello	brillo	cuello
19.	pluma	tema	palma	lima	broma	crema
20.	diente	puente	frente	fuente	siente	gente
21.	casa	cosa	fresa	rosa	besa	risa
22.	fruta	cinta	ruta	gota	gusta	pinta
23.	salta	canta	falta	lata	venta	pata
24.	alto	moto	gato	pato	lento	plato
25.	bebe	debe	nube	cabe	sube	sabe
26.	freno	fino	pino	cono	vino	mano
27.	mira	pera	cara	llora	hora	tira
28.	ancho	hecho	bicho	ocho	dicho	techo
29.	cerdo	dedo	codo	todo	dardo	dado
30.	pasa	casa	asa	masa	grasa	tasa
31.	grande	guarde	verde	pierde	arde	tarde
32.	cerdo	pudo	dardo	gordo	codo	zurdo
33.	hongo	lago	algo	pego	jugo	mango
34.	garra	barra	gorra	jarra	cierra	tierra
35.	cerro	perro	carro	zorro	gorro	chorro
36.	ajo	rojo	bajo	viejo	ojo	fijo
37.	ala	pila	isla	vela	pala	tela
38.	peine	gane	cine	carne	tiene	pone
39.	poca	toca	boca	brinca	cerca	busca
40.	vago	hago	trago	pago	lago	mago
41.	cama	drama	ama	rama	fama	dama
42.	alta	multa	salta	vuelta	falta	puerta
43.	luche	eche	leche	noche	broche	coche
44.	pesca	rasca	busca	rosca	mosca	tosca
45.	blanco	banco	cinco	charco	tronco	circo
46.	tienes	cisnes	fines	viernes	ganes	lunes
47.	hoja	bruja	paja	ceja	baja	hija
48.	vuelve	nueve	llave	tuve	nieve	breve
49.	clavo	pavo	huevo	polvo	nuevo	lavo
50.	calvo	tuvo	cuervo	vivo	sirvo	salvo

APPENDIX F

Participant number, gender, age, years/months in the U.S., country of origin, initial presentation ear, and scores (number correct out of 50) for right ear Lists 1-6 and left ear Lists 1-6.

Part. #	Gen.	Age	Years in U.S.	Country	Ear	R1	R2	R3	R4	R5	R6	L1	L2	L3	L4	L5	L6
1	F	32	1 mo.	C.R.	R	49	48	50	50	49	50	50	50	49	49	50	50
2	M	29	3	Peru	R	50	50	50	50	50	49	50	50	50	50	50	50
3	M	35	17	Mex.	R	50	50	50	50	50	50	49	50	50	50	50	50
4	F	31	5	Spain	R	50	50	50	50	50	50	50	49	50	50	50	50
5	M	28	25	Chile	R	50	49	49	50	50	50	50	50	50	50	50	50
6	F	31	22	C.R.	R	49	49	50	50	49	50	50	50	50	50	49	50
7	F	29	7	Peru	R	50	50	48	50	50	50	50	48	45	50	50	49
8	M	29	5	Col.	R	50	50	50	50	50	50	50	49	50	50	50	50
9	F	40	22	Mex.	R	50	50	50	50	50	50	50	50	50	50	50	50
10	F	33	25	Mex.	R	50	48	49	50	50	50	50	50	50	50	50	50
11	F	47	20	Spain	R	50	50	50	50	48	49	50	50	50	50	50	50
12	F	27	8	P.R.	R	50	50	50	50	50	50	50	50	50	50	50	50
13	F	33	24	Par.	R	49	50	50	50	50	50	50	50	50	50	50	50
14	F	31	8	Peru	R	50	50	50	50	50	50	49	50	49	49	50	50
15	M	43	18	Peru	R	50	50	50	50	50	50	50	50	50	50	50	50
16	F	23	14	Mex.	R	50	50	50	50	50	50	50	50	50	50	50	50
17	M	41	7	Ven.	R	50	50	50	50	50	50	50	50	50	50	50	50
18	F	20	2	Peru	L	50	50	50	50	50	50	50	49	50	50	50	50
19	F	50	21	Peru	L	50	50	50	50	50	50	49	50	50	50	50	50
20	F	21	20	P.R.	L	48	48	49	50	49	48	48	49	50	50	50	49
21	F	19	3	Pan.	L	50	50	49	50	50	50	50	50	49	50	50	50
22	M	33	5	Mex.	L	50	50	49	50	50	50	49	50	49	49	50	50
23	F	21	4	Chile	L	50	50	50	50	50	50	50	49	50	50	50	50
24	M	29	23	Peru	L	50	50	49	50	49	50	50	50	49	50	50	50
25	M	47	21	P.R.	L	50	50	50	50	50	50	50	50	50	50	50	50
26	M	56	9	Arg.	L	50	50	50	50	50	50	50	50	50	50	50	50
27	F	51	9	Arg.	L	50	50	50	50	50	50	50	50	50	50	50	50
28	F	41	20	Spain	L	50	49	50	50	50	50	50	50	50	50	50	49
29	M	19	1	Ven.	L	49	49	50	50	50	50	50	49	50	50	50	50
30	F	20	9	Arg.	L	50	50	50	50	50	50	50	50	50	50	50	50
31	M	36	10	Par.	L	50	48	50	50	50	50	50	48	50	50	50	48
32	M	35	8	Mex.	L	50	50	50	50	50	50	50	50	50	50	50	50
33	M	28	21	Peru	L	50	50	49	50	50	50	50	50	50	50	49	50
34	M	41	8	Mex.	L	50	50	49	50	50	49	50	50	49	50	50	49
35	F	50	36	Nic.	L	50	50	50	50	49	50	49	50	50	49	50	50
36	M	42	19	Spain	L	50	50	50	50	50	49	50	50	50	50	50	48
37	F	20	14	Nic.	R	50	50	50	50	50	50	50	50	50	50	50	50
38	M	25	21	D.R.	L	50	49	50	49	50	49	48	48	49	50	50	49
39	M	22	17	Ecu.	L	49	49	50	50	50	50	50	50	50	50	50	50
40	F	23	14	D.R.	L	50	47	50	50	50	50	50	50	50	50	50	50
41	F	21	11	Mex.	L	50	50	50	50	50	49	50	49	50	49	50	49
42	F	36	2 mos.	Arg.	L	50	49	50	50	49	50	50	50	50	50	50	50
43	F	35	7	Arg.	R	50	50	50	50	49	50	50	50	50	50	49	50
44	F	48	21	Mex.	R	50	49	49	50	50	49	50	50	50	50	50	49

Note. Part.=Participant, Gen.=Gender, Arg.=Argentina, Col.=Colombia, C.R.=Costa Rica, D. R.=Dominican Republic, Ecu.=Ecuador, Mex.=Mexico, Nic.=Nicaragua, Pan.=Panama, Par.=Paraguay, P.R.=Puerto Rico, Ven.=Venezuela

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