PSYCHOMETRICALLY EQUIVALENT BISYLLABIC WORDS FOR SPEECH RECEPTION THRESHOLD TESTING IN ARABIC

by

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ABSTRACT

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The use of speech audiometry is essential in audiological testing. One of the most important elements of speech audiometry is speech reception threshold. To provide services for the growing population of non-English speaking people, audiologists need speech audiometry materials in a variety of languages. The purpose of this study was to develop, digitally record, evaluate, and equate Arabic bisyllabic words for use in testing speech reception threshold. Ninety frequently used bisyllabic words were digitally recorded by a male talker of standard Arabic. These words were presented to 20 normally hearing subjects in 2 dB increments at intensity levels ranging from -10 to 22 dB HL. Psychometric functions were then determined for all 90 words using logistic regression. Words with steep psychometric functions were selected for inclusion in the test CD. The intensities of these selected words were adjusted to match the mean subject PTA within 2 dB, and a list of words was developed which was homogenous with respect to slope

and audibility. The words are contained on tracks 2 and 3 of the *Brigham Young University Arabic Speech Audiometry Materials (Disc 1.0)* CD.

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Introduction

Audiologists today are faced with the issue of serving the growing population of non-English speaking people. In order to provide the best service, audiologists need materials in a client's native language to assess speech communication abilities. This is not a problem when performing pure-tone audiometry. However, when using speech audiometry to test an individual's ability to perceive speech, it is vital to have evaluation materials available in that client's native language.

The use of speech audiometry in audiological testing is important for several reasons. First, speech stimuli represent the core of the auditory stimulation that occurs in everyday life. Second, the understanding of speech is important for integration into society. Third, individuals participating in speech audiometry tests are usually familiar with the words used, thus speech audiometry has a high degree of validity (Ramkissoon, 2001).

An essential component of speech audiometry is the speech reception threshold (SRT). In 1988, the American Speech-Language Hearing Association (ASHA) defined SRT as "the minimum hearing level for speech at which an individual can recognize 50% of the speech material" (p. 86). The SRT is important because it can be used to better understand an individual's communication ability in daily life situations. SRT testing has been shown to be reliable in its agreement with pure-tone thresholds. Therefore, it can be used as a check on the consistency of test results as well as provide a baseline "from which to determine the presentation of speech material in suprathreshold testing" (Epstein, 1978, p. 669). The SRT test is not time consuming and is a reliable estimate of a patient's loss of sensitivity for conversational messages (Epstein, 1978).

In developing speech audiometry materials, it is important that test materials be both valid and reliable. In order to assure that this occurs, test materials must meet several criteria. First, the words used in speech audiometry must be familiar to the listener. This ensures that the audiologist is measuring the listener's auditory threshold rather than vocabulary knowledge. Second, the words must have phonetic dissimilarity, which does not allow for similar or rhyming words. Phonetic dissimilarity ensures the absence of auditory discrimination. Third, the words must be relatively homogenous with respect to threshold and must have steep psychometric function slopes. This refers to the ease with which words are understood when spoken at a constant level by a normal speaker. If the words are homogeneous, this reduces the number of test items, which is desirable in acquiring the speech threshold (Hudgins, Hawkins, Karlin, & Stevens, 1947). These conditions are vital in developing speech audiometry materials in English as well as in other languages.

Speech audiometry materials have been developed in several languages including Spanish (Christenson, 1995), Italian (Greer, 1997), Russian (Aleksandrovsky, McCullough, & Wilson, 1998; Pola, 2003), Brazilian Portuguese (Harris, Goffi, Pedalini, Gygi, & Merrill, 2001), Korean (Harris, Kim, & Eggett, 2003), Polish (Harris, Nielson, McPherson, Skarzynski, & Eggett, 2004), and Mandarin (Nissen, Harris, Jennings, Eggett, & Buck, 2005). These materials greatly assist in the audiological evaluation of individuals whose native language is not English.

Speech audiometry materials have also been developed in the Arabic language (Alusi, Hinchcliffe, Ingham, Knight, & North, 1974; Ashoor & Prochazka, 1982; Ashoor & Prochazka, 1985; Soliman, 1976). Four of these tests are adult speech recognition tests, which were developed in Moroccan by Messouak (as cited in Ashoor & Prochazka, 1982), Iraqi (Alusi et al., 1974), Egyptian (Soliman, 1976), and Saudi (Ashoor & Prochazka, 1982) dialects. Alusi et al. (1974) and Ashoor and Prochazka (1982) reported that their tests were recorded on tape and modeled after the recording of English speech recognition tests. However, these tests have not been widely circulated in Arab countries (Abdulhaq, 2005).

The purpose of the present investigation is to further contribute to the development of Arabic speech audiometry materials by producing digitally recorded standardized words in Arabic in the Palestinian/Jordanian dialect for the use of measuring the SRT. This will provide speech audiometry test materials for audiologists in the United States who are familiar with this dialect of the Arabic language for testing individuals whose native language is Arabic. It will also provide a recorded word list for audiologists in Arabic speaking countries to use in measuring the SRT.

Review of Literature

Speech Audiometry

In standard audiological evaluations, pure-tone testing is a preferred method because of its high validity, reliability, and simplicity in administration. However, even though thresholds for pure-tone stimuli are easily measured and reliable, speech is a more valuable stimulus because it can be used to determine communicative ability in everyday life (Harris et al., 2001). According to Alusi et al. (1974), speech audiometry provides “a measure of the linguistic sense that is made of what is perceived” (p. 212).

Measurement of the SRT is one of the processes used to determine an individual’s hearing threshold for speech. This process of finding a speech threshold has several purposes, one of which is to quantify a person's hearing threshold level for speech. Another purpose, which is important clinically, is to provide a check of validity for pure-tone test results (ASHA, 1988). In addition, speech audiometry is an effective measure of an individual's communication ability (Bell & Wilson, 2001). All of these reasons indicate why the "measurement of hearing for speech has proved essential to the full assessment of the educational and rehabilitational needs of patients with permanent auditory impairments" (Carhart, 1951, p. 62).

It is necessary in the audiological evaluation of an individual with a hearing impairment to relate the results of tests to a prediction of the individual's ability to hear and understand speech. This information is important in determining the expected success with amplification devices and in assessing the possible improvement that can be gained from an aural rehabilitation program. Pure-tone audiometry does not provide the information necessary for such an assessment (Epstein, 1978). Therefore, speech audiometry is a fundamental part of any comprehensive audiological examination.

Elements of Speech Audiometry

There are two parts of a hearing loss of concern in an individual's hearing evaluation. The first is the extent of the loss and the second is the nature of the loss (Epstein, 1978). The extent of the loss refers to the loss of sensitivity as a result of hearing impairment. This is dealt with by comparing threshold measures to a relative normative sample. This measure is termed the SRT. In 1988 ASHA defined the SRT as "the minimum hearing level for speech at which an individual can recognize 50% of the speech material" (p. 86). Therefore, during this test clients must repeat or somehow indicate recognition of 50% of the words presented.

The nature of the hearing loss is more complex and measures individuals' ability to use their residual hearing. It is important to know how well they can identify a speech signal with use of amplification. These measures are obtained at suprathreshold levels and have been termed word recognition tests. In word recognition testing speech signals are amplified to levels that will offset the hearing deficit. Information is gathered to know at what amplification level an individual can recognize speech signals (Epstein, 1978). Both SRT and word recognition are vital components to obtain in an audiological evaluation.

Speech Reception Threshold

This study will focus on the element of speech audiometry known as the SRT. Epstein in 1978 reported that "there is a close relationship between the speech reception threshold and the pure-tone average for the speech frequencies" (p. 669). Therefore, this measure is important in audiological testing because it not only assists in identifying the threshold for speech but also confirms the results of pure-tone testing. It also serves as a reference level for additional speech tests (Harris et al., 2001). In addition, the SRT test is useful clinically because it is not time consuming and has shown to be an efficient estimate of individuals' loss of sensitivity for conversational messages (Epstein, 1978).

Spondaic words are the standard and recommended test material for determining SRT in English. Spondaic words are two-syllable words that contain equal stress on both syllables. Spondaic words are preferred in SRT testing because of their homogeneity in audibility (ASHA, 1988). In 1948, Egan reported that when different types of words were presented to trained listeners, spondees had the highest homogeneity of audibility. This is important because it facilitates exact measurements of the hearing threshold for speech within a small range of intensities. There may be circumstances, such as advanced age, decreased language facility, and poor physical condition of the client that may require the use of alternative test materials. However, the use of speech stimuli that are not as homogeneous as spondaic words may compromise the reliability of the SRT (ASHA, 1988).

The SRT measure indicates the level needed for speech to reach audibility. Once this has been found, it can be compared to normative thresholds obtained from typical listeners. The audiologist can use SRT measures to find the amount that speech must be amplified in order for the individual with the hearing loss to effectively communicate. One of the most apparent clinical applications of this measure is determining whether or not an individual has a sufficient hearing loss to require a hearing aid (Carhart, 1951).

Other purposes for determining SRT as stated by Priede and Coles in 1976 include measuring progress during audiometric training, measuring results of surgery, and determining a patient's suitability for a certain treatment. Because the SRT is so useful in audiometric testing and in determining clients' communication ability, it is crucial that valid and reliable test materials are available. In order to assure this, several criteria must be followed when developing and recording SRT test stimuli.

Criteria of Test Stimuli

In English, spondaic words are generally used as the test material for measurement of the SRT, and it is important that the words are homogeneous and familiar (ASHA, 1988). If words are homogenous, then they should be intelligible at the same presentation level. Therefore, the words are interchangeable (Carhart, 1951). Homogeneity of test words with respect to intelligibility is crucial because it increases the accuracy of the establishment of the SRT. It also allows the use of fewer test items, which decreases test time and listener fatigue (Young, Dudley, & Gunter, 1982).

Familiarity of test words is important because it ensures that the test is valid (Nissen et al., 2005). According to Rudmin in 1987, when hearing assessments were performed with unfamiliar words the validity of the SRT measurement was seriously compromised. The words should be as simple and familiar as possible to make certain that the test measures speech threshold rather than knowledge of vocabulary. For nonnative English speakers, listening to words that are unfamiliar and infrequent is difficult and reduces the value of SRT measurements obtained under these conditions (Ramkissoon, 2001). Familiarization is also necessary to ensure that the client can auditorily recognize the test words and that the client’s responses can be interpreted accurately by the audiologist (ASHA, 1988).

It is also important that test items contain phonetic dissimilarity. Phonetic dissimilarity ensures that the words do not provide additional auditory cues like those found in rhyming words (Ramkissoon, 2001). For example, if words such as *plowboy* and *cowboy,* which differ in only one sound, were included on a word list, this would increase the test’s difficulty by demanding a finer discrimination. This is not useful in determining the SRT (Hudgins et al., 1947).

Criteria for Recording

When developing speech audiometry materials, it is important to use native talkers of the target language (Weisleder & Hodgson, 1989). Assessment of word recognition using recordings in a non-native dialect may reduce performance of the client (Wilson & Moodley, 2000). In this study a native Arabic speaker from Jordan was used to record bisyllabic Arabic words. In obtaining the SRT, either recorded material or a monitored-live-voice technique can be used. Because it is difficult for a speaker to produce test stimuli at the same hearing level and in the same manner for every trial, the use of recorded material is preferred. This allows better control of intensity of test items as well as provides a consistent speech pattern of the recorded talker. Using recorded material ensures that the test material is standardized for each client tested (ASHA, 1988). It also reduces variability of the speaker's accent during testing of the SRT. It is important to note that digital recordings are preferred over tape recordings due to factors such as longer storage life, improved signal-to-noise ratio, and reduced harmonic distortion (Nissen et al., 2005).

Non-English Speech Audiometry Materials

Historically, many studies have focused on improving speech audiometry materials in English. However, the improvement of these materials in other languages has received less attention (Nissen et al., 2005). In the United States, 85% of audiologists are mono-lingual talkers of English. However, a large segment of the U.S. population is from non-English speaking countries. Using test materials that are not in an individual's first language may lead to test bias, which may threaten the validity of the results (Ramkissoon, 2001). Therefore, the need for high quality speech audiometry materials in a variety of languages is needed for audiologists in the U.S. as well as throughout the world.

Arabic Speech Audiometry Materials

There have been several speech audiometric tests published in Arabic. The first was developed in the Moroccan dialect by Messouak in 1956 (as cited in Ashoor &

Prochazka, 1982). After this, a list of 78 bisyllabic words was developed. However, this test has not been evaluated to determine homogeneity and familiarity of the test items (Hanna, 1976). Along with these tests, there have been tests developed in Iraqi (Alusi et al., 1974), Egyptian (Soliman, 1976), and Saudi (Ashoor & Prochazka, 1982) dialects of Arabic. These speech audiometry tests were developed for use with adults. There has also been a pediatric test developed in Saudi (Ashoor & Prochazka, 1985).

Alusi et al. (1974) and Ashoor and Prochazka (1982) reported using magnetic tape to record their tests. As mentioned above, digital recordings are preferred over tape recordings due to advantages such as longer storage life, improved signal-to-noise ratio, no wow and flutter associated with tape playback, and ability to modify digital signal in a highly efficient manner (Harris et al., 2001; Nissen et al., 2005).

Alusi et al. (1974) and Ashoor and Prochazka (1982) used monosyllabic words in developing their lists. Therefore, there is currently no published or reliable bisyllabic word list available in Arabic for use in measuring the SRT. There is also no list available in the Palestinian/Jordanian dialect. Alusi et al. reported that the dialectal differentiation in Arabic is appreciable. Therefore, more lists need to be developed in different Arabic dialects. The purpose of this study is to develop and digitally record a list of bisyllabic words in Standard Arabic in the Palestinian/Jordanian dialect. Standard Arabic was chosen because of its wide use in schools, news, and entertainment media, which allows it to meet the criteria of familiarity (Alusi et al., 1974). This word list could be used by audiologists in the Arabic countries of Jordan and Palestine in determining the SRT for individuals who speak that dialect.

The Arabic Language

The Arabic alphabet first appeared in 512 A.D. With it came a "rich and flourishing literature… [of] scientific, poetic, secular and religious works" (Alusi et al., 1974, p. 213). Arabic is classified as a Semitic language and is used throughout the Arabic world, which spans from North Africa in the west to South-West Asia in the east (Ashoor & Prochazka, 1982; Bakalla, 1984).

One of the main characteristics of the Arabic language is *diglossia*. The word diglossia is made up of two elements. The prefix *di* means two and *glossia* means language. This indicates that two forms of the same language co-exist, each part performing a separate function. Diglossia is not only found in Arabic, but in Greek and Swiss German as well (Bakalla, 1984).

In Arabic the two levels of the language are the oral dialects and the written/read dialects. The oral dialect is called Colloquial Arabic, and the written and read dialect is called Literary Arabic. Colloquial Arabic is what native Arabic speakers use in their day to day conversations with each other. It may be different due to factors such as religion, geography, and demography (Rabin & Rosenhouse, 2000). Some of the differences in Colloquial Arabic could include simplifications of rules of grammar, new words borrowed from other languages, and alternative forms of some phonemes (Amayreh, 2003). This form of the language varies from country to country and even from area to area within each country (Bakalla, 1984).

Literary Arabic, also known as Standard Arabic, is unifying for the Arabic people because it is used in reading and writing, but also may be used in oral speech. However, not everyone has a thorough knowledge of this form of the language (Versteegh, 1997).

Literary Arabic is used in prayers, political speeches, conference lectures, and media and is what is formally studied in the schools (Rabin & Rosenhouse, 2000). Literary Arabic is seen as the "high" or "prestigious" form of the Arabic language (Versteegh, 1997).

Children speak Colloquial Arabic until they begin school. At school they are taught the symbols and consonants associated with Standard Arabic (Amayreh, 2003). Standard Arabic has a relatively stable phonological system, which differs in certain areas from the phonological systems of the varieties of Colloquial Arabic. However, because of increased literacy, Standard Arabic and Colloquial Arabic are becoming increasingly intermingled (Rabin & Rosenhouse, 2000).

Even though the people in Arabic speaking countries share Standard Arabic, there are many different dialects that distinguish the Arabic language that is spoken in each country. The dialects have been divided into several broad groups, including dialects of the Arabian Peninsula, Syro-Lebanese dialects, Mesopotamian dialects, Egyptian dialects, and Maghrebi dialects. The Syro-Lebanese dialects can be further divided into three groups: Lebanese/Central Syrian dialects, North Syrian dialects, and Palestinian/Jordanian dialects. In this study the Palestinian/Jordanian dialect was used. This dialect includes the South Palestinian/Jordanian dialects, the Palestinian town dialects, and the Central Palestinian village dialects (Versteegh, 1997). Most of the participants in the study were from Jordan, however several came from Palestine as well.

Method

Participants

Twenty native Arabic speakers participated in evaluating the 90 bisyllabic Arabic words used in this investigation. All of the subjects were from the countries of Jordan and

Palestine and self reported speaking Standard Arabic. Each subject was given a pure-tone air-conduction test and exhibited pure-tone thresholds ≤15 dB HL (American National Standards Institute, 2004) from 125 to 8000 Hz at all octave and midoctave frequencies. Subjects also had static acoustic admittance between 0.3 and 1.4 mmhos with peak pressure between -100 and +50 daPa (ASHA, 1990). Information about each subject can be found in Table 1.

Materials

Words. Commonly used bisyllabic Arabic words were chosen for this study. The words were chosen from 3 sources: (a) a word frequency list provided by Landau (1959), which was derived from daily newspapers from Lebanon, Egypt, Iraq, and Palestine, as well as modern prose; (b) lists of Arabic key words for learners of everyday Arabic as a second language (Quitregard, 1994), (c) and children's storybooks. The words chosen had a similar form in both Colloquial and Standard Arabic (Ashoor & Prochazka, 1985). A native Arabic judge from Jordan reviewed the words and ordered them according to familiarity. The judge then took out the inappropriate and unfamiliar words and reduced the list to the 90 bisyllabic words used in the study. The final list of the 90 bisyllabic Arabic words can be found in Table 2.

Talkers. Five Jordanian males agreed to participate in recording the Arabic words. Initial recordings were made of 5 minutes of continuous speech from each of the talkers. Five Jordanian natives judged the talkers on Jordanian dialect and on a 10 point scale of ease of understanding. The top ranked talker was selected and he then completed the recording of the bisyllabic words.

Due to the patriarchal nature of the Arabic culture, only a male talker was used to

Table 1

Age (in years) and Pure Tone Threshold (dB HL) Descriptive Statistics for the 20 Arabic Participants

	M	*Minimum*	*Maximum*	*SD*
Age	23.1	18	39	4.9
125 Hz	1.8	-10	10	4.9
250 Hz	0.5	-10	10	5.4
500 Hz	4.0	-5	15	5.0
750 Hz	3.5	-5	15	4.3
1000 Hz	2.8	-5	10	4.1
1500 Hz	3.3	0	10	3.7
2000 Hz	1.8	-5	10	4.1
3000 Hz	2.3	-10	15	6.2
4000 Hz	1.8	-10	15	6.1
6000 Hz	1.0	-10	15	7.7
8000 Hz	-0.8	-10	15	7.1
PTA	2.8	-5.0	8.3	3.2

Table 2

Mean Performance for 90 Arabic Male Bisyllabic SRT Words

#	Word	a[a]	b[b]	Slope at 50%[c]	Slope 20-80%[d]	Threshold[e]	ΔdB[f]	Headroom	ΔdB[g]
1	عَرَب	2.71478	-0.24608	6.2	5.3	11.0	8.2	2.5	2.5
2	مَلك	3.36766	-0.44482	6.3	5.5	7.6	4.7	2.4	2.4
3	وزير	4.49241	-0.39934	12.2	10.5	11.2	8.4	6.6	6.6
4	مسلم	5.58802	-0.48923	8.0	7.0	11.4	8.6	5.4	5.4
5	جامع	2.95625	-0.36208	8.9	7.7	8.2	5.3	3.8	3.8
6	سلام	3.38409	-0.32667	5.0	4.3	10.4	7.5	6.1	6.1
10	احمر	2.96133	-0.25330	8.5	7.3	11.7	8.9	0.0	0.0
11	عالم	2.74840	-0.31674	9.7	8.4	8.7	5.8	0.0	0.0
12	كتاب	3.25421	-0.25857	7.9	6.9	12.6	9.8	5.3	5.3
13	صاحب	3.06956	-0.39037	9.3	8.1	7.9	5.0	1.3	1.3
14	قانون	4.14394	-0.36769	9.0	7.8	11.3	8.4	5.1	5.1
15	طالب	3.20273	-0.25150	8.8	7.6	12.7	9.9	7.6	7.6
20	واسع	3.99485	-0.37536	9.9	8.5	10.6	7.8	1.5	1.5
21	موضوع	2.46174	-0.32616	12.4	10.8	7.5	4.7	6.5	6.5
22	مطعم	1.98587	-0.25876	10.0	8.7	7.7	4.8	0.5	0.5
23	استاذ	4.16116	-0.34593	6.5	5.6	12.0	9.2	5.4	5.4
25	انسان	4.93028	-0.42324	5.9	5.1	11.6	8.8	6.2	6.2
26	مدير	6.35493	-0.42953	10.9	9.4	14.8	12.0	9.4	9.4
28	جنوب	3.85222	-0.34107	7.6	6.5	11.3	8.5	6.3	6.3
30	صورة	5.34614	-0.27719	12.0	10.3	19.3	16.5	4.9	4.9
31	زواج	2.82644	-0.36951	7.7	6.7	7.6	4.8	4.5	4.5
32	شمال	2.66320	-0.26367	10.0	8.7	10.1	7.3	4.5	4.5
33	سرعة	2.66545	-0.36849	8.8	7.6	7.2	4.4	5.7	5.7
34	واجب	2.85633	-0.41731	9.8	8.4	6.8	4.0	3.2	3.2
38	اصلي	6.30575	-0.40359	10.1	8.7	15.6	12.8	3.6	3.6
40	مكان	2.92712	-0.37741	8.3	7.2	7.8	4.9	4.0	4.0
41	فندق	5.18594	-0.40851	8.5	7.4	12.7	9.9	-7.0	9.9
43	فكرة	3.69668	-0.36493	5.1	4.4	10.1	7.3	-2.0	7.3
44	مطر	3.10329	-0.25830	9.2	8.0	12.0	9.2	5.2	5.2
46	ساحل	2.92135	-0.17394	9.7	8.4	16.8	14.0	2.5	2.5
47	قائد	3.97137	-0.35196	6.3	5.4	11.3	8.5	4.5	4.5
48	موسم	5.75509	-0.42235	11.1	9.6	13.6	10.8	4.1	4.1
49	سؤال	3.15342	-0.34272	9.4	8.1	9.2	6.4	2.0	2.0
51	دولة	4.40400	-0.40259	8.2	7.1	10.9	8.1	3.6	3.6
53	ثورة	4.26944	-0.31058	6.5	5.6	13.7	10.9	3.5	3.5
54	حاكم	3.76315	-0.31729	8.6	7.5	11.9	9.0	1.7	1.7
55	مادة	5.89229	-0.39046	10.6	9.2	15.1	12.3	2.0	2.0
57	فرصة	3.69976	-0.35417	10.7	9.3	10.4	7.6	2.0	2.0
58	أمير	4.76632	-0.43211	8.5	7.4	11.0	8.2	4.9	4.9
59	دفاع	3.51140	-0.34636	10.0	8.6	10.1	7.3	3.4	3.4
60	سفر	4.06279	-0.29690	6.9	6.0	13.7	10.9	1.1	1.1
63	منزل	4.70598	-0.47027	9.2	8.0	10.0	7.2	4.5	4.5
65	عدو	3.06529	-0.27407	6.6	5.7	11.2	8.4	0.5	0.5
66	جهاد	3.55894	-0.48254	9.2	8.0	7.4	4.5	4.2	4.2
67	دعوة	3.05486	-0.35189	10.4	9.0	8.7	5.9	5.3	5.3
68	مسجد	2.37024	-0.33364	10.1	8.7	7.1	4.3	2.3	2.3
71	جمال	3.63186	-0.38622	12.2	10.6	9.4	6.6	4.6	4.6

72	ذهب	2.93903	-0.23830	9.4	8.2	12.3	9.5	0.9	0.9
73	حديد	2.78966	-0.23479	10.2	8.8	11.9	9.1	0.3	0.3
74	معنى	4.85951	-0.28158	9.1	7.9	17.3	14.4	0.7	0.7
75	مطار	4.58416	-0.44445	6.5	5.6	10.3	7.5	5.7	5.7
76	كامل	3.61791	-0.17490	4.3	3.8	20.7	17.9	3.5	3.5
80	عنوان	2.41749	-0.27876	8.8	7.6	8.7	5.8	7.0	7.0
81	ذاتي	8.97731	-0.45866	10.6	9.1	19.6	16.7	1.3	1.3
83	جملة	4.82687	-0.45463	8.6	7.4	10.6	7.8	7.7	7.7
84	عامل	5.07564	-0.21898	9.1	7.8	23.2	20.3	2.5	2.5
85	سكر	5.74616	-0.37410	10.1	8.7	15.4	12.5	5.2	5.2
87	مسكين	7.05740	-0.49734	7.8	6.7	14.2	11.4	4.1	4.1
88	واحد	2.62724	-0.24025	7.9	6.9	10.9	8.1	2.7	2.7
89	شريف	1.78280	-0.23333	9.8	8.4	7.6	4.8	3.9	3.9
90	جندي	4.56530	-0.42976	8.9	7.7	10.6	7.8	9.0	9.0
91	حياة	1.25007	-0.26285	10.8	9.4	4.8	1.9	0.6	0.6
93	مفتاح	3.75992	-0.47703	8.7	7.5	7.9	5.1	2.2	2.2
94	بشر	3.00467	-0.37736	8.2	7.1	8.0	5.1	3.2	3.2
95	ظلام	2.07418	-0.25904	7.4	6.4	8.0	5.2	5.0	5.0
97	سجين	5.23014	-0.40521	11.8	10.2	12.9	10.1	4.1	4.1
100	فقير	5.36810	-0.48726	6.9	5.9	11.0	8.2	5.2	5.2
102	جراح	1.51774	-0.32168	12.1	10.4	4.7	1.9	2.3	2.3
103	شاعر	2.52260	-0.35429	8.8	7.6	7.1	4.3	4.9	4.9
104	وفاة	3.22198	-0.19818	8.3	7.2	16.3	13.4	3.5	3.5
106	سفير	4.52733	-0.33960	9.7	8.4	13.3	10.5	5.0	5.0
109	مجرم	5.21704	-0.38764	6.0	5.2	13.5	10.6	7.1	7.1
112	قبيلة	4.58868	-0.37269	5.9	5.1	12.3	9.5	6.7	6.7
113	شباك	3.16852	-0.36064	7.0	6.1	8.8	6.0	5.3	5.3
114	جريح	2.64535	-0.35103	11.1	9.6	7.5	4.7	6.5	6.5
116	مجنون	4.43840	-0.39444	4.4	3.8	11.3	8.4	8.0	8.0
118	مصري	4.76988	-0.49680	7.0	6.0	9.6	6.8	4.6	4.6
119	ذكاء	3.93072	-0.40061	11.5	9.9	9.8	7.0	5.1	5.1
120	خالد	4.59711	-0.23609	11.4	9.8	19.5	16.6	3.8	3.8
122	سلوك	6.61181	-0.43426	5.5	4.7	15.2	12.4	7.3	7.3
123	زعيم	3.55705	-0.30254	9.4	8.1	11.8	8.9	4.2	4.2
125	مسرح	3.67159	-0.47812	12.4	10.8	7.7	4.8	5.4	5.4
126	حسد	4.48623	-0.30816	6.0	5.2	14.6	11.7	1.2	1.2
127	سلطة	5.43266	-0.40105	5.8	5.0	13.5	10.7	6.0	6.0
128	محام	4.04704	-0.35212	10.7	9.3	11.5	8.7	1.2	1.2
132	سماء	4.79522	-0.40410	6.6	5.7	11.9	9.0	6.7	6.7
133	عدوان	2.69913	-0.33100	11.9	10.3	8.2	5.3	4.1	4.1
136	كرة	3.55444	-0.33997	9.4	8.2	10.5	7.6	5.4	5.4
139	هلال	4.00060	-0.20275	6.5	5.6	19.7	16.9	2.2	2.2
140	صياد	3.31462	-0.38622	10.1	8.8	8.6	5.8	7.1	7.1
	Average	3.90697	-0.35042	8.8	7.6	11.4	8.5	8.5	8.5
	Minimum	1.25007	-0.49734	4.3	3.8	4.7	1.9	1.9	1.9
	Maximum	8.97731	-0.17394	12.4	10.8	23.2	20.3	20.3	20.3
	Range	7.72724	0.32340	8.1	7.0	18.5	18.5	18.5	18.5
	SD	1.29929	0.07972	2.0	1.7	3.6	3.6	3.6	3.6

[a]a = regression intercept. [b]b = regression slope. [c]Psychometric function slope (%/dB) at 50% was calculated from 49.999 to 50.001%. [d]Psychometric function slope (%/dB) from 20–80%. [e]Intensity required for 50% intelligibility. [f]Target change in intensity required to adjust the threshold of a word to the mean PTA of the subjects (2.83 dB HL). [g]Actual change in intensity required to adjust the threshold of a word to the mean PTA of the subjects (2.83 dB HL)

record the bisyllabic words (Barakat, 1993). This differs from previous studies in which male and female talkers were used to make the recordings.

Recordings. The recording of the words took place in a large anechoic chamber at Brigham Young University located in Provo, Utah, USA. The chamber has a noise floor of approximately 0 dB SPL, which allows for a signal-to-noise ratio recording of approximately 65 dB. A Larson Davis model 2541 1.27 cm microphone was used and was positioned approximately 15 cm from the talker at a 0^{o} azimuth and covered by a widescreen. The microphone was connected to a Larson-Davis 900B 7.62 cm microphone preamp, which was coupled to a Larson Davis model 2200C preamp power supply. The signal was digitized with 24-bit quantization at a 44.1 kHz sampling rate using an Apogee AD-8000 analog-to-digital converter. The preamp gain was set to utilize the full range of the 24-bit analog-to-digital converter. The signal was subsequently stored on a hard drive for later editing.

The talker pronounced each word at least 4 times with a brief pause between each production. The talker was asked to speak at a natural rate with normal intonation. In order to avoid list effects, the first and last productions of each word were eliminated from the study. A native judge rated each word for clarity of production, and the best production of each word was selected for use in the speech reception test. Sadie Disk Editor software was used to edit the intensity of each selected word (Studio Audio & Video Ltd, 2004) to yield a final recording with the same average root mean square (RMS) power as the 1 kHz calibration tone in order to equate the test word threshold audibility (Harris et al., 2004; Nissen et al., 2005). The final word recording was saved to a *wav* file.

Procedures

Custom software was used to control the timing of presentation and randomization of the 24-bit bisyllabic words. The wav file was routed from a computer to a Grason Stadler model 1761 audiometer. The stimulus words were routed from the audiometer to the participant through a single TDH-50P headphone. Testing of each participant was conducted in a double-walled sound suite that met ANSI S3.1 standards for maximum permissible ambient noise levels for the ears-not-covered condition using one-third octave bands (ANSI, 1999).

Before testing each participant, the external inputs to the audiometer were calibrated to 0 VU by using the 1 kHz calibration tone on the wav file. The audiometer was calibrated before, weekly, and after data collection. This calibration was completed according to ANSI S3.6 specifications (ANSI, 2004).

Evaluation of bisyllabic words. After passing a hearing screening exam, each participant took part in one test session of the bisyllabic words. Before evaluating the bisyllabic words, participants were familiarized with the words by listening to a list of the words in alphabetical order at 50 dB HL. They were given a list of the bisyllabic words along with instructions in English telling them what to do. They were told that they would hear the words at a comfortable loudness level and that they should simply listen to the words as they followed along on the list. They were also told that these words would be used in the next part of the experiment.

After familiarization, the 90 bisyllabic words were presented at different intensity levels, ranging from -6 to 22 dB HL in 2 dB increments. The beginning intensity was determined by finding the participant’s pure tone average and subtracting 4 dB from this number. If the participant correctly repeated any of the words at the initial level, the intensity was moved down in 2 dB increments until no words were identified. After this beginning level was found, the test continued by moving up in 2 dB increments. The sequence at which the 90 bisyllabic words were presented was randomized before presentation at each intensity level. Before beginning the evaluation of the test words, the participants were given the following instructions in English:

> You will hear bisyllabic Arabic words (words with two syllables), which may become louder or softer in intensity. At the very soft loudness levels it may be difficult for you to hear the words. Please listen carefully and repeat the words you hear. If you are unsure of the word, you are encouraged to guess. If you have no guess, please be quiet and listen for the next word. Do you have any questions?

All participants spoke English fluently and an interpreter was available to answer any questions. Participants then listened to the bisyllabic words at the different intensity levels and repeated them verbally. The words were scored as being correct or incorrect by a native Arabic judge. Three judges were used throughout the study. One judge was from Jordan, and the other two were from Israel. If needed, each participant was allowed to have rest periods during the test session.

Results

After raw data collection, logistic regression was used to find the regression slope and intercept for each of the 90 bisyllabic words. The regression slope and intercept were then inserted into a modified logistic regression equation that was used to calculate the percent correct at each intensity level. The original logistic regression equation is as follows:

$$\log\frac{p}{1-p} = a + b \times i \tag{1}$$

In Equation 1 p is the proportion correct at any given intensity level, a is the regression intercept, b is the regression slope, and i is the presentation level at dB HL. After Equation 1 is solved for p and multiplied by 100, Equation 2 is then obtained in which P is percent correct recognition:

$$P = (1 - \frac{\exp(a + b \times i)}{1 + \exp(a + b \times i)}) \times 100 \tag{2}$$

It is possible to predict the percentage correct at each specified intensity level by inserting the regression slope, regression intercept, and presentation level into Equation 2. Correct recognition percentage was determined for each of the bisyllabic words for a range of -10 to 18 dB HL in 1 dB increments.

In order to find the intensity level required for a given proportion, Equation 1 was solved for i (see Equation 3). By inserting the preferred proportions into Equation 3, it is possible to determine the threshold (intensity required for 50% intelligibility), the slope (%/dB) at threshold, and the slope from 20 to 80% for each psychometric function. When solving the equation for the threshold (p = 0.5) Equation 3 can be simplified to Equation 4:

$$i = \frac{\log\frac{p}{1-p} - a}{b} \tag{3}$$

$$i = \frac{-a}{b} \tag{4}$$

By solving Equation 3, the calculations for threshold (intensity required for 50% correct perception), slope at 50%, and slope from 20 to 80% were found for each bisyllabic word. Thresholds for the 90 bisyllabic words ranged from 4.7 to 23.2 dB HL (*M* = 11.4 dB HL). Psychometric functions for each bisyllabic word were found using Equation 2. The psychometric functions for each of the 90 bisyllabic words can be found in Figure 1. Figure 1 shows a wide range in slopes and thresholds for the 90 bisyllabic words. The slope of the psychometric functions, from 20 to 80%, for the 90 bisyllabic words ranged from 3.8 to 10.8%/dB (*M* = 7.6%/dB). It was found that the psychometric functions slopes at 50% threshold were steeper than the slopes from 20 to 80%. Slopes at 50% threshold ranged from 4.3 to 12.4%/dB (*M* = 8.8%/dB).

As mentioned earlier, words used to measure SRT should be homogenous, which means they should have steep psychometric slopes (Wilson & Strouse, 1999). In order to achieve this, the 23 words that had the steepest psychometric function slopes with enough available headroom to allow adjustment within 2 dB of the average PTA of the participants were selected to be included in the final list of bisyllabic words. The slope at 50%, slope at threshold, and threshold for the 23 selected words are listed in Table 3. The available headroom for each bisyllabic word is presented in Table 2. The psychometric functions for the 23 bisyllabic words are presented in Figure 3 with the logistic regression slopes and intercepts being used to fit the data. The composite psychometric functions for the selected bisyllabic words for the recordings before any intensity adjustments were made are contained in Figure 2. At 50% threshold, psychometric function slopes ranged from 5.8 to 12.1%/dB.

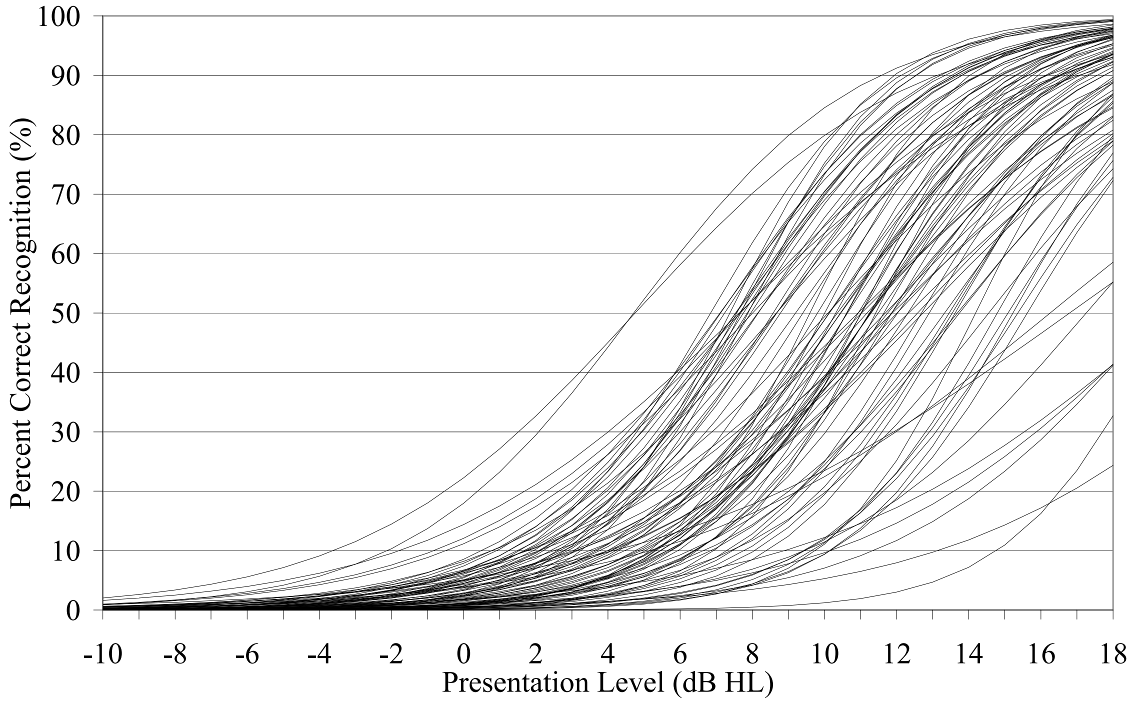

Figure 1. Psychometric functions for all 90 Arabic bisyllabic words prior to any intensity adjustment for male talker recordings.

Table 3

Mean Performance for 23 Selected Arabic Male Bisyllabic SRT Words

#	Word	a[a]	b[b]	Slope at 50%[c]	Slope 20-80%[d]	Threshold[e]	ΔdB[f]	Headroom	ΔdB[g]
3	وزير	4.49241	-0.39934	12.2	10.5	11.2	8.4	6.6	6.6
5	جامع	2.95625	-0.36208	8.9	7.7	8.2	5.3	3.8	3.8
21	موضوع	2.46174	-0.32616	12.4	10.8	7.5	4.7	6.5	6.5
33	سرعة	2.66545	-0.36849	8.8	7.6	7.2	4.4	5.7	5.7
34	واجب	2.85633	-0.41731	9.8	8.4	6.8	4.0	3.2	3.2
40	مكان	2.92712	-0.37741	8.3	7.2	7.8	4.9	4.0	4.0
66	جهاد	3.55894	-0.48254	9.2	8.0	7.4	4.5	4.2	4.2
67	دعوة	3.05486	-0.35189	10.4	9.0	8.7	5.9	5.3	5.3
68	مسجد	2.37024	-0.33364	10.1	8.7	7.1	4.3	2.3	2.3
71	جمال	3.63186	-0.38622	12.2	10.6	9.4	6.6	4.6	4.6
80	عنوان	2.41749	-0.27876	8.8	7.6	8.7	5.8	7.0	7.0
83	جملة	4.82687	-0.45463	8.6	7.4	10.6	7.8	7.7	7.7
89	شريف	1.78280	-0.23333	9.8	8.4	7.6	4.8	3.9	3.9
90	جندي	4.56530	-0.42976	8.9	7.7	10.6	7.8	9.0	9.0
91	حياة	1.25007	-0.26285	10.8	9.4	4.8	1.9	0.6	0.6
94	بشر	3.00467	-0.37736	8.2	7.1	8.0	5.1	3.2	3.2
102	جراح	1.51774	-0.32168	12.1	10.4	4.7	1.9	2.3	2.3
103	شاعر	2.52260	-0.35429	8.8	7.6	7.1	4.3	4.9	4.9
114	جريح	2.64535	-0.35103	11.1	9.6	7.5	4.7	6.5	6.5
119	ذكاء	3.93072	-0.40061	11.5	9.9	9.8	7.0	5.1	5.1
125	مسرح	3.67159	-0.47812	12.4	10.8	7.7	4.8	5.4	5.4
133	عدوان	2.69913	-0.33100	11.9	10.3	8.2	5.3	4.1	4.1
140	صياد	3.31462	-0.38622	10.1	8.8	8.6	5.8	7.1	7.1
	Average	3.00540	-0.36803	9.2	8.0	8.1	5.2	4.9	4.5
	Minimum	1.25007	-0.48254	5.8	5.0	4.7	1.9	0.6	0.6
	Maximum	4.82687	-0.23333	12.1	10.4	11.2	8.4	9.0	7.8
	Range	3.57680	0.24921	6.2	5.4	6.5	6.5	8.4	7.2
	SD	0.91691	0.06262	1.6	1.4	1.6	1.6	2.0	1.7

[a]a = regression intercept. [b]b = regression slope. [c]Psychometric function slope (%/dB) at 50% was calculated from 49.999 to 50.001%. [d]Psychometric function slope (%/dB) from 20□80%. [e]Intensity required for 50% intelligibility. [f]Target change in intensity required to adjust the threshold of a word to the mean PTA of the subjects (2.83 dB HL). [g]Actual change in intensity required to adjust the threshold of a word to the mean PTA of the subjects (2.83 dB HL)

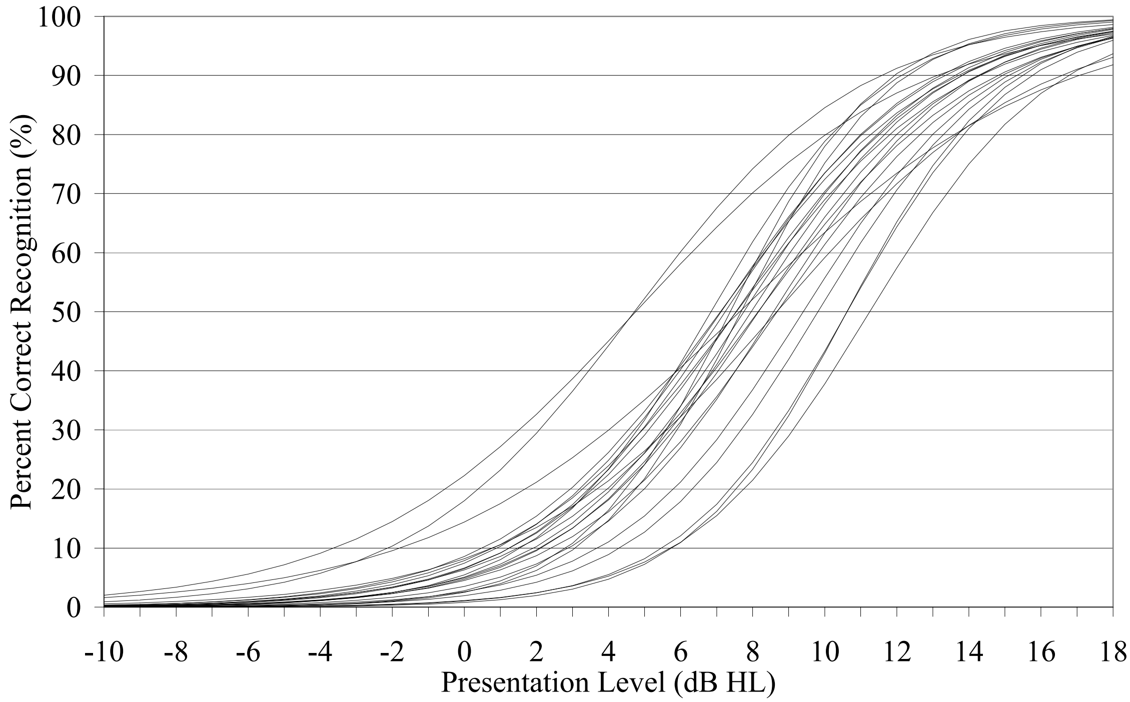

Figure 2. Psychometric functions for 23 selected Arabic bisyllabic words prior to any intensity adjustment for male talker recordings.

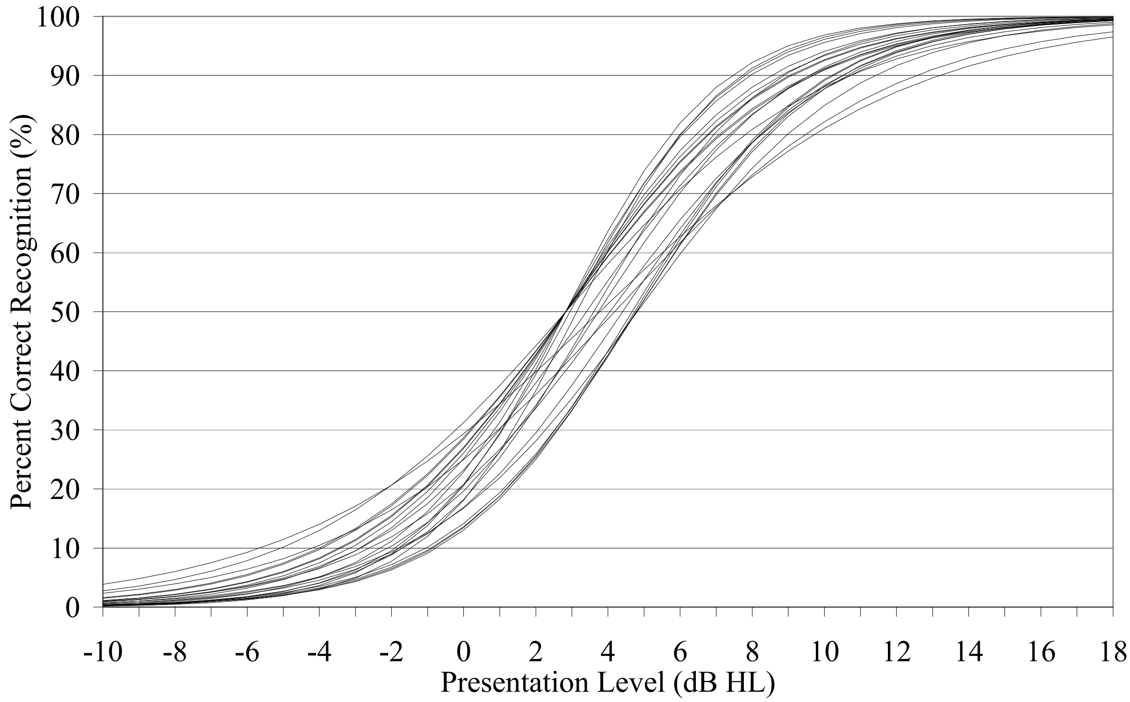

Figure 3. Psychometric functions for 23 selected Arabic bisyllabic words after intensity adjustment for male talker recordings.

In order to improve homogeneity of audibility among the 23 selected bisyllabic words, the intensity of each word was digitally adjusted so that the 50% threshold of each word was equal to the average PTA of the participants (2.83 dB HL). The actual intensity change was restricted because of the limited available headroom. All changes resulted in a 50% threshold within 2 dB of the average PTA of the participants. These adjustments are presented in Table 3.

Discussion

The purpose of this study was to develop a homogeneous subset of Arabic bisyllabic words to be used in measuring the SRT. This was accomplished for recordings of a male native Arabic talker. The homogeneity of the subset of bisyllabic Arabic words can be seen by referring to Figure 3. This contains the predicted psychometric functions for the 23 selected bisyllabic words after intensity adjustment. These 23 selected bisyllabic words as spoken by the male talker are much more homogeneous with respect to audibility and psychometric function slope than the original unadjusted bisyllabic words (Figure 1). The mean psychometric functions before and after intensity adjustment are presented in Figure 4.

The slopes from 20 to 80% for the 23 bisyllabic words included a range of 5.0 to 10.4%/dB (*M* = 8.0%/dB) for the male talker. The means for the slopes from 20 to 80% for the Arabic bisyllabic psychometric functions are in close agreement with means for SRT materials that have been reported in English. For English spondaic words, the mean slope has been reported between 7.2 %/dB and 10 %/dB (Hudgins et al., 1947). However, the mean slopes for other languages have not been similar to those found in this study. The mean slope for Mandarin trisyllabic SRT materials was reported to be 11.3%/dB for

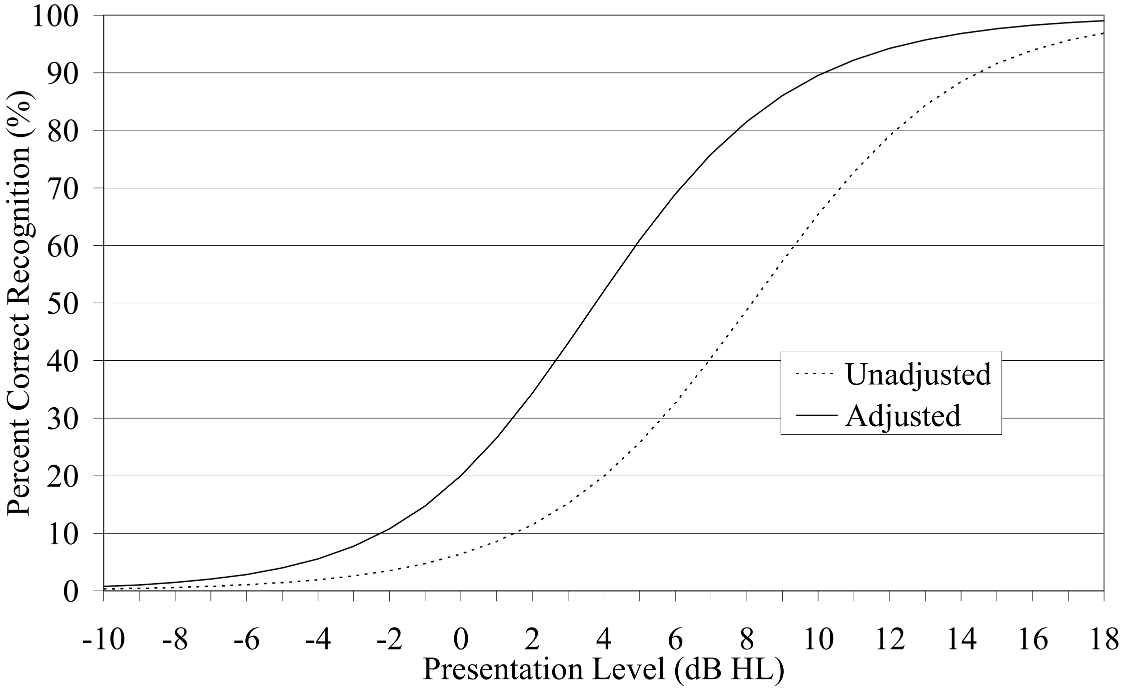

Figure 4. Mean psychometric functions for 23 selected Arabic bisyllabic words before (dashed line) and after intensity adjustment (solid line) for male talker recordings.

the male talker (Nissen et al., 2005). For Polish bisyllabic SRT materials, the mean slope was reported to be 10.1%/dB for the male talker (Harris et al., 2004). Additionally, Korean bisyllabic SRT materials had a slope of 10.3%/dB for the male talker (Harris et al., 2003). Therefore, these findings show that the Arabic language is more difficult to hear, which results in a lower mean slope for the 23 selected bisyllabic words.

In order to develop new digitally recorded materials to be used in determining SRT, a lot of time is required. However, the benefits are significant in time saved if these high quality materials are used by audiologists in evaluations. The availability of digital speech audiometry materials on CD is considerably useful for the audiologist. With these materials, the audiologist is able to select which words to use from a longer list of stimuli. The audiologist is also able to present the stimuli in random orders with the use of a computer (Nissen et al., 2005).

Over the years the development of high quality digital speech audiometry materials has improved, especially for the English language. However, the development of these materials in many other languages is still lacking. The selected Arabic bisyllabic words from this study should be used in further research to compare the SRT with the PTA of normal hearing and hearing impaired populations (Nissen et al., 2005). A recent study by McArdle and Wilson in 2006 demonstrates the need for this comparison. McArdle and Wilson administered 18 QuickSIN sentence lists to young adults with normal hearing and to elderly listeners with sensorineural hearing loss. The results showed that all 18 lists were equivalent for the young adult group. However, 4 of the 18 lists were out of the equivalence range for the elderly group. This demonstrates that elderly people with sensorineural hearing loss are not a homogenous group. Therefore, sentence and word lists need to be tested on the intended population. The selected Arabic bisyllabic words should be tested on individuals with hearing impairment.

In addition, this study only tested the bisyllabic Arabic words in a sound suite. Further research should be performed to test the selected Arabic bisyllabic words in the presence of noise. It has been found that the use of fluctuating noise and continuous noise influences the results of SRT testing (Wagener & Brand, 2005). These types of noise should be used in future testing of the selected Arabic bisyllabic words.

Also, additional speech materials in Arabic should be developed. Arabic has many different dialects; this study only focused on the Palestinian/Jordanian dialect. Other studies should be conducted to develop speech audiometry materials in other Arabic dialects. This would allow audiologists in many Arabic countries the opportunity to use high quality digitally recorded speech audiometry materials in their audiological evaluations.

In conclusion, the result of this study was the development of a homogeneous subset of 23 bisyllabic Arabic words. These words can be used to measure the SRT of individuals whose native language is Arabic. These bisyllabic words are familiar and homogeneous with respect to psychometric slope and audibility. The threshold variability for these words was reduced by the modifications in intensity of individual words which were made. A CD containing the 23 Arabic bisyllabic words was created for use in measuring the SRT of individuals whose native language is Arabic. These bisyllabic words were equated with respect to threshold audibility and are contained on tracks 2 and 3 of the *Brigham Young University Arabic Speech Audiometry Materials (Disc 1.0)* CD. Performance of these materials on individuals with hearing impairment still needs to be established. Future research should be conducted to establish the reliability and validity of the bisyllabic words for use with adults with conductive and sensorineural hearing loss. Research should be done on individuals with various types and degrees of hearing impairment to determine the clinical value of the bisyllabic words.

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APPENDIX A
INFORMED CONSENT DOCUMENT

Participant:______________________________________Age:__________

You are asked to participate in a research study sponsored by the Department of Audiology and Speech Language Pathology at Brigham Young University, Provo, Utah. The faculty director of this research is Richard W. Harris, Ph.D. Students in the Audiology and Speech-Language Pathology program may assist in data collection.

This research project is designed to evaluate a word list recorded using improved digital techniques. You will be presented with this list of words at varying levels of intensity. Many will be very soft, but none will be uncomfortably loud to you. You may also be presented with this list of words in the presence of a background noise. The level of this noise will be audible but never uncomfortably loud to you. This testing will require you to listen carefully and repeat what is heard through earphones or loudspeakers. Before listening to the word lists, you will be administered a routine hearing test to determine that your hearing is normal and that you are qualified for this study.

It will take approximately two hours to complete the test. Testing will be broken up into 2 or 3 one hour blocks. Each subject will be required to be present for the entire time, unless prior arrangements are made with the tester. You are free to make inquiries at any time during testing and expect those inquiries to be answered.

As the testing will be carried out in standard clinical conditions, there are no known risks involved. Standard clinical test protocol will be followed to ensure that you will not be exposed to any unduly loud signals.

Names of all subjects will be kept confidential to the investigators involved in the study. Participation in the study is a voluntary service and no payment of monetary reward of any kind is possible or implied.

You are free to withdraw from the study at any time without any penalty, including penalty to future care you may desire to receive from this clinic.

If you have any questions regarding this research project you may contact Dr. Richard W. Harris, 131 TLRB, Brigham Young University, Provo, Utah 84602; phone (801) 422-6460. If you have any questions regarding your rights as a participant in a research project you may contact Dr. Renea Beckstrand, Chair of the Institutional Review Board, 422 SWKT, Brigham Young University, Provo, UT 84602; phone (801) 422-3873, email: renea_beckstrand@byu.edu.

YES: I agree to participate in the Brigham Young University research study mentioned above. I confirm that I have read the preceding information and disclosure. I hereby give my informed consent for participation as described.

______________________________________ ________________
Signature of Participant Date

______________________________________ ________________
Signature of Witness Date

APPENDIX B

Description of BYU Arabic Speech Audiometry Materials CD

Track 1	1 kHz calibration tone.
Track 2	Bisyllabic words for use in measuring the SRT in alphabetical order for familiarization purposes.
Track 3	Bisyllabic words for use in measuring the SRT in random order, repeated in blocks for a total duration of 5 minutes.
Track 4	Speech Discrimination List 1 – 50 monosyllabic words in random order.
Track 5	Speech Discrimination List 2 – 50 monosyllabic words in random order.
Track 6	Speech Discrimination List 3 – 50 monosyllabic words in random order.
Track 7	Speech Discrimination List 4 – 50 monosyllabic words in random order.
Track 8	Speech Discrimination List 1A – 25 monosyllabic words in random order.
Track 9	Speech Discrimination List 1B – 25 monosyllabic words in random order.
Track 10	Speech Discrimination List 2A – 25 monosyllabic words in random order.
Track 11	Speech Discrimination List 2B – 25 monosyllabic words in random order.
Track 12	Speech Discrimination List 3A – 25 monosyllabic words in random order.
Track 13	Speech Discrimination List 3B – 25 monosyllabic words in random order.
Track 14	Speech Discrimination List 4A – 25 monosyllabic words in random order.
Track 15	Speech Discrimination List 4B – 25 monosyllabic words in random order.

Tracks 16-24 contain Arabic recordings of routine instructions for various audiometric tests.

Track 16 Instructions for speech reception threshold-verbal response:

" الهدف من هذا الفحص هو قياس أقل مستوى من الصوت الذي يمكنك عنده سماع الكلمات و تكرارها. سوف تستمع إلى مجموعة من الكلمات قد تختلف في قوة الصوت, كل مرة تسمع كلمة الرجاء تكرارها. قم بتكرار الكلمات حتى و إن كان الصوت منخفض جدا, و يمكنك أن تحزر. إذا لم تفهم الكلمة و لا تستطيع أن تحزر الرجاء البقاء صامتا وانتظر الكلمة التالية."

Track 17 Instructions for speech discrimination- verbal response:

"الهدف من هذا الفحص هو قياس مدى قدرتك على فهم وتكرار الكلمات عند تقديمها على مستوى صوت ثابت. الرجاء تكرار الكلمات عند سماعها، إذا لم تكن متأكد يمكنك أن تحزر. إذا لم تفهم الكلمة ولا تستطيع أن تحزر الرجاء البقاء صامتا و انتظر الكلمة التالية."

Track 18 Instructions speech audiometry-masking in non-test ear- verbal response:

" خلال هذا الفحص سوف تسمع تشويش في إحدى الأذنين و كلمات في الأذن الأخرى، الرجاء التركيز على الكلمات و تجاهل التشويش. الرجاء تكرار كل كلمة تسمعها، إذا لم تكن متأكد يمكنك أن تحزر. إذا لم تفهم الكلمة ولا تستطيع أن تحزر الرجاء البقاء صامتا و انتظرالكلمة التالية."

Track 19 Instructions for speech audiometry – written response:

"الهدف من هذا الفحص هو قياس مدى قدرتك على فهم وتكرار الكلمات عند تقديمها على مستوى صوت ثابت. عند سماعك الكلمة الرجاء كتابتها على الورقة المخصصة للفحص، إذا لم تكن متأكد يمكنك أن تحزر. إذا لم تفهم الكلمة ولا تستطيع أن تحزر الرجاء وضع خط في الفراغ المخصص للكلمة وانتظر الكلمة التالية."

Track 20 Instructions for speech audiometry-masking in non-test ear – written response:

" خلال هذا الفحص سوف تسمع تشويش في إحدى الأذنين و كلمات في الأذن الأخرى، الرجاء التركيز على الكلمات و تجاهل التشويش.عند سماعك الكلمة الرجاء كتابتها على الورقة المخصصة للفحص، إذا لم تكن متأكد يمكنك أن تحزر. إذا لم تفهم الكلمة ولا تستطيع أن تحزر الرجاء وضع خط في الفراغ المخصص للكلمة و انتظرالكلمة التالية."

Track 21 Instructions for pure-tone audiometry- hand raising:

" الهدف من هذا الفحص هو قياس أقل مستوى من الصوت الذي يمكنك سماعه. سوف تسمع عدة رنات في احدى الاذنين ومن ثم في الاذن الاخرى. بعض الرنات سوف تكون سهلة السمع ولكن معظمها سوف تكون خفيفة و صعبة السمع وبعضها تكون في غاية الصعوبة. الرجاء رفع اليد كل مرة تسمع فيها رنة وابقائها مرفوعة طالما تسمع الرنة. عند توقف الرنة أنزل يدك بسرعة. تذكر، إرفع يدك كل مرة تسمع فيها الرنة مهما كان الصوت منخفض."

Track 22 Instructions for pure-tone audiometry – masking in non-test ear – hand raising:

"خلال هذا الفحص سوف تسمع رنات مع وجود تشويش في الصوت. الرجاء تجاهل التشويش و ركز في الاستماع الى الرنات. التشويش سوف يتغير في الشدة الرجاء الاستماع الى الرنات. الرجاء رفع اليد كل مرة تسمع فيها رنة وابقائها مرفوعة طالما تسمع الرنة. عند توقف الرنة أنزل يدك بسرعة. تذكر، إرفع يدك كل مرة تسمع فيها الرنة مهما كان الصوت منخفض."

Track 23 Instructions for pure-tone audiometry – button pressing:

" الهدف من هذا الفحص هو قياس أقل مستوى من الصوت الذي يمكنك سماعه. سوف تسمع عدة رنات في احدى الاذنين ومن ثم في الاذن الاخرى. بعض الرنات سوف تكون سهلة السمع ولكن معظمها سوف تكون خفيفة و صعبة السمع وبعضها تكون في غاية الصعوبة. الرجاء الضغط على الزر كل مرة تسمع فيها رنة والاستمرار في الضغط طالما تسمع الرنة. عند توقف الرنةارفع اصبعك عن الزر بسرعة. تذكر، اضغط الزر كل مرة تسمع فيها الرنة مهما كان الصوت منخفض."

Track 24 Instruction for pure-tone audiometry – masking in non-test ear –button pressing:

"خلال هذا الفحص سوف تسمع رنات مع وجود تشويش في الصوت. الرجاء تجاهل التشويش و ركز في الاستماع الى الرنات. التشويش سوف يتغير في الشدة الرجاء الاستماع الى الرنات. الرجاء اضغط على الزر كل مرة تسمع فيها رنة واستمر بالضغ طالما تسمع الرنة. عند توقف الرنة ارفع اصبعك عن الزر بسرعة. تذكر، اضغط على الزر كل مرة تسمع فيها الرنة مهما كان الصوت منخفض."