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Samoan Speech Audiometry: Developing Word Recognition Materials for Native Speakers of Samoan

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For Native Speakers of Samoan

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ABSTRACT

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Hearing can be evaluated through the presentation of tones or speech. Speech audiometry determines an individual's speech recognition threshold and word recognition score. Traditionally these materials were developed using familiar, frequently used, monosyllabic words. Currently, there are various types of word recognition materials including those which use word lists, short half-lists, and materials which use sentences level stimuli with competing noise. Word recognition materials were first developed in Standard American English; today, materials are now readily available in many other languages. When possible, word recognition materials are developed digitally to standardize their presentation. Currently, no recorded word recognition materials are commercially available for native speakers of Samoan. Bisyllablic words were chosen, rated, recorded, and prepared for subject testing. All subjects were native speakers of Samoan with adequate hearing, meeting required standards for audiological research. Results indicated that no significant differences were found among bisyllabic word lists or half-lists developed in the current study. Subject word recognition performance and psychometric function slopes were comparable to the results of other related studies. All materials were recorded onto CD and made commercially available. It is hoped that this resource will aid trained professionals in the diagnosis and remediation of hearing loss in Samoan-speaking individuals.

Keywords: speech audiometry, word recognition, Samoan

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Introduction

The evaluation of an individual's hearing involves administering a battery of tests. Collectively, these assessments complement each other in defining the degree, type, and configuration of hearing loss. Audiological evaluations also intend to provide information that describes the functional impact of hearing loss on communication.

Pure tone audiometry, the test often thought of as the hearing test, presents a series of sinusoidal tones (or beeps), to the listener, at specific frequencies to establish a person's hearing acuity. However, pure tone audiometry can only assess the auditory system's ability to "carry a simple stimulus" (Egan, 1979, p. 190), and provides little information about the individuals ability to understand speech; speech audiometry is a type of audiological evaluation designed to better describe these abilities and attempts to indicate how an individual may hear and understand spoken discourse by presenting words, instead of tones, during testing (Epstein, 1978). Speech audiometry materials were first developed in Standard American English but are now available in various other languages such as Spanish (Harris & Christensen, 1996), Portuguese (Harris, Goffi, Pedalini, Merrill, & Gygi, 2001), Italian (Greer, 1997; Turrini et al., 1993), Russian (Harris et al., 2007), Polish (Harris, Nielson, McPherson, & Skarzynski, 2004), Mandarin Chinese (Nissen, Harris, Jennings, Eggett, & Buck, 2005), and Tongan (Sever, 2008). However, digitized materials are not currently available in the Samoan language for speech audiometry testing. The purpose of this study was therefore to develop digital word recognition materials for native speakers of Samoan.

Review of Literature

Speech Audiometry

There is an important difference "between the threshold for speech [perception] and the ability to understand the speech that is heard" (Gelfand, 2001, p. 267). This is clearly illustrated

by some of the most common complaints from those with hearing impairments including, "I can hear, but I can't understand….[or]….speech sounds muffled" (Gelfand, 2001, p. 267). With the exception of the most severe cases, hearing loss diminishes the intensity, clarity, or intelligibility of speech, and not its detection. Therefore, hearing tests have been designed to assess the function of the auditory system using speech stimuli as pure tone average (PTA) testing can only make the "grossest generalizations [regarding] the degree of disability in speech communication" (Martin & Clark, 2009, p. 126), caused by hearing loss.

As its name implies, speech audiometry involves presenting speech stimuli (usually words) through an audiometer to measure and qualify an individual's ability to recognize and understand speech; this process typically involves administering test materials to determine two different but related measures: speech recognition threshold (SRT) and the word recognition score (WRS). Inconsistencies in the terminology used in speech audiometry (Martin & Clark, 2009), make it necessary to give a brief summary of the terms used in early literature and those used today according to current recommendations.

The term speech *reception* threshold was used previous to speech *recognition* threshold; in time, concerns arose with the accuracy of this term, as listeners are asked to repeat recognized words during testing, not merely receive them (Konkle & Rintelmann, 1983). The American Speech-Language and Hearing Association (1988) also recommends, in the *Guidelines for Determining Threshold Level for Speech*, that the term speech recognition threshold is preferable to the traditional term speech reception threshold. As with SRT, WRS testing in early literature was called *articulation testing* or *articulation scores*. The two latter terms are no longer in use but in their time they intended to describe the purpose of speech audiometry test in assessing the "degree of correspondence between the stimulus and the response" (Gelfand, 2001, p. 267).

More recent terms include *speech discrimination score* and the *word recognition score* (WRS). *Suprathreshold speech recognition score* is also a term used as WRS materials are usually determined and administered at a levels above the speech reception threshold (Gelfand, 2001). Much like the preferred nomenclature for SRT, speech recognition score is currently the recommended term for this type of evaluation, as recognition best describes the patient's task in terms of their response (Gelfand, 2001). Word recognition score is also an equally accepted term provided its use refers only to materials whose test items are known to be words (Martin & Clark, 2009). As SRT and WRS testing are thus closely related, it is prudent to include a brief overview of SRT testing before giving a full review of the development, use, and administration of WRS materials.

SRT indicates the intensity level (in dB HL) where an individual can correctly recognize 50% of the words presented (American Speech-Language and Hearing Association, 1988). Materials used for SRT testing are often closed set spondaic (two syllable) words with equal stress on both syllables. Closed set word lists are first shown to the listener before testing in order to familiarizing the subject with the test items (words). SRT testing is often done before WRS testing as the person's speech recognition threshold determines the intensity level at which WRS items are presented.

Traditional Word Recognition Materials

Word recognition materials were originally developed to test military communication systems during World War II (Gelfand, 2001; Martin & Clark, 2009). Several of the word lists still in use today, were deployed to assess the efficiency of telephone and radio lines as they attempted to transmit minimal acoustic content while maintaining the listener's ability to understand the message presented (Martin & Clark, 2009). Egan (1948) developed the earliest word recognition lists in the Psychoacoustic Laboratories (PAL) at Harvard University where he

produced 20 lists of 50 American English words. Eight of the 20 lists were recorded and published as the PAL PB-50 (Martin & Clark, 2009). Each word was a monosyllabic item with a scoring weight of 2% per word. Each list was *phonetically balanced* (PB), meaning the relative frequency of phonemes within a test list were "as close as possible to the distribution of speech sounds used" (Gelfand, 2001, p. 268) in that language. Egan (1948) made use of Dewey's (1923) frequency analysis of 100,000 words in newsprint to establish his target distribution for the PB-50. The PB-50 was a precursor to two of the most widely used materials for testing word recognition available today, the Central Institute for the Deaf (CID) W-22 and the Northern University Auditory Test Number 6, or NU-6 (Gelfand, 2001; Martin & Clark, 2009).

Evidence suggested that several unfamiliar words in the PB-50 lead to poor inter-list reliability (Hirsh et al., 1952). Thus, in an effort to improve familiarity and the phonetic balance of Egan's (Egan, 1948) early lists, Hirsh et al. (1952) eliminated most of the items on the PB-50, retaining only 120 of the original 1000 words. After this selection, they continued to add their own lexical choices to produce the CID W-22 (Gelfand, 2001; Martin & Clark, 2009). Smaller in size than its predecessor, the CID W-22 was comprised of four lists (1-4) of 50 words, which were in turn each recorded with six randomizations. In addition to Dewey's (1923) phonemic distribution, Hirsh and colleagues also used an analysis of English business telephone conversations by French, Carter, and Koenig (1930) to achieve phonetic balance for their materials. As a mark of improved familiarity, it is noted that 95% of the words on the CID W-22 were listed among the top 4000 words most commonly found in Thorndike's (1932) *A Teacher's Word Book of Twenty Thousand Words Found Most Frequently and Widely in General Reading for Children and Young People* (Gelfand, 2001).

The NU-6 was based on the work of Lehiste and Peterson (1959), who were influenced by Egan (1948) but independent in their modification of the concept of phonetic balance to that of *phonemic balance*. Phonemes are by distinction, "groups of speech sounds (each of which is a phonetic element) that are considered as being the same by native speakers of a language. Thus, all phonetic differences are not phonemically relevant" (Gelfand, 2001, p. 268). For example, the phoneme /p/ with all its allophones (such as those found in *pat* versus *pit*) are all identified phonemically as /p/ although phonetically there are differences in the acoustic and articulatory characteristics of each allophone (Gelfand, 2001). In light of the insurmountable task of analyzing and calculating the frequency distribution of each phoneme with all its allophones, "the phonetic construction of English [or any other language] is such that there is no way to truly balance a list of words phonetically…because of the almost infinite number of variations" (Martin & Clark, 2009, p. 142). Lehiste and Peterson (1959) judged phonemic balance to be a more realistic goal and in turn developed ten 50-word lists in such a fashion using the words from Thorndike and Lorge's (1944) *The Teacher's Word Book of 30,000 Words*. Each item was a monosyllabic word containing a consonant-nucleus-consonant (CNC) structure, meaning each word had a consonant followed by a vowel or diphthong, followed by another consonant. Tillman, Carhart, and Wilber (1963) took 93 of Lehiste and Peterson's (1962) CNC words to create the NU-4 (two 50-word lists). Later the number of words in the NU-4 were increased from 100 to 200 words (185 were from Lehiste and Peterson's 1962 material) to develop the four lists of 50-words now comprising the NU-6.

To summarize, the first traditional word recognition materials were created with familiar, frequently used, monosyllabic words that were, in various ways, considered an appropriate and representative acoustic sample of the English language. Today, numerous other phonetically and

phonemically balanced materials are available but the W-22 and NU-6 remain the most commonly used materials by audiologists to test the hearing of English American speakers (Martin, Champlin, & Chambers, 1998). Most materials are now available with both male and female talkers and are commercially available on compact disc (CD).

Types of Word Recognition Tests

Half-lists. As indicated by the format of traditional word recognition materials, word lists are typically 50-words in length. However, in an effort to save time, it has become the clinical practice of some audiologists to administer half-lists of 25-words, weighting each correct response or word as 4%. Objections against this procedure include (a) one half list may not equally contain the same number of audible phonemes, (b) the difficulty of recognizing or discriminating words may be significantly different between the two halves of a list, and (c) splitting a list compromises the phonetic of phonemic balance, although it is given that this standard is not truly attainable (Gelfand, 2001). In contrast, Tobias (1964) asserts that phonetic/phonemic balance is unnecessary in "useful diagnostic" (p. 99) testing as half-lists do in fact measure the same features as full lists. Thornton and Ruffin (1978) also provide evidence that half-lists produced reliable results as do full 50-word lists. Audiologists appear to be convinced of the benefits of this procedure according to Martin et al. (1998), who further claim that many audiologists prefer to use 25-word list during word recognition testing. Of course popular methods can and are different from those methods supported by evidence (Wiley, Stoppenbach, Feldhake, Moss, & Thordardottir, 1995).

Phonetically balanced word lists. As addressed previously, there appears to be considerable doubt as to the reality of truly phonetically balanced materials. Regardless, materials continue to be created according to this principle. Of note however, is the work of Martin, Champlin, and Perez (2000), who compared the WRS of PB and non-balanced words

lists on subjects with normal hearing and sensorineural hearing loss. Their results indicated that the scores were near identical, bringing into question whether word lists are or need to be phonetically balanced.

Short isophonemic words lists. Boothroyd (1968) developed 15 short word lists with the purpose of reducing administration time without threatening validity. Each list contained ten consonant-vowel-consonant (CVC) words with a total of 30 phonemes. Each phoneme was scored individually and not in the all-or-nothing approach adopted with traditional materials. Martin and Clark (2009) further comment that "time saved…can be considerable when multiple word lists are employed for attaining word recognition performance at a number of intensities" (p. 144). In some studies, no significant differences have been found between tests using short isophonemic word lists and the full list from the CID W-22 (Gelfand, 2001).

Open and closed response sets. Open response sets are commonly used to assess speech recognition and requires a listener to repeat the presented stimuli (the word, phrase, or sentence) without "prior knowledge" (Gelfand, 2001, p. 268) of the possible answer. Both the CID W-22 and NU-6 use this method of response. In fact, response possibilities are almost infinite, as the listener is encouraged to say what ever they heard, guessing if necessary. Closed response sets require the listener to indicate their answer from a discrete number of answer choices; for example, pointing to a picture, an actual object, or choosing the correct word from a designated list. Such response conditions are naturally most suited to children and other individuals needing special considerations. Examples of the most well known closed set word recognition tests include the Rhyme Test (Fairbanks, 1958), California Consonant Test (Owens & Schubert, 1977), Picture Identification Task (PIT;Wilson & Antablin, 1980), Word

Intelligibility by Picture Identification (WIPI; Ross; Lerman, 1970), and the Northwestern University Children's Perception of Speech (NUCHIPS) test (Elliot & Katz, 1980).

Testing word recognition with sentences. Jerger, Speaks, and Trammell (1968) were one of the first to criticize the use of single words for speech recognition testing. These authors felt that word lists did not provide adequate information regarding the "changing pattern [of speech] over time" (Jerger et al., 1968, p. 319) or in other words the time domain of speech (Martin & Clark, 2009). Sentences that assess and determine speech recognition have therefore also been developed. However, these stimuli have been criticized by the research community because (a) memory and learning effects impact performance, and (b) sentence structure allows a listener who is a "good guesser" (Martin & Clark, 2009, p. 145) to gain more meaning than another listeners without such abilities. Jerger et al. (1968) developed ten synthetic sentences, each containing seven words, which carried no meaning. Ironically, early experiments showed that the task was not difficult enough when tested in a quiet environment. As a result, most sentence material today is presented with competing signals such as white noise or multitalker babble. "Many audiologist feel that speech recognition tests carried out in quiet do not tax patients'…abilities sufficiently to diagnose the kind of communication problems…experienced in daily life" (Martin & Clark, 2009, p. 145).

Factors for Consideration

In selecting the most appropriate type of test material, audiologists and other professionals providing speech audiometry evaluations must consider the demands placed on the individual being assessed within the chosen test conditions. Factors to consider include the linguistic demands of test items, their delivery style and form, determining the intensity or intensities at which testing will be done, and the language abilities of the individual being evaluated.

Lexical considerations. "Speech audiometry involves material that is inherently linguistic in nature" (Gelfand, 2001, p. 278). Words for any test should be chosen with care considering the frequency and familiarity of each item. Word familiarity (i.e. whether the stimuli is known or understood by the listener) significantly affects performance during speech recognition testing (Owens, 1961); concerns regarding word familiarity have thus been addressed since the development of the very first traditional word lists. Unfamiliar or obscure words immediately change the conditions of testing, as a listener's response is now an indication of their hearing acuity and language ability. Checks and methods should be employed to avoid unfamiliar words being included in materials for the population they are intended for. Word frequency is also another related factor which has a well-established effect on performance, namely "those that occur more frequently are more easily recognized" (Gelfand, 2001, p. 273).

Test form. Clinicians should be amply aware of alternative forms for each test. More than one form of each test is usually provided as more than one administration is often required; for example, testing each ear separately. Test form equivalents and how they score against each other must also be considered.

Carrier phrases. Research on the significance of using carrier phrases such as, "*say the word* _____," or "*you will say* _____," have generated mixed results and opinions. Some studies indicated they make a significant difference in performance (Gelfand, 1975; Gladstone & Siegenthaler, 1971), and others to the contrary (Martin, Hawkins, & Bailey, 1962; McLennan & Knox, 1975). It is feasible that some listeners perform better with such cues, but equally possible is their potential to become irritated or distracted by such repetition (Gelfand, 2001).

Initial testing levels. Testing at more than one intensity level is strongly encouraged as it assists the administrator in finding the listeners highest WRS. Routine testing is usually given

at 30 to 35 dB SL (relative to SRT) for those with normal hearing, and 40 dB SL for the hearing impaired (Gelfand, 2001). It is thought that many audiologists perform this kind of testing at most comfortable level (MCL), but this is not advisable because the MCL is actually a range rather than a level (Gelfand, 2001). The highest speech recognition scores are often above the individual's MCL (Clemis & Carver, 1967; Dirks & Morgan, 1983; Posner & Ventry, 1977; Ullrich & Grimm, 1976).

Recorded voice versus live voice. Word recognition materials are available in written form or as recorded tests. Written materials require the clinician or audiologist to say the words through a microphone. That speech signal is then modified and presented to the listener during administration. The distinction between the two becomes most important as the intelligibility of the same word is affected by differences among talkers, as even repeated productions from the same talker over time are not the same. Kreul, Bell, and Nixon (1969) even claim that the same word list spoken by two different talkers constitute two different tests. This claim is supported by evidence from several studies where significantly different speech recognition results were obtained from common listeners tested with different talkers (Bess, 1983; Gengel & Kupperman, 1980; Hood & Poole, 1980; Penrod, 1979) and the same talker over time (Brandy, 1966). Clinicians themselves, during live voice presentations, differ and vary in how they say test words. Some use a conversational manner while others try to speak clearly, deliberately, or even both if they begin to respond to the nature of listener responses. This variation between conversational and deliberate speech can significantly affect intelligibility (Picheny, Durlach, & Braida, 1985). These concerns constitute strong evidence for using recorded test materials whenever possible. Martin and Clark (2009) further assert that recorded materials claim advantage over live voice as they "provide a consistency of presentation…independent of

the…clinician" (p.127). With the advent of the CD and other digital technology, clinicians can retain the flexibility and time once ascribed to live voice testing. Of course in special situation live voice may be more appropriate for the special needs of patients or when no recorded version of the test is available.

Foreign language influences and implications. As mentioned before, word recognition materials are inherently linguistic and thus their use may implicate factors such as phonology and morphology and "exacerbate word familiarity effects" (Gelfand, 2001, p. 278). Gat and Keith (1978) showed that foreign speakers typically obtain lower scores on English speech recognition tests than native English speakers. The ideal solution is for each person to be tested in his or her own native language by a native or at least a fluent speaking audiologist. The least desirable alternative is to test a patient with materials in an unfamiliar language, which confounds the results because of the linguistic mismatch between stimuli and the patient's language abilities. If faced with such a difficult situation, all efforts should be made to obtain material in the desired language and perform audiometric testing using closed-set responses. In this way, "recorded test items can be presented in the patient's language and her responses can be scored without being influenced by the perceptions of the clinician" (Gelfand, 2001, p. 280). Again, closed-set responses can be identifying pictures or the listener may write down or circle their own response from a given answer bank.

The Samoan Language

Creating Samoan word recognition materials required a clear understanding of the Samoan language including its classification, use, and linguistic features. The following sections provide a general description of these topics.

Language classification and countries of use. According to Lewis (2009), world languages can be grouped into language families; similar to the convention of tracing the

genealogical lines of a human family tree, a given language can also be described in context of its linguistic family tree. Lewis further claims that almost all languages are related to other languages, and linguists have used terms such as phylum, family, and branch to express the similarity or linguistic affiliation between languages (Lewis, 2009). Samoan is classified as a Polynesian language. There are 37 languages in this linguistic group with two major branches, Tongic and Nuclear; the Tongic branch includes the Tongan and Niue language. The island of Niue lies approximately 350 miles north east of Tonga and has a dialect similar to Tongan (Lewis, 2009). The Nuclear branch includes the remaining 35 languages with some of its more notable members including Samoan, Tahitian, Māori, and Hawaiian (Lewis, 2009). All Polynesian languages stem from of the Central-Eastern Oceanic branch of the Malayo-Polynesian language family (Campbell, 2000; Lewis, 2009). Malayo-Polynesian languages are found in regions throughout Southeast Asia and the Pacific Ocean, making it one of the biggest language groups in the world. Geographic centers for this language family includes the Malay Peninsula, Indonesia, Papua New Guinea, the Philippines, Madagascar, New Zealand, and the Melanesian, Micronesian, and Polynesian islands ("Malayo-Polynesian languages," 2008).

The locality of Samoan speaking people and their communities are more diverse than the geography of their language family. Samoan and English are both considered official languages of the Independent State of Samoa (formerly known as Western Samoa) and American Samoa (a US territory). American Samoa's 2000 census indicated that the countries population at that time was 57,291 persons, 44,833 (78.2%) of which designated Samoan as their primary language spoken in the home (U.S. Census Bureau, 2004). The Independent State of Samoa (here after referred to as Samoa) conducted a national census in 2001, at which time their population count was 176,710 (Samoan Statistics Department, 2001); unfortunately, there are no publicly

available statistics indicating the number of Samoan speakers in Samoa, although the percentage is presumed to be high considering the countries national language.

Other regions with significant Samoan speaking populations include New Zealand, Australia, and the United States. Census and national statistical reports from those countries during 2006-2008 total Samoan speakers near 170,000; in 2006 the New Zealand census recorded 85,428 Samoan speakers nationally (Statistics New Zealand, 2006), Australia recorded 28,525 in the same year (Australian Bureau of Statistics, 2006), and the 2006-2008 American Community Survey counted 57,368 native Samoan speakers nationwide (U.S. Census Bureau, 2010). It is difficult to accurately determine the total number of native Samoan speakers worldwide as the schedule of national censuses do not coincide or uniformly include data regarding language spoken in the home. However, it is prudent to deduce that the number of native speakers outside the Samoan islands (i.e. American Samoa and Samoa) is significant and constitute populations who would also benefit from standardized and language specific audiometric materials.

Orthography and phonology. The Samoan alphabet has ten consonants and five vowels. The consonants are /f/, /g/, /l/, /m/, /n/, /p/, /s/, /t/, /v/ and the glottal stop which is written orthographically as an upside down comma, /‘/ (Lesa & Mayer, 2008). The five vowels are /a/, /e/, /i/, /o/, and /u/; in some regard each vowel constitutes two separate letters-certainly two phonemes-as each can be phonetically long or short (Lesa & Mayer 2008; Milner, 1993). Long vowels are marked with a macron /-/, as seen over the *a* and *o* in the word mālō meaning guest or visitor. Some authors consider the macron to be the sixteenth letter of the Samoan alphabet (Lesa & Mayer, 2008; Simanu & Simanu-Klutz, 1999). Each vowel, including double vowels or diphthongs, is produced separately and distinctly as slight changes in vowel

pronunciation will often carry different lexical meanings (Pratt, 1984; Simanu & Simanu-Klutz, 1999).

> Many natives are exceedingly careless and incorrect in the pronunciation of consonants, and even exchange or transpose them without confusion, and almost unnoticed by their hearers; as *manu*, for *namu*, a scent; *lagoga* for *lagouna*, to understand; *lava'au* for *vala'au*, to call; but *they are very particular about the pronunciation of the vowels*. (Pratt, 1984, p. 2)

Samoan diphthongs include /au/, /ai/, /ae/, /ei/, /ou/, and /ue/. Three other letters, /h/, /k/, and /r/ have been introduced into the language to accommodate the adoption of foreign or cognate words. Each phoneme is produced in isolation as follows, with orthographic examples given in parenthesis: a (f*a*ther), e (g*e*t), i (kn*ee*), o (*a*ll), u (b*oo*t), fa (*fah*), ga (*ngah*), la (b*lah*), mo (*ma*ll), nu (*noo*n), pi (*pee*k), sa (*sa*lute), ti (*tee*), vi (*vee*); he (*hea*d), ka (*ka*rate), and ro (*ro*ll) (Simanu & Simanu-Klutz, 1999). The phoneme /g/ is never produced as it is in English, like in the word *go*. Instead it is always nasalized and produced as a -ng sound as in si*ng* (Pratt, 1984). Foreign words have been adopted into the Samoan vocabulary after they have been sufficiently modified by interspersing vowels among any consonant blends (Simanu & Simanu-Klutz, 1999). There are no consonant clusters in Samoan or the phonemes /b/, /d/, /c/, /g/, /w/, and /z/; when adopting any word with such letters, /b/ is substituted with /p/, /d/ becomes /t/, /c/ becomes /k/, /z/ becomes /s/ and /w/ becomes /u/ (Pratt, 1984; Simanu & Simanu-Klutz, 1999).

Finally, a significant change in Samoan orthography occurred during the 60s and 70s. The macron and glottal stop were selectively removed from written language with the exception of people's names, their titles, and place names (Simanu & Simanu-Klutz, 1999). Milner (1993) observed that even when the glottal stop is used, it is used "only sporadically and often

inconsistently, even by the same writer in the same letter or printed page" (p. xvii-xviii). Indeed, Simanu and Simanu-Klutz (1999) indicate that for some "native speakers of Samoan, the inclusion of…[the macron and glottal stop] may be offensive" (p. vii), as contextual cues and knowledge of Samoan culture should be used to "decipher pronunciation and meaning" (p. vi).

Syllable structure and stress. The combination of consonants and vowels are called syllables. Syllable structure, as described by Crystal (2003), includes an onset, nucleus (also called center or peak) and coda. In the most minimal sense a syllable must contain a vowel or vowel like sound (i.e. a syllabic consonant like /r/ or /l/). The syllable nucleus may, or may not, have one or more preceding consonant, called the syllable onset, and one or more consonant following the nucleus called the syllable coda (Crystal, 2003). Syllables which have a coda are traditionally called closed syllables and those without are designated as open (Crystal, 2003). All Samoan syllables are open, meaning they all end with a vowel (Pratt, 1984); this rule in turn dictates that all Samoan words also end in a vowel. Samoan syllables cannot contain more than three letters, as each consonant must be separated by a mediating vowel. Again, there are no consonant clusters in Samoan, limiting syllable structures to either V, CV, or CVV-the last including a diphthong (Milner, 1993; Pratt, 1984).

The stress or accent within a word typically falls on the penultimate syllable (Milner, 1993; Pratt, 1984). Words ending in a long vowel will hold primary stress, as will those ending in *–ga*, diphthongs and words with affixed particles, which cause the stress to move forward (Pratt, 1984). Reduplicated words have two accents and compound words may have several more (Pratt, 1984).

Morphology and semantics. It is pertinent to preface any discussion regarding Samoan grammar with a statement by Milner (1993), which reads:

> [The] grammatical descriptions which have been used for centuries past in the description of European languages…are founded upon categories which have frequently proved to be unserviceable for the description on non-European languages, such as those of the Austronesian group, to which Samoan belongs. (Milner, 1993, p. xix)

Lesa and Mayer (2008) suggest much the same, in that "Samoan words are not generally classed into discrete parts of speech as in English, a word normally thought of as an adjective in English may be used as an adjective, noun or verb in Samoan" (p. 94). Instead, these views imply that it is best to think of Samoan as having *base* or *root* words (Milner, 1993), which are either inflected or combined with other particles to indicate their meaning and function.

Base words cannot be broken down into further grammatical parts (Crystal, 2003), and according to Milner (1993), Samoan base forms are identified by at least one of the following criteria: (a) they retain meaning when produced in isolation, (b) are lexical and not grammatical in nature, (c) are not monosyllabic but are potentially syllabic, vocalic, or disyllabic reduplications, and (d) they belong to a large, almost "exhaustive" (Milner, 1993, p. xxiv) class of words. In contrast, particles are grammatical segments which cannot be used meaningfully when produced in isolation; also many are monosyllabic and collectively form a small-delineated class of morphological members.

Nouns. Lesa & Mayer (2008) explain that the particle *'o* must be placed before a noun at the beginning of a sentence or a noun in isolation. This convention transforms the base word, which could be either verbal or nominal, into a noun. For example, *'o le teine 'aulelei* means the beautiful girl, but *'o le 'aulelei o le teine* means the beauty of the girl. *'O* is only used before nouns and pronouns. *Le* is placed before nouns when they are definite as seen in the previous example. Nouns without a singular article are presumed to be plural (Lesa & Mayer, 2008). *Se*

is used instead of *le* when nouns are definite or expressing negative. *Ni* is the plural form of *se* (Campbell, 2000; Lesa & Mayer, 2008). *Ma* is roughly translated as the conjunction *and* which may join two nouns together (Lesa & Mayer, 2008).

Pronouns. As in English, Samoan has both first, second, and third person singular and plural pronouns (Lesa & Mayer, 2008). However, a distinction is made between plural pronouns that include the listener and those that do not include the listener. Another form recognizes sets of two people, as a unique numbered plural. Pronouns are not marked for gender (Lesa & Mayer, 2008). A pronoun with the prefix *la* or *lo*, for singular nouns and *a* or *o* for plural nouns, marks possession (Lesa & Mayer, 2008).

Demonstratives. Demonstrative pronouns mark three degrees or relationships of orientation, namely this, that, and these near the speaker, away from the speaker, and/or near the listener, and distant from the listener or speaker. Demonstrative pronouns are marked as singular or plural (Lesa & Mayer, 2008).

Possession. As already indicated, *a* and *o* are genitive markers, comparable to the English word *of*. *O* is used when the nature of possession is "inalienable [and the ownership is] not transferable" (Campbell, 2000; Lesa & Mayer, 2008, p. 103), like referring to a body part or ones relatives. The letter *a* is used before a noun when the possessive relationship can be taken away or changed, as in the possession of an object like a car, friendship, or animal (Lesa & Mayer, 2008).

Adjectives. Campbell (2000) explains that adjectives both follow nouns and agree with them in number. Adjectives often have separate plural forms by either reduplicating or omitting part of its single form; examples include the word for big, *lapo'ā* (singular) and *lapopo'a* (plural).

Verbs. Verbs stems or base forms are intrinsically neutral and do not change to express tense; rather, tense and aspect are marked as past, present, complete, definite, or habitual by one of six common particles (Campbell, 2000; Lesa & Mayer, 2008). These include: *e* marking implied future or present indefinite, *ua* marking immediate perfective actions or states, *'olo'o* marking present continuous actions, *na* marking past tense, *sa* marking past perfect states or actions, and *'ole'ā* marking future definite, as opposed to implied future tense (Lesa & Mayer, 2008).

Prepositions. Location is expressed by placing the preposition *i* or *'i* (or its modified form *iā* or *'iā*) in addition to one of the many locative words before proper nouns and names. Example of common locative words include: *totonu* (inside), *luma* (in front), *tua* (behind), *fafo* (outside), and *luga* (above) (Lesa & Mayer, 2008).

Negation. *Lē* indicates negation and is comparable to the English word *not***.** When placed before a word, it negates whatever it precedes and is often used in addition to the *e* tense marker; for example, *'o le maile*, it's a dog, is changed to *e lē'o se maile*, it's not a dog (Lesa & Mayer, 2008).

Syntax. Samoan words order is most often VSO (Campbell, 2000; Lewis, 2009). Verb phrases appear first with other components following in varying order which may follow as subject, object, time then location (Lesa & Mayer, 2008). Grammatical case is not determined by word order requiring both subject and object to be marked to distinguish one from the other (Lesa, 2008).

Dialect and register. Lewis (2009) states that there are no significant dialectical variations between different Samoan speakers, but there are register differences in phonology which are significant. These registers constitute three different register-based levels of the

Samoan language: informal (for everyday communication), respect-sometimes called the language of "politeness" (Pratt, 1984, p. vii), and finally ceremonial which is also called the Chief's language (Simanu & Simanu-Klutz, 1999). Informal, everyday Samoan is "the language of the senses, the practical, and the children" (Simanu & Simanu-Klutz, 1999, p. vii), while the language of respect is reserved for communication with visitors, people in authority, and elders (Simanu & Simanu-Klutz, 1999). The Chief's language is only used during ceremonies, hosting important guests, and during negotiations (Simanu & Simanu-Klutz, 1999).

Lewis (2009) also indicates that the lexical characteristics of Samoan are shared with other languages, namely 70% of its lexical features are shared with the Wallisian language (spoken in the French territory of Wallis and Futuna), 67% are shared with Rarotongan (the language of the Cook Islands), 66% with the Tongan language, and 62% with Paumotu, the language of the Tuamotu islands (Lewis, 2009).

Samoan Word Recognition Materials

At this time, no commercially recorded speech audiometry materials are available for native speakers of Samoan. Audiologists, or other trained professionals, are required to use whatever words lists are available to them, and the process of live voice to present stimuli to their Samoan patients. By way of example, Appendix A contains copies of words lists currently used at the LBJ Tropical Medical Center, in Pango Pango, American Samoa (M. T. Saelua, personal communication, March 8, 2010).

Method

Subjects

Twenty native Samoans (9 male and 11 female) were chosen as listeners to evaluate the bisyllabic word lists developed in the current study. By self report, all subjects were native speakers of Samoan and indicated that they considered it to be their first language. The age of

the subjects ranged from 18 to 39 years old (M = 27.15), and the length of time each had spent in the U.S., at the time of testing, ranged from 3 to 34 years (M =*16.3*). All subjects underwent pure-tone air-conduction testing, resulting in a group threshold of ≤15 dB at octave and mid-octave frequencies between 125 and 8000 Hz. Static acoustic admittance for all subjects was between 0.2 and 1.3 mmhos with peak pressure between –90 and +10daPa (American Speech-Language and Hearing Association, 1990; Roup, Wiley, Safady, & Stoppenbach, 1998). Table 1 provides summary statistics of subject thresholds.

Materials

Words. Bisyllabic words were chosen as test stimuli as most monosyllabic words in Samoan carry insufficient lexical meaning in isolation (Milner, 1993). Words were selected from a singular language resource produced by the senior lecturer and program director of Samoan Studies, G. A. Hunkin, at Victoria University of Wellington, New Zealand. Hunkin (2001) indicates that the purpose of this resource was to produce a word frequency list for the Samoan language as "no list of this type had been complied before" (Hunkin, 2001, p. i). To generate such a frequency list, it was necessary for the author to compile and analyze a corpus of Samoan texts, which he did by following established criteria and principles delineated by Kennedy's work, *Introduction to Corpus Linguistics* (1998), and Biber, Conrad, and Reppen's text, *Corpus Linguistics: Investigating Language Structure Use* (1998). In addition to the guidelines given by these authors, Hunkin's Samoan corpus was also influenced by the structure of the *Survey of English Usage*, the *Brown University Standard Corpus of Present-Day American English*, and the *International Corpus of English*.

A number of previous studies, where no frequency dictionary was available for the development of word recognition materials in foreign languages, have used a web-based software, which identified high frequency words from on-line texts (Nissen et al., 2005).

Table 1

Pure Tone Threshold (dB HL) Descriptive Statistics for 20 Normally Hearing Samoan Subjects

kHz	*M*	*Minimum*	*Maximum*	*SD*
0.125	0.5	-10	10	5.8
0.25	1.3	-10	10	7.0
0.5	4.5	-10	15	6.7
0.75	4.8	-5	15	6.0
1.0	5.0	-10	15	5.8
1.5	7.8	-5	15	5.7
2.0	6.5	-5	15	5.4
3.0	4.3	-5	15	6.5
4.0	5.0	-5	15	6.1
6.0	3.0	-10	15	6.4
8.0	3.0	-10	15	6.2
PTA[a]	5.3	-6.7	11.7	5.1

[a]PTA = arithmetic average of thresholds at 0.5, 1.0, and 2.0 kHz

Although this resource proved successful for several languages, results generated in this way proved unreliable for Samoan due to the inconsistent use of Samoan diacritics (the glottal stop, /’/ and macron, /-/) in everyday Samoan literature. As mentioned before, the convention of omitting these diacritics (Simanu & Simanu-Klutz, 1999), requires the context of a sentence, or paragraph, to resolve questions regarding word meaning. Software targeting isolated words from online texts is not able to capture syntactic or discourse cues required for accurate frequency lists of Samoan words. Approximately 350 of the highest ranked bisyllabic words from the frequency word list developed by Hunkin (2001) were chosen and judged by four native Samoan speakers who rated the relative familiarity of each word on a scale ranging from 1 to 5; each judge was asked to rate how familiar they thought each word would be to most native teen to adult-aged Samoans. Each number on the scale represented the following level of familiarity: 5 (*extremely familiar*), 4 (*very familiar*), 3 (*average familiarity*), 2 (*seldom used*), and 1 (*rarely used*). Any word which received a rating of three or less was eliminated from the pool of potential words, as they were deemed culturally insensitive or inappropriate for the study. At the conclusion of this process, 250 words were selected for testing and evaluation.

Talkers. Initial voice recordings of three male and three female native speakers were recorded for talker evaluation and selection. A panel of eight native judges evaluated each recording or voice. Judges was asked to rank each female and male talker, from best to worst, considering voice quality, accent, and pronunciation. The highest-ranking male and female talker was chosen respectively for all remaining recordings.

Recordings. All recordings were made in a double-walled sound suite at Brigham Young University in Provo, Utah, USA. A Larson-Davis model 377B41, 1.27 cm model microphone was used for all recordings. The microphone was positioned approximately 15 cm

from each talker at a 0˚ azimuth. The microphone was connected to a Larson-Davis model PRM902 microphone preamp, which was coupled to a Larson-Davis model 2221 microphone preamplifier power supply. The signal was digitized by a Benchmark Analogue to Digital 1 (ADC1), 24-bit converter and stored on a hard drive for later editing. A 44.1 kHz sampling rate with a 24-bit quantization was used for all recordings, in addition to utilizing a 24-bit analog-to-digital converter. During the recording of test words, talkers were instructed to repeat each bisyllabic word four times with a slight pause between each pronunciation. The first and last repetition of each word was excluded from the study to avoid listing effects. The two remaining medial productions were then judged by a native speaker to determine the best quality production for the final word lists.

The intensity of each word was edited as a single utterance using Sadie Disk Editor software (Studio Audio & Video Ltd., 2007) to obtain the same average RMS power as a 1000 Hz calibration tone in an initial attempt to equate test word audibility (Harris et al., 2004; Wilson & Strouse, 1999). After editing, each word was saved individually as a 24-bit wav file.

Procedures

The randomization and presentation of each word to the listener in the sound suite was controlled by custom software which channeled each wav file into the output of a Grason Stadler model 1761 audiometer. The words or stimuli were then routed from the audiometer to the listener by way of a single TDH-50P headphone. The presentation timing of all stimuli and the subsequent scoring of all words were controlled by the study's native Samoan interpreter. All testing was conducted in a double walled sound suite which met ANSI S3.1 standards for maximum permissible ambient noise levels for ear not covered conditions using one-third octave-bands (American National Standards Institute, 1999).

External outputs to the audiometer were calibrated prior to testing each subject to 0 VU, using a 1000 Hz calibration tone. Audiometric calibrations were completed according to ANSI S3.6 specifications (American National Standards Institute, 2004) before data collection began, during each week of testing, and after data collection was completed. No change in audiometric calibration was necessary. Each subject attended one session prior to word recognition testing, to pass a pure-tone air conduction hearing test at 15 dB HL or better. Subjects were not familiarized with test words prior to testing. All 250 words were randomized into ten lists of 25-words and presented to the first ten subjects. After that testing, the words were again pooled and randomized a second time into ten different word lists for presentation to the remaining ten subjects. Each word was presented an equal number of times at each intensity levels for evaluation, ranging from -5 dB to 40 dB HL, increasing in 5 dB increments. Subjects were presented one lists at each intensity level, meaning that each subject completed ten lists. The order of words within each list was randomized during the presentation. All subject responses to test stimuli were scored by the same native interpreter throughout data collection. Responses were only marked correct if they matched the target stimuli in both pronunciation and lexical tone. Prior to the administration of word recognition testing, each subject was given the following instructions in English and Samoan:

> You will hear lists of Samoan words at a number of different loudness levels. Each word is two syllables in length. At the very soft levels it may be difficult for you to hear the words. Please listen carefully and repeat out loud the word that you hear. If you are unsure of a word, you are encouraged to guess. If you have no guess say, *I don't know*, or wait silently for the next word. Do you have any questions?

Results

Results from data collection were analyzed using descriptive and inferential statistical methods. Before data analysis, it was judged necessary to remove two words from both male and female words lists (and their corresponding data points) in an effort to maintain internal consistency and reliability. The study's native interpreter, a trained Samoan linguist and teacher, identified two words during the course of testing as linguistically inappropriate and deviant from the word selection criteria. After this adjustment, the remaining 248 words used in word recognition testing were ranked from highest to lowest according to listener performance or correct identification across all intensity levels. This was done for both male and female words respectively. The highest 200 ranked words were chosen for statistical analysis and divided into one of four equivalent lists using an S-curve distribution-residual words were eliminated from the pool of test stimuli. The S-curve distribution was completed as follows: the first four words were assigned to each list (i.e. the first word was placed in list one, the second in list two, the third in list three, and the fourth in list four). The next four words were assigned likewise but in reverse order with the fifth word being assigned to list four, the sixth to list three and so on. This back and forth distribution was repeated until all 200 words were assigned a list, and each list contained 50 words. This process was performed for both male and female words. The resulting four equivalent bisyllabic word lists for male and female talkers are presented in Tables 2 and 3 respectively.

Each bisyllabic list was further divided into two half-lists of 25 words. This was done by randomly assigning the first word in each list as either A or B, with the second word receiving the designation of the other letter. Through counterbalancing, the remaining words in each list were subsequently given a letter designation allowing each full list to be equally divided into half-list A, and half-list B, as presented in Tables 4 and 5.

Table 2

Samoan Male Bisyllabic Lists in Rank Order from Most Difficult to Easiest

List 1		List 2		List 3		List 4	
kopi	lagi	sulu	ma'i	pogai	fia	afi	māmā
ula	o'o	mafai	tūmau	mautū	fofō	togi	nu'u
fana	pule	tumu	i'a	fefe	loka	tele	mate
tali	pese	fusu	goto	ofi	ea	āfu	solo
leva	lalo	vale	lima	tamā	'ese	usu	sesē
galu	manu	fua	fīnau	gutu	sui	galo	'ave
pa'ō	lāiti	luma	a'e	nanā	sole	sili	maliu
motu	gaoi	matai	ipu	moe	tusi	lēmū	loto
sene	alu	'ie	aitu	pou	'a'ao	sami	uila
pepe	tīgā	tolu	a'ai	va'a	koko	tupu	logo
kiki	galue	pa'i	se'e	tofu	a'o	tu'i	tasi
lā'ei	iva	tuli	lūlū	'ato	'ata	luga	'aumai
musu	'ava	valu	fitu	te'i	moa	tagi	fa'i
tinā	'autū	oti	ma'a	ufi	fo'i	ā'au	lele
miti	pusa	gata	mata	su'e	ola	ifo	suka
tulou	leo	tofi	saka	tama	uso	selau	ala
fafo	ita	si'i	faitau	tōfā	paipa	uta	taeao
pisi	mauga	malae	aso	'uma	pepa	laki	'ai
lotu	fe'au	'āfai	'apa	sisi	'aua	'emo	lavea
fu'a	sa'o	mala	pisa	mōlī	toto	fala	nofo
fatu	tausi	susū	ono	teu	ata	'upu	pito
te'a	āiā	fetū	vāivai	pu'e	sasa	tupe	aogā
afā	tālā	misi	tuai	tago	sola	'eli	'auai
sua	oso	vave	fānau	poto	lā'au	futu	mālō
maila	māmoe	ulu	pa'ū	toa	leai	mamā	va'ai

Table 3

Sāmoan Female Bisyllabic Lists in Rank Order from Most Difficult to Easiest

List 1		List 2		List 3		List 4	
'apa	tusi	poto	iva	pepē	'auai	laki	gaoi
ifo	lotu	li'o	tali	tofu	āfu	inu	'umi
usu	ma'a	fana	tumu	loli	māmoe	sua	afe
fia	tu'u	miti	i'a	ta'u	uso	valu	kiki
ipu	maila	lele	'upu	tāne	gata	'ato	se'e
tupu	fu'a	misa	luga	lūlū	sui	lilo	tu'i
musu	toto	tausi	lēmū	kopi	lanu	'ie	'emo
sulu	'ova	fala	'uma	motu	fo'i	'ofu	lāiti
ufi	tīgā	si'i	susū	leva	leo	oso	ma'i
ā'au	suka	tua	fafo	oti	aso	fea	galo
'aina	'autū	pese	maliu	tulou	ea	galue	fitu
tofi	tama	teine	lima	sami	āvā	'a'ao	ofi
talo	pa'ū	pule	ono	fofō	lā'ei	tago	tinā
fa'i	su'e	uila	'ave	koko	'afa	mautū	mata
ulu	ala	mapu	moa	saka	lā'au	moni	logo
loka	sasa	fefe	ula	fusi	vāivai	togi	liu
sole	'aumai	alu	a'e	mafai	gutu	taimi	toa
tūmau	tamā	sola	malae	fatu	tolu	selau	lalo
fusu	māmā	mate	tōfā	'āfai	mo'i	fīnau	'ata
loto	a'o	nanā	'ava	tasi	taeao	manu	tālā
faiga	leai	mauga	tupe	tino	pa'ō	afi	va'ai
a'ai	'aua	gafa	ola	tuli	pepa	āiā	sa'o
tauvā	lavea	tuai	moe	itū	fale	luma	ata
pito	'ai	faitau	fe'au	mamā	mōlī	mala	mālō
fetū	aogā	fono	fānau	'ese	o'o	tatau	nofo

Table 4

Sāmoan Male Bisyllabic Half-lists in Rank Order from Most Difficult to Easiest

1A	1B	2A	2B	3A	3B	4A	4B
ifo	'apa	poto	li'o	pepē	tofu	laki	inu
usu	fia	miti	fana	ta'u	loli	valu	sua
tupu	ipu	lele	misa	tāne	lūlū	'ato	lilo
musu	sulu	fala	tausi	motu	kopi	'ofu	'ie
ā'au	ufi	si'i	tua	leva	oti	oso	fea
'aina	tofi	teine	pese	sami	tulou	'a'ao	galue
fa'i	talo	pule	uila	fofō	koko	tago	mautū
ulu	loka	fefe	mapu	fusi	saka	togi	moni
tūmau	sole	alu	sola	mafai	fatu	taimi	selau
fusu	loto	nanā	mate	tasi	'āfai	manu	fīnau
a'ai	faiga	mauga	gafa	tino	tuli	afi	āiā
tauvā	pito	faitau	tuai	mamā	itū	mala	luma
tusi	fetū	fono	iva	'ese	'auai	tatau	gaoi
lotu	ma'a	tumu	tali	māmoe	āfu	afe	'umi
maila	tu'u	i'a	'upu	uso	gata	kiki	se'e
fu'a	toto	lēmū	luga	lanu	sui	'emo	tu'i
tīgā	'ova	'uma	susū	fo'i	leo	lāiti	ma'i
suka	'autū	maliu	fafo	ea	aso	fitu	galo
pa'ū	tama	lima	ono	āvā	lā'ei	ofi	tinā
su'e	ala	moa	'ave	lā'au	'afa	logo	mata
'aumai	sasa	ula	a'e	vāivai	gutu	liu	toa
tamā	māmā	tōfā	malae	mo'i	tolu	'ata	lalo
leai	a'o	'ava	tupe	taeao	pa'ō	tālā	va'ai
'aua	lavea	moe	ola	fale	pepa	ata	sa'o
aogā	'ai	fe'au	fānau	mōlī	o'o	mālō	nofo

Table 5

Sāmoan Female Bisyllabic Half-lists in Rank Order from Most Difficult to Easiest

1A	1B	2A	2B	3A	3B	4A	4B
sene	tupu	miti	solo	pine	leai	luga	usu
tamā	musu	tatau	misa	aogā	pepe	ta'u	valu
fe'e	leva	popo	inu	lilo	pisi	'ata	uso
'a'ao	tūmau	faitau	fu'a	'aina	koko	galu	saka
koko	tofu	te'i	sesē	tulou	fatu	'ofu	oti
'ie	manu	tōfā	a'ai	āiā	tua	ulu	suka
tago	fafo	ā'au	oso	uila	fale	motu	i'a
fānau	pusi	pu'e	moni	pepē	tali	fofō	mautū
pese	mate	sola	pito	fetū	mālō	tagi	fusi
tinā	lūlū	ufi	se'e	fa'i	tuai	mauga	āiā
maila	loka	nanā	ma'a	māmoe	tuli	tausi	'āfai
tu'i	sisi	futu	loli	fīnau	faiga	tāne	ala
'emo	'uma	i'u	lanu	'aua	sui	gaoi	su'e
fitu	kiki	gutu	sulu	toto	fua	fo'i	teu
tusi	āfu	'uma	lenei	tālā	sasa	luma	lele
tu'u	afi	galue	'umi	loto	tasi	mata	afe
ita	ma'i	lāiti	'upu	'eli	'ese	fono	kopi
'ava	'apa	mafai	māmoe	aitu	'ova	lotu	tumu
liu	ula	vāivai	malae	talo	sa'o	gafa	ono
sua	lima	pa'ū	'ave	tolu	tīgā	moa	a'e
āvā	'afa	goto	logo	lā'au	tino	'autū	'auai
lavea	taimi	mo'i	tama	ofi	mamā	pa'ō	va'ai
ata	maliu	'aumai	toa	mala	susū	alu	lalo
'ato	mōlī	aso	pepa	tupe	fala	ola	lavea
nofo	a'o	o'o	moe	fana	fea	sami	'ai

Logistic regression was used to calculate the regression slopes and regression intercepts for each list, and half-list for both male and female words. Regression slope and intercept values were then inserted into a modified logistic regression equation (equation 1), which calculated the percentage of correct performance at all intensity levels.

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

Equation 1 can be explained as follows: p is the percentage of correct word recognition, a is regression intercept, b is regression slope, and i is the presentation intensity level in dB HL. By inserting the values for regression intercept, slope, and intensity level (a, b and i), the percentage of correct word recognition (P) can be determined. Values for intensity ranged from -5 to 40 dB HL, in 5 dB increments. The values for percentage of correct word recognition were then used to construct psychometric functions for each of the four lists and eight half-lists for male and female talkers.

$$i = \frac{\log \frac{P}{1 - P} - a}{b} \quad (2)$$

Equation 2 was used to determine the threshold (the intensity level for 50% correct word recognition), the slope at the threshold, and the slope between 20%-80% for each list and half-list. Again, regression intercept (a) and regression slope (b) values were used in addition to the percentage of correct recognition (P) to determine the desired intensity level in dB HL (i). Table 6 and Table 7 provide summary statistics for values derived from equation 1 and 2, namely regression intercept, regression slope, and the psychometric function slope at 50% and 20%-80% for all male and female lists and half-lists; these tables also indicate the threshold for 50% intelligibility and the intensity change required to adjust the threshold of each list and half-list to the mean threshold of all male and female lists combined.

Table 6

Mean Performance of Samoan Male Bisyllabic Lists and Half-lists

List	a[a]	b[b]	Slope at 50%[c]	Slope 20-80%[d]	Slope Threshold[e]	ΔdB[f]
1	3.75073	-0.23021	5.8	5.0	16.3	0.17
2	3.89195	-0.23959	6.0	5.2	16.2	0.12
3	3.81872	-0.23437	5.9	5.1	16.3	0.17
4	4.25791	-0.26047	6.5	5.6	16.3	0.23
M	3.92983	-0.24116	6.0	5.2	16.3	0.17
Minimum	3.75073	-0.26047	5.8	5.0	16.2	0.12
Maximum	4.25791	-0.23021	6.5	5.6	16.3	0.23
Range	0.50718	0.03026	0.8	0.7	0.1	0.10
SD	0.22620	0.01343	0.3	0.3	0.0	0.04
1A	3.68578	-0.22623	5.7	4.9	16.3	0.17
1B	3.81872	-0.23437	5.9	5.1	16.3	0.17
2A	4.13434	-0.25527	6.4	5.5	16.2	0.07
2B	3.68578	-0.22623	5.7	4.9	16.3	0.17
3A	3.85393	-0.23653	5.9	5.1	16.3	0.17
3B	3.78433	-0.23227	5.8	5.0	16.3	0.17
4A	4.44983	-0.27137	6.8	5.9	16.4	0.28
4B	4.08546	-0.25071	6.3	5.4	16.3	0.17
M	3.93727	-0.24162	6.0	5.2	16.3	0.17
Minimum	3.68578	-0.27137	5.7	4.9	16.2	0.07
Maximum	4.44983	-0.22623	6.8	5.9	16.4	0.28
Range	0.76405	0.04514	1.1	1.0	0.2	0.20
SD	0.26576	0.01601	0.4	0.3	0.1	0.05

[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]Change in intensity required to adjust threshold to the mean threshold for male and female lists (16.12 dB HL).

Table 7

Mean Performance of Samoan Female Bisyllabic Lists and Half-lists

List	a[a]	b[b]	Slope at 50%[c]	Slope 20-80%[d]	Slope Threshold[e]	ΔdB[f]
1	3.46345	-0.21732	5.4	4.7	15.9	-0.18
2	3.34231	-0.20976	5.2	4.5	15.9	-0.19
3	3.38152	-0.21221	5.3	4.6	15.9	-0.19
4	3.56483	-0.22296	5.6	4.8	16.0	-0.13
M	3.43803	-0.21556	5.4	4.7	15.9	-0.17
Minimum	3.34231	-0.22296	5.2	4.5	15.9	-0.19
Maximum	3.56483	-0.20976	5.6	4.8	16.0	-0.13
Range	0.22252	0.01320	0.3	0.3	0.1	0.06
SD	0.09845	0.00585	0.1	0.1	0.0	0.03
1A	3.31730	-0.20754	5.2	4.5	16.0	-0.14
1B	3.62872	-0.22837	5.7	4.9	15.9	-0.23
2A	3.56649	-0.22447	5.6	4.9	15.9	-0.23
2B	3.15157	-0.19724	4.9	4.3	16.0	-0.14
3A	3.26648	-0.20568	5.1	4.5	15.9	-0.24
3B	3.50590	-0.21928	5.5	4.7	16.0	-0.13
4A	3.59525	-0.22485	5.6	4.9	16.0	-0.13
4B	3.53506	-0.22110	5.5	4.8	16.0	-0.13
M	3.44585	-0.21607	5.4	4.7	15.9	-0.17
Minimum	3.15157	-0.22837	4.9	4.3	15.9	-0.24
Maximum	3.62872	-0.19724	5.7	4.9	16.0	-0.13
Range	0.47715	0.03113	0.8	0.7	0.1	0.11
SD	0.17614	0.01115	0.3	0.2	0.1	0.05

[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]Change in intensity required to adjust threshold to the mean threshold for male and female lists (16.12 dB HL).

A two-way Chi-square (χ^2) analysis was performed to determine whether there were any significant statistical differences between male and female lists and half-lists. List and intensity were the independent variables, with listener response as the dependent variable. Results of the analysis indicated that there were no significant differences among the four male lists, $\chi^2(3, N = 20) = 1.87, p = 0.60$, or eight half-lists, $\chi^2(7, N = 20) = 2.95, p = 0.89$. Likewise, no significant differences were found among the four female lists, $\chi^2(3, N = 20) = 0.52, p = 0.92$, or half-lists, $\chi^2(7, N = 20) = 2.08, p = 0.96$. Analysis of the slopes of the psychometric functions from each lists and half-lists were also completed. Results found no significant differences among the slopes of the four male lists, $\chi^2(3, N = 20) = 2.10, p = 0.55$, or eight half-lists, $\chi^2(7, N = 20) = 3.42, p = 0.84$. Again, no significant differences were found among the slopes of the four female lists, $\chi^2(3, N = 20) = 0.58, p = 0.90$, or eight half-lists, $\chi^2(7, N = 20) = 2.69, p = 0.91$. In summary, there were no significant interactions between intensity and list, as independent variables, indicating the differences among psychometric function slopes for male and female lists and half-lists were negligible.

After statistical analysis, improvements were made to increase the psychometric equivalency of all the lists as a collective group of stimuli. The intensity level of every bisyllabic word was digitally adjusted, using Adobe Audition 2.0 (Adobe Systems Inc., 2005), to equate the 50% threshold of all lists and half-lists to the midpoint (16.12 dB HL) between the mean thresholds of the eight male and female half-lists. Table 6 and Table 7 detail the intensity adjustments made to words in each male and female list and half-lists respectively. The degree of adjustment needed for male and female words differed; male words were increased in intensity by less than 0.30 dB, and female words were adjusted to decreasing intensity by less than 0.25 dB. Figure 1 presents the psychometric functions for male and female bisyllabic lists

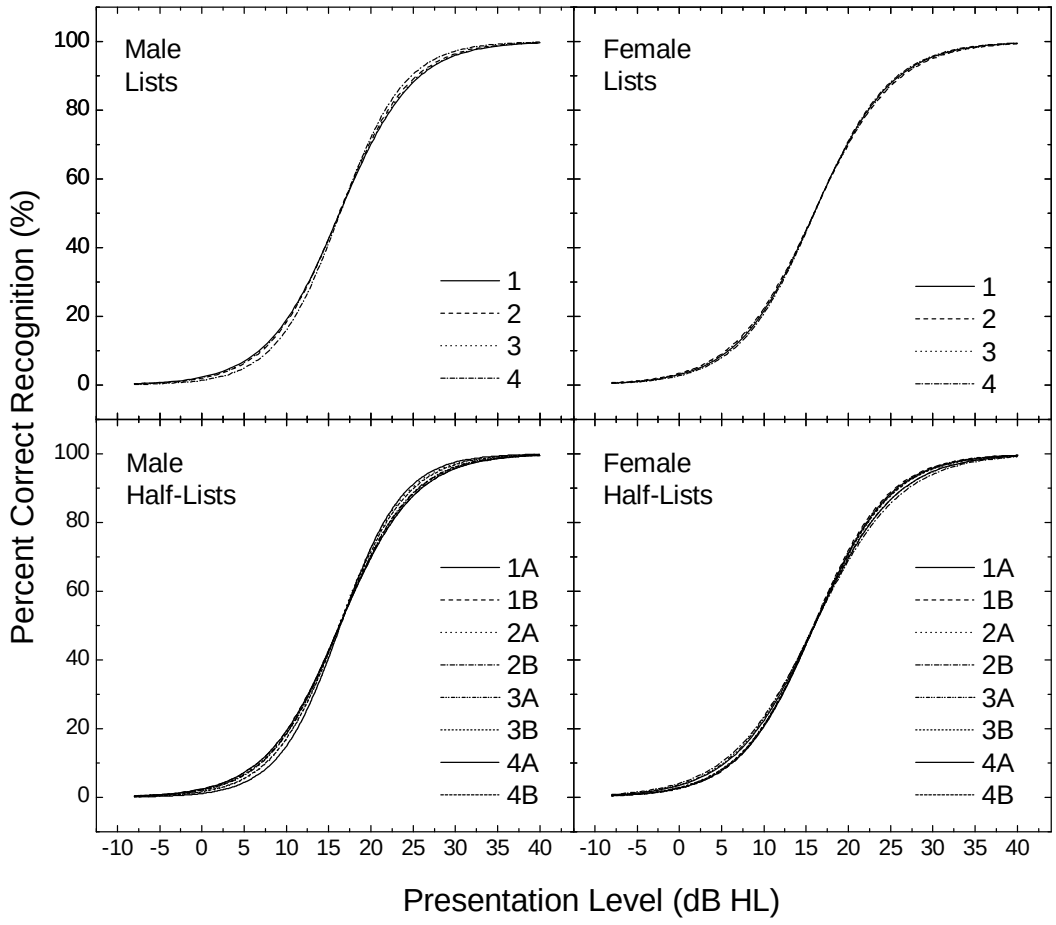

Figure 1.

Psychometric functions for the four Samoan bisyllabic lists and eight half-lists for male talker and female talker recordings before intensity adjustments.

and half-lists before the intensity adjustment, while Figure 2 presents the psychometric functions after the adjustment was completed. Finally, Figure 3 presents a collective representation of all the male and female lists and half-lists before and after the intensity adjustment.

Discussion

At this time there are no standardized speech audiometry materials commercially available in the Samoan language. The current study was conducted to develop digital, psychometrically equivalent word lists and half-lists for native speakers of Samoan. Two-hundred bisyllabic words were used as test stimuli including eight lists of 50-words (four male, four female) and sixteen half-lists of 25-words (eight male and eight female). The word lists developed were considered homogenous in regard to psychometric slope and the 50% threshold for correct word recognition. As the pure tone average (PTA) and resulting word recognition thresholds vary between subject groups used to develop similar word recognition materials in other languages (Nissen et al., 2005; Nissen, Harris, Jennings, Eggett, & Buck, 2005; Nissen, Harris, & Slade, 2007; Wang, Mannell, Newall, Zhang, & Han, 2007), psychometric function slope remains a relative measure of subject performance in the development of any given word recognition test.

Comparative Analysis of Previous Studies

The psychometric slope at threshold for the Samoan bisyllabic lists and half-lists developed in this study ranged from 5.7 to 6.8%/dB (M = 6.0%/dB) for male words, and 4.9 to 5.7%/dB (M = 5.4%/dB) for female words. The slope at 20-80% ranged from 4.9 to 5.9%/dB (M = 5.2%/dB) and from 4.3 to 4.9%/dB (M = 4.7%/dB) for male and female lists and half-lists respectively. The mean PTA for this subject group was 5.3 dB HL, while their 50% word recognition threshold was roughly 10 dB higher at 16.12 dB HL.

Wilson and Oyler's (1997) findings are noteworthy as they assessed the equivalence of the NU-6 and W-22, two of the most common word recognition materials available in English.

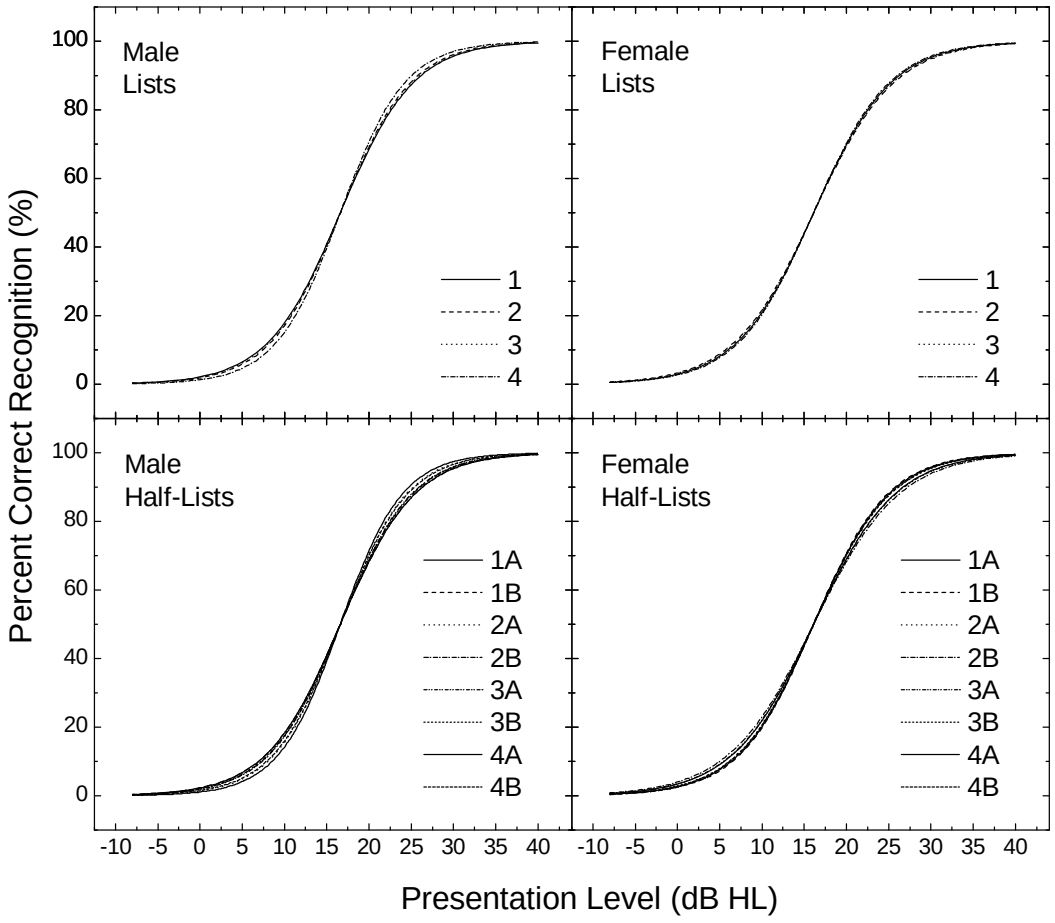

Figure 2.

Psychometric functions for the four Samoan bisyllabic lists and eight half-lists for male talker and female talker recordings after intensity adjustments to produce 50% performance at 16.12 dB HL.

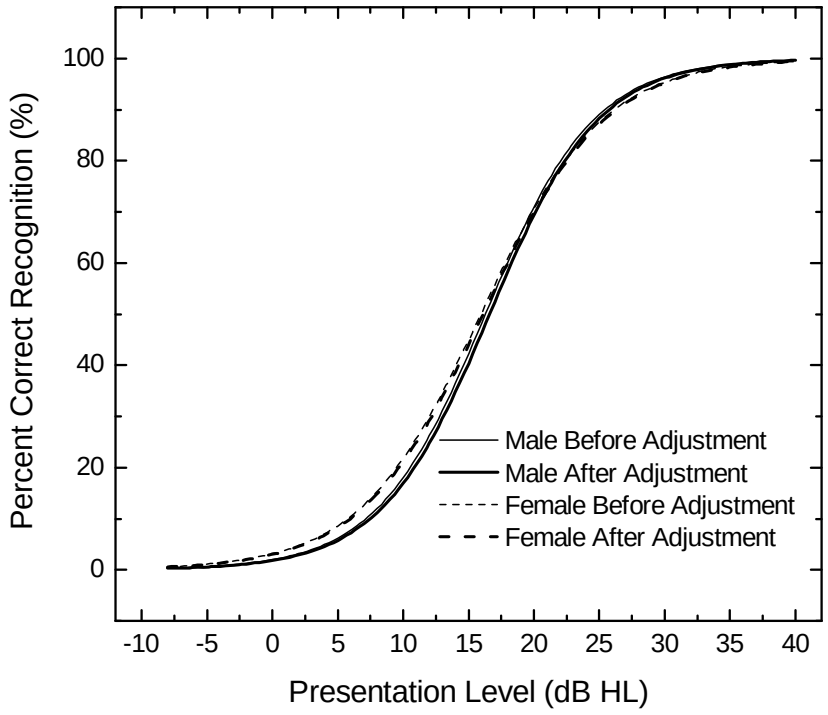

Figure 3.

Mean psychometric functions for male and female Samoan talker bisyllabic word lists before and after intensity adjustment. Intensity adjustments were made to each list and half-list to produce 50% correct performance at 16.12 dB HL.

A compact disk (CD), made available by Auditec of St. Louis, containing the first three word lists of each test was used on 24 normal hearing subjects in quite and noise. Words from both materials were interleaved and presented to subjects at 0 to 30 dB HL in 5 dB increments (Wilson & Oyler, 1997). Results from this study determined that the mean slopes for the NU-6 and CID W-22, when tested on normal hearing subjects in quiet, were 4.4%/dB and 4.8%/dB respectively. These values for psychometric slope were slightly different than those found by Beattie, Edgerton, and Svihovec (1977), who conducted a similar study years previous using the same test materials recorded on cassette tape. Beattie et al. (1977) assessed the mean slope of the NU-6 to be 4.2%/dB and the W-22 as 4.6%/dB. Differences in slope between these studies were explained by differing calibration method and procedures which determined presentation levels (Wilson & Oyler, 1997). Wilson and Oyler (1997) therefore suggested that the SRT and psychometric function from the Beattie et al. (1977) study were "artificially low" (Wilson & Oyler, 1997, p. 433).

The psychometric function slopes (at 50% and 20-80%) for words lists in the current study were marginally higher than those percentages found in the English materials just mentioned. However, the differences in slope were small, approximately 1.5%, suggesting that the lists and half-lists of Samoan words developed in this study are suitable for use among the Samoan speaking population. Small differences in slope which did exist may be explained by subtle variations in dialect among the Samoan speakers used in this research, varying speech rate between the male and female talkers, and the linguistic nature of the Samoan language.

The 20 native Samoan subjects and two Samoan talkers, who participated in this study, were homogenous in language use but diverse in their place of birth and where they were raised through childhood. The male talker used for word recordings was born in California and raised

in Utah. The study's female talker was born in American Samoa and raised in Hawaii. Seven subjects were born and raised in American Samoa, while one other subject was born in American Samoa but raised in the US. Further more, seven subjects were born and raised in the US, with another four subjects born in the US but raised in American Samoa. Finally, the last remaining subject was born in Australia and raised in American Samoa. As stated before, Lewis (2009), in his prolific work entitled *Ethnologue: Languages of the World*, confirms that there are no significant dialect differences between native speakers of Samoan. However, it is relevant to consider that perhaps within the context of conversation, pronunciation and lexical differences are not linguistically significant but may be audiologically significant, or at least influential enough to cause subtle differences in recognition scores between subjects who grew up in different Samoan speaking countries or communities.

It was noted after talker recordings that the speaking rate of the male talkers was perceptually higher (or faster) than the study's female talker. Although given the same instructions during recording procedures, the female talker appeared to produce a more deliberate pronunciation of each word while the male speaker produced each word at a rate perhaps analogue to the rate found in continuous speech. A faster speaking rate may influence the clarity of acoustic information during word recognition testing. However, statistical analysis indicated that there were no differences within listener performance on male versus female word lists and half-lists.

The phonological and acoustic characteristics of the Samoan language may provide the most convincing explanation for subtle differences in psychometric slope between Samoan and English word recognition materials. The Samoan language is notably vowel-laden when compared to English, as its syllable structure does not allow for consonant blends. Samoan only

uses 13 consonant phonemes in contrast to the 26 consonant phonemes used in English. The perception of speech is most influenced by vowel intensity (as vowels carry the most acoustic energy), while consonants play a greater role in speech recognition, when compared to perception, as they provide the acoustic cues necessary to distinguish between words with similar vowel components.

Comparing the psychometric function slope of the Samoan materials developed in this study to those developed for the English language is relevant as English has enjoyed standardized word recognition tests for over 50 years. Many English tests have endured extensive scrutiny from researchers as to their validity and reliability. However, it is also prudent to make a similar comparison with languages within the same language family as Samoan. The psychometric slope at the 50% threshold found for Tongan bisyllabic word lists and half-lists for male and female talkers were 6.3%/dB and 6.2%/dB respectively (Seaver, 2008). The slope at 20-80% was found to be 5.4%/dB for male words and 5.3%/dB for female words (Seaver, 2008). Again, the differences in slope between these materials developed for Tongan and the materials develop in this study for Samoan are negligible. These similarities in psychometric slope are not surprising, as the Samoan language shares 66% of its lexical characteristics with the Tongan language (Lewis, 2009).

Recommendations for Future Research

While the current word lists and half-list are suitable for Samoan speakers, lexical items are judged appropriate for teen and adult-aged individuals only, not children. Word recognition materials appropriate for Samoan speaking children still need to be developed and pose a valid topic for further research. In addition to developing materials for a pediatric Samoan population, further research should also be done to determine the test-retest reliability of all lists and half-

lists developed in the current study. Efforts to determine test-retest reliability can strengthen the findings of the current research and increase the reliability of materials by reducing outliers (Gelfand, 1998). Other suggestions for further research include testing Samoan subjects with words presented in background noise. All subjects who participated in the current study were tested in a quiet environment using a double walled sound booth. However, individuals with normal and impaired hearing rarely listen in such conditions as most daily communication occurs in the presence of noise. Indeed, Wilson and McArdle (2005) affirm that the most common complaint made to audiologist by those with hearing loss is the loss of ability to understand speech in noisy environments, especially noise generated by several speech sources. It therefore becomes important to test word recognition in quiet and in noise despite increasing the length of an audiological evaluation in doing so (Wilson & McArdle, 2005). Thus, future research may choose to develop Samoan words and sentences in noise for word recognition testing. Finally, further research is needed to assess the effectiveness of the current materials in evaluating individuals with varying types and degrees of hearing loss to determine the continuity of results among these different populations (McArdle & Wilson, 2006).

In summary, the purpose of this study included identifying, recording, and testing appropriate bisyllabic words to develop word recognition materials for native speakers of Samoan. All word recognition word lists and half-lists, materials for testing SRT, audiometric instructions for listeners, and a 1 KHz calibration tone were recorded onto CD and made commercially available. It is hoped that this resource will aid trained professionals in the diagnosis and remediation of hearing loss in Samoan-speaking people.

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Appendix A

LBJ Tropical Medical Center Word Recognition Lists

Samoan Speech Discrimination Lists

List No. 1		List No. 2	
1. SA	26. MU	1. VEU	26. SA
2. SAU	27. SU	2. VAI	27. SAU
3. TEU	28. SUA	3. TOA	28. TEU
4. TAU	29. MUA	4. FAO	29. TAU
5. TIA	30. LEA	5. TO	30. TIA
6. SIA	31. MEA	6. VAE	31. SIA
7. FIU	32. FEA	7. FOA	32. FIU
8. FIA	33. LU	8. MOA	33. FIA
9. MAU	34. FU	9. NOA	34. MAU
10. GAU	35. LA	10. SAI	35. GAU
11. MA	36. TU	11. TAI	36. MA
12. FA	37. VAU	12. FAI	37. SAU
13. TI	38. LIU	13. LOU	38. TI
14. PIA	39. NEI	14. FOU	39. PIA
15. LUA	40. FEI	15. SOU	40. EVA
16. FUA	41. SEI	16. PUA	41. FUA
17. FAU	42. TAI	17. TUA	42. FAU
18. LAU	43. SUI	18. KI	43. LAU
19. LUE	44. LUI	19. SOA	44. LUE
20. SEU	45. TUI	20. AU	45. SEU
21. VA	46. PEA	21. MAI	46. VA
22. PA	47. SEA	22. TUE	47. PA
23. TA	48. TAO	23. OA	48. TA
24. TI	49. OA	24. POU	49. SEI
25. VI	50. POU	25. MOU	50. LA

Appendix B

Informed Consent
RESEARCH PARTICIPATION FORM

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 complete your participation in this research project you will be paid the amount of $_____ for your participation.

If you have any questions regarding this research project you may contact Dr. Richard W. Harris, 131 TLRB, Brigham Young University, Provo, UT 84602; phone (801) 422-6460 or Dr. Shawn L. Nissen, 138 TLRB, Brigham Young University, Provo, UT 84602, phone (801) 422-5056. If you have any questions regarding your rights as a participant in a research project you may contact Dr. Lane Fischer, Chair of the Institutional Review Board, 340-L MCKB, Brigham Young University, Provo, UT 84602; phone (801) 422-8293, email: lane_fischer@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 C

Selected Bisyllabic Words

1	'āfai	noun	if
2	'autū	verb, noun	center around, revolve around, core, center, main theme
3	'ie	noun	kind of pandanus (leaf), general name for plaited matting, kilt or skirt, material, cloth, sheet. Linen
4	a'ai	noun; verb	village, town; eating, (pl.) eating
5	'a'ao	noun; verb	limb; present, be conceited
6	ā'au	noun	reef
7	a'e	verb	go up, climb, return
8	'afa	noun	plaited cord, line; species of fish; half
9	afā	noun	storm, gale, hurricane
10	afe	verb, noun	thousand, turn, turn over, hem
11	afi	noun	fire, bundle of fish, package, parcel
12	āfu	noun	sweat, waterfall,wither
13	'ai	noun; particle	eat, bite, score, goal, point, probably, it is likely
14	āiā	verb adjective	have a claim to be entitled to, interfere, meddle
15	'aina	verb	be eaten, be eaten up, be edible
16	aitu	noun	ghost, spirit
17	ala	noun; verb	path, road, way, method, reason for, bridge; be awake, wake up, stay awake; scratch; catch a fish by trolling
18	alu	verb	go, get, spent, lost, escape
19	a'o	verb	learn, teach train.
20	aogā	noun	use, value,
21	'apa	noun; verb	tin, can, cement-sheet; beat, lash
22	aso	noun	day, date, food supplied on a daily rota, party celebration; dawn
23	ata	noun	picture, photograph, movie, shadow, light and shade of morning
24	'ata	verb; noun	laugh (laughter), smile
25	'ato	noun	basket, luggage, baggage
26	'aua	verb	not, do not (interjectionj: don't!)
27	'auai	verb	join, join up, take part
28	'aumai	verb	bring, get,
29	'ava	noun	shrub, kava, food or drink (polite term), liquor, alcohol
30	āvā	noun	wife
31	'ave	verb; noun	give, hand, carry, take, send, drive a car, ride a horse; sunbeam, ray of sunshine; fruit-bearing stalk of the bread-fruit tree
32	ea	verb	raise, elevate, look up, come up (to the surface), free, release
33	'eli	verb	dig, dig up, mine; suffer from a sharp pain
34	'emo	verb; noun	blink, flash; twinkle (of eye), flash (of lightening)
35	'ese	verb, adjective	other, different, foreign, alien, wrong, strange, unusual, weird
36	fafo	preposition, noun	outside, out of, overseas
37	fa'i	verb; noun	name for banana-plants and fruit

38	faiga	noun	method of doing something, model, style, system, treatment, production preperation
39	faitau	verb	count, read, census
40	fala	noun	mat, name given to a number of tree-plants of genus Pandanus, pineapple
41	fale	noun	house
42	fana	verb, noun	shoot, gun, rifle
43	fānau	verb, noun	born, give birth (offspring)
44	fatu	noun; verb	heart (the organ), seed, grain, core essence compose, make up, invent
45	fea	adverb	where to?
46	fe'au	noun	thing to be done, business, errand, mission, commission
47	fe'e	noun	octopus
48	fefe	verb, noun	fear, be afraid, be anxious, sacred, fear, anxiety
49	fetū	noun	star
50	fia	prefix, noun	denotes a desire to do something, (number) three
51	fīnau	verb; noun	argue, quarrel; argument
52	fitu	noun	(number) seven
53	fofō	verb, noun	apply massage (medical tx), give medical tx, remedy, cure
54	fo'i	verb,	come back, return, quite, fairly (as in fairly good as..), slightly, more or less
55	fono	noun; verb	meeting, council, conference; mend, patch, plug, fill; provide food to accompany kava
56	fua	noun, particle	fruit, flower, bloom, egg, products, name for plants in a class or group; measure, size, scales, table; just, only, without, to no purpose, heedless, freely;
57	fu'a	noun	flag, banner
58	fusi	verb	blind, lash, bandage, bundle, championship
59	fusu	verb	box, fight with fists
60	futu	noun	foot (measurement), tree which fruit used for fishing nets and poisoning fish.
61	gafa	noun	fathom; lineage, geneology
62	galo	verb; noun	forget; name of parrot fish; disappear, slip out, fade (away)
63	galu	noun	wave, breaker
64	galue	verb	work
65	gaoi	noun	thief, theft
66	gata	verb; noun	come to an end, terminate; snake
67	goto	verb	(of ship) sink, get bogged down, (of sun) set
68	gutu	noun	mouth, beak, bill
69	i'a	noun	fish (and turtles, whales)
70	ifo	verb	bow (down), control, restrain, give in, surrender, worship, make formal apology
71	inu	verb	drink
72	ipu	noun	cup, bowl, dish, ceremonial drink of kava for chief
73	ita	verb, noun	angry, anger

74	i'u	verb, noun	be finished, ended, turn out, happen, have to resort, end, consequence, tail
75	iva	noun	(number) nine
76	kiki	verb	kick
77	koko	noun, verb	Cocoa
78	kopi	noun	copy
79	lā'au	noun	plant, tree, wood, apparatus, set, instrument,
80	lā'ei	noun; verb	clothes, put on, wear
81	lagi	noun	sky, heaven
82	lāiti	verb	(plural term) small, little, young, slight
83	laki	noun	luck
84	lalo	noun, preposition	down, under
85	lanu	noun	color
86	lavea	verb	(perfective): be hurt, affected by, be hit, be cut
87	leai	verb	say no, not to exist, absent
88	lele	verb; noun	fly; (pronoun) that (there)
89	lēmū	verb; adverb	be slow, gentle; slowly, gently, quietly, softely
90	lenei	noun	(pronoun) this
91	leo	noun; verb	voice, sound; watch over, look after, policeman, police
92	leva	verb; noun	(of events) a long time since, (of things) old, ancient; tree (sp. Cerbera)
93	lilo	verb	be lost to view, be concealed from the understanding
94	lima	noun	(number) five; upper limb, arm including hand, sleeve,
95	liu	verb	after, change, turn into, change into
96	logo	verb, noun	perceive, notify, large wooden gong
97	loka	noun	lock
98	loli	noun, verb	kind of edible sea cucumber, be ready, all set, large truck
99	loto	noun, verb	heart (figurative), heart felt, will (consent, agree)
100	lotu	noun; verb	act of worship, church, religion, church service; persevere
101	luga	preposition; verb	on, over, up, above, divide, disagree
102	lūlū	verb, noun	shake, sow, lottery
103	luma	adverb (locative); noun	in front of, forward
104	ma'a	prefix; noun	(prefix), stone
105	mafai	verb	can, (be) able to.
106	ma'i	verb, noun	(be) sick, fall ill, infection, disease, sickness, patient, pregnancy
107	maila	noun	mile
108	mala	noun	scourge, plague, tragedy, disaster
109	malae	noun	open space in the middle of a village, sports ground, playground
110	maliu	verb, noun	(polite term) die , death
111	mālō	noun	guest, visitor, government
112	mamā	verb	(be) clean, (be) clear, (be) pure, (be) innocent
113	māmā	noun; verb	lung; (be) light (lightness)
114	māmoe	noun	sheep, cultivated plant near houses

115	manu	noun	bird, animal, cattle, horse; pattern, design
116	mata	verb; noun; particle	raw, uncooked; eye (pl.) face, point of, cutting edge, blade, spring (of water) eye glasses, goggles; used with numerals
117	matai	noun	titled head of Samoan extended family, master
118	mate	verb; noun	die, guess; noun
119	mauga	noun	hill, mountain
120	mautū	verb, adjective	long lasting, permanent.
121	misa	verb, noun	quarrel, fight
122	misi	noun, verb	Miss; titles placed before European ministers of religion, fail to hit
123	miti	noun	sip, whiff, kind of sucking noise made to draw attention quietly; dream, coco-nut cream mixed with sea-water or water and salt, name given to the cuckoo shrikes or trillers
124	moa	noun	chicken, hen, spinning top; solar plexus, epigastrium, middle
125	moe	verb, noun	sleep
126	mo'i	verb; adverb	(be) true, (be) genuine, real; really truly
127	mōlī	noun	lamp
128	moni	verb, adjective	(be) true, (be) real, (be) honest, sincere
129	motu	verb; noun	break (of a flexible cord or line)
130	musu	verb	be utterly uncooperative, sullen and obdurate, refuse, sulk
131	nanā	verb	hide
132	nofo	verb	live, dwell, stay, remain, sit, lodge,
133	nu'u	noun	village, home, country, homeland
134	ofi	verb	go through get into (narrow passage or space), be room
135	'ofu	noun; particle	garment, dress, (pl.) clothes, food in small bundles; (particle used with numerals of food items)
136	ola	verb; noun	live, be alive, get over, recover from, live by, live on, grow, increase, give birth, remit
137	ono	noun; verb	(number) six; be fitting, suitable, be fit proper
138	o'o	verb; noun	reach, arrive, take place, manage (to do), visit (a patient); germinating coco-nut, spongy growth
139	oso	verb; noun	jump, hop, dash, jump on, rush upon, break into, invade, destroy, ravage; (gift) food for traveller, provisions for a journey
140	oti	verb, noun	die, death
141	'ova	verb	go over the boundary (a cricket ball)
142	pa'i	verb; noun	touch; touch
143	paipa	noun	tabacco-pipe, water pipe, electric cable, valve, tube, tap
144	pa'ō	verb; noun	clash, make an unnecessary amount of noise; noise, (music) beat
145	pa'ū	verb, noun	fall, sink, fail, (of responsibility) fall on, devolve, fall, crush
146	pepa	noun	paper, form, playing cards, pepper
147	pepe	noun	butterfly; name given to parts of the house which abut its end (where it is customary for orators to sit)
148	pepē	verb	(pl) die, dead (of animals), go out, low, out, numb, paralysed, heal

149	pese	noun, verb	sing (song, music)
150	pine	noun; verb	pin, haripin, safety-pin, thole-pin, badge, peg, mark; pin
151	pisa	verb; noun	make verbal noise
152	pisi	verb	splash, be busy
153	pito	verb, adjective, noun	(be or come) next, edge, cliff, border, end, extremity, point
154	pogai	verb (noun)	be due to, caused by (stem, stump, root, origin, cause)
155	popo	noun	ripe coconut
156	poto	verb, noun	(be) clever, intelligent, (be) skilled, expert, learned, (be) wise; wisdom
157	pou	noun	house post, pillar
158	pu'e	verb, noun	catch, clutch, grasp, arrest, capture, take
159	pule	noun	authority, power, right to control, decision, corporate body of authority, director, manager; name given to molluscs of Cowrie shells
160	pusa	verb; noun	box, chest, truck
161	pusi	noun	name from moray eels, cat
162	saka	verb	boil
163	sami	noun	sea
164	sa'o	verb; noun	(be) right, correct, truth; senior title holder, title of paramount chief, chief
165	sasa	verb; noun	beat, thrash, cane, slash; rod, cane
166	se'e	verb	slide, glide, slip, skid, wrench, dislocate
167	selau	noun	(number) hundred
168	sene	noun	cent
169	sesē	verb	miss (a target); (be) wrong (wrong, fault)
170	si'i	verb	put up, raise, rise, lift, copy, quote; hold in one's arms or on one's lap, sit on someone's lap
171	sili	verb, adjective	be highest, topmost, be great, principal, best, go beyond, sick out, protrude; put the (object) up (ontop), exalt, extol
172	sisi	noun, verb	raise, hoist. Hang, small snails, cheese
173	sola	verb	run away, escape
174	sole	interjection	term used when addressing or calling a boy (or a man)
175	solo	verb, noun, particle	wipe, towel, landslid, movement forward (of a group)
176	sua	verb; adjective	contain water, rise, flow, lever, uproot, dig up
177	su'e	verb	look for, try to find, search, explore, try for; open, uncover, lift, raise (corner)
178	sui	verb	change, replace, represent; add to water, dilute
179	suka	noun	sugar
180	sulu	verb	(of garment) put on, wrap around, put in, insert, sheathe, put on, wear, tuck in, slide, illuminate, light up (torch), shine on to, flee, fall headlong
181	susū	verb, adjective, noun	go or come, be wet, moisture

182	taeao	noun	morning, early morning, imporant or auspicious occassions (in Samoan history)
183	tagi	verb; noun	cry, weep, make a noise, utter a cry, ask for, beg, request, appeal; claim, petition, suit, case; kind of fish
184	tago	verb	take, get, touch (to feel with hand)
185	taimi	noun	time, time (music), turn
186	tālā	noun	Dollar
187	tali	verb	reply, receive, reciprocate, receive welcome guests; guard, parry, ward off, catch; fill (one's belly)
188	talo	noun	Taro (plant)
189	tama	noun	child of a woman, chief, boy, youth
190	tamā	noun	father
191	tāne	noun	husband, man, male
192	tasi	noun; verb	(number) one, same, only one (single); however
193	tatau	verb; noun	fit, proper, necessary, fitting, suitable; turn of tide; tattooing
194	ta'u	verb	tell, announce, mention, suggest
195	tausi	verb; noun	take care of, look after, keep to, stick to; wife (of an orator)
196	te'a	verb	pass, be parted, separate, be dismissed, part, depart, be weaned, be divorced
197	te'i	verb	start, be surprised, shocked, happen suddenly
198	tele	verb, noun	much, many, numerous, loud; plane
199	teu	verb, noun	put away, keep, pack, store up, deposit, put something in order, bury, dress, decorate, welcome, receive guests, bunch
200	tīgā	verb	(be) painful, (be) sore, (be) hurt
201	tinā	noun	mother
202	tino	noun; verb	body, (pl) limbs; be openly expressed, revealed
203	toa	verb; noun	(be) brave, bold, ironwood tree and its timber
204	tōfā	verb	(polite term) sleep, goodbye
205	tofi	verb, noun	split, cleave, divide; detail, assign, appoint, position
206	tofu	verb; particle	dive, plunge (dive, plunge); each single, each and every
207	togi	verb, noun; noun	throw, grade, put on a mark, dot
208	tolu	noun	(number) three
209	toto	noun	blood
210	tua	noun, preposition	back, behind
211	tuai	verb; noun	be late, be delayed, take a long time; grater, grating-tool
212	tu'i	verb; noun	give a blow or punch, knock, hit
213	tuli	verb; noun	chase, pack off, expel, hunt; joint of the body, knee
214	tulou	expression	Expression to say excuse me or pardon me
215	tūmau	verb	cling to, stick fast to, abide by.
216	tumu	verb	be full of
217	tupe	noun	concave disk (used in the game lafoga-tossing coco-nut shells) , money, knee cap, value of a shell fish, large climbing plant
218	tupu	verb; noun	King, grow, arise, break out, happen, occur, sovereign, monarch
219	tusi	verb, noun	point, draw, write, (letter, book, [pl] ledgers, pig reserved for a special purpose, register, resignation)

220	tu'u	verb	put down, let down, cut down, fell, leave, give up, give, grant, hand (over), give ones mind to, put, place,
221	ufi	verb; noun	cover, put a cover over (a thing); general name for yams (common yams)
222	uila	noun	lightening, electricity, bicycle
223	ula	verb/noun	smoke, make fun of, joke of, name given to several crustaceans
224	ulu	verb; noun	head, go into, enter
225	'uma	verb	be finished, be done, endless, eternal, entire, complete, whole of, each, every, finish, conclude, bring to an end
226	'umi	verb, adjective	(be) long
227	'upu	noun	word, remark, statement
228	uso	noun	same gender sibling
229	usu	verb	rise and leave, early in the morning
230	uta	noun; verb; adverb (locative)	load, cargo; beware of ; ashore, on the side towards the land
231	va'a	noun	boat, ship, vessel, craft
232	va'ai	verb	look at, look (open one's eyes)
233	vāivai	verb, noun	weak of body, puddle
234	vale	verb; noun	fool, (be) of no use, in vain, unproductive, ordinary, informal, of no importance, worthless, bad, unpleasant; lunatic, imbecile
235	valu	noun; verb	(number) eight; scrape, grate, peel, skin, scratch
236	vave	particle; verb	early, in good time; quick, fast, too early