Development of phonemically balanced word lists in Tamil language for adults

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Abstract

Objective: Speech audiometry testing procedure encompasses the assessment of individual's speech recognition abilities. Standardized words are utilised for the assessment procedures which are commonly phonemically balanced. The present study aimed to develop a large set of 25 phonemically balanced bisyllabic word lists in Tamil language for adults and also standardized the same on individuals with normal hearing sensitivity and different degrees of hearing impairment. **Participants:** One hundred individuals with normal hearing sensitivity and 40 individuals with different degrees of hearing loss were assessed. **Methods:** A pool of 1015 bisyllabic Tamil words was sourced and these were subjected to familiarity rating and content validation. After these, 760 words were selected for phonemic balancing and 25 word lists were prepared with 25 words each. All the 25 word lists were presented to 100 individuals with normal hearing sensitivity at 40 dB SL. A PI- PB function was obtained on 30 among these 100 individuals. The lists were validated on 40 individuals with different degree of hearing impairment. **Results:** The results of the present study revealed a mean SIS in adults with normal hearing sensitivity ranged from 99.72% to 100%. There was no significant difference ($p > 0.05$) across the 25 word lists in adults with normal hearing sensitivity. All 25 word lists provided similar scores indicative of list equivalency. A performance-intensity function in adults with normal hearing sensitivity revealed that SIS score increased as the sensation level increased from 10 dB SL to 40 dB SL. A significant decrease in SIS was observed as the degree of hearing loss increased ($p < 0.05$). **Conclusion:** The 25 word lists can be utilised for SIS testing in Tamil language for adults during routine audiological evaluation including assessment hearing aid benefit and for research purpose.

INTRODUCTION

Speech audiometry is a collection of behavioral hearing assessment procedures that uses speech as the stimulus. One of the tests in speech audiometry is establishing speech identification score (SIS). SIS reflects the ability of an individual to identify speech at supra-threshold levels and it is generally assessed using phonemically balanced (PB) words. SIS can be useful in finding out the degree of communication handicap, differential diagnosis, and selection of amplification devices. In addition, SIS can be used to trace the benefits of hearing aid and to monitor rehabilitation (Gelfand, 2009).

The first few materials developed for obtaining SIS were PAL PB-50 word list (Egan, 1948), CID W-22 test and NU-6 test (Tillman & Carhart, 1966) and all the above were in English. Later, speech audiometry materials were developed in different languages such as Russian (Aleksandrovsky, McCullough, & Wilson, 1998), Spanish (Christensen, 1995), Italian (Turrini et al., 1993), Portuguese (Harris, Goffi, Pedalini, Gygi, & Merrill, 2001) etc. These developed material followed criteria postulated by Hudgins, Hawkins, Karlin, & Stevens (1947) over the years with slight modifications in the terminology and a few additions. The original criteria as well as the modifications are discussed below.

1.1 Criteria for development of speech material

Hudgins et al. (1947) had deemed four criteria to be essential for developing a speech audiometry material. They are as follows:

1.1.1 Item familiarity

1.1.2 Phonetic dissimilarity

1.1.3 Normal sampling of speech sounds

1.1.4 Homogeneity with respect to basic audibility

1.1.1 Item Familiarity

The familiarity of the test items should be important as the developed material will be evaluated on a wide range of individuals from varied distribution of levels of education and social standards (Ashoor & Prochazka, 1982). Almost all the developed word lists utilise the familiar items in their test lists. However, there were several ways in which the familiar items in the test list can be utilised. In foreign languages, few developed word lists were prepared by employing the words which are published in a word corpus based on their frequency of occurrence of words in that language (Fu, Zhu, & Wang, 2011; Wang, Mannell, Newall, Zhang, & Han, 2007). These word lists obtained from word corpus doesn't employ the phonetic/ phonemic balancing of the word list. The next method is the most commonly employed procedure, in which the test items are sourced from school textbooks, daily newspapers, magazines, novels, storybooks and dictionaries. After sourcing of the test items, the words need to be refined using various levels of familiarity rating scales to filter out the words to maintain the familiarity of the word perception to be similar across the test items which is rated by a wide range of individuals across all levels of education and social status.

1.1.2 Phonetic Dissimilarity

Hudgins et al. (1947) claimed that the speech audiometry test is not a test of intelligence or vocabulary rather it is a test of speech intelligibility and hence the test items employed should be simple and familiar. Phonetic dissimilarity is the term used when the words don't share phonetic elements such as rhyming (Nissen et al., 2011). Having minimally different or similar words in the test item will increase only the difficulty of the test and not the effectiveness of the test. Use of monosyllabic words in the development of word list may incur this difficulty, that the test item may be phonetically similar which at times create confusion to the listeners. Hence to overcome this, few of the researchers had

come up with the idea of developing the word lists with bisyllabic words which reduced the occurrence of phonetically similar units in the test items.

1. 1.3 Normal sampling of speech sounds

Hudgins et al. (1947) reported that representing all of the speech sounds in the English language for developing the word list is essential and termed this step as normal sampling of speech sounds. The construction of any speech audiometry material should be concerned about the phonetic composition of the language as an effort to replicate the sounds of everyday language (Hirsh et al., 1952). While developing a speech audiometry material a most frequently faced issue is that the material should be balanced phonetically or phonemically. According to Causey, Hood, Hermanson and Bowling, (1984), phonetic and phonemic balances were two different concepts. Phonetic balance refers to the occurrence of phonemes in each word lists that mimic that of the frequency of occurrence of phonemes in the representative sample of the language. Phonemic balance, on the other hand, indicates that the frequency of occurrence of phonemes are equal across all the lists in the set.

Phonetic balanced material should quantitatively represent all the phonemes in the spoken language, i.e., the frequency of phonemes in the word list to be similar in terms of frequency of occurrence of phonemes in that particular language in which the word list is being developed (Lyregaard, 1997). The reason for this balance was that the amount of frequent phoneme employed in the test lists was more likely to represent the everyday listening environment. It also quantifies the outcome better than using an infrequent phoneme of a particular language. There were many word lists that employ phonetic balance (Egan, 1948; Fu et al., 2011; Han et al., 2009; Hirsh et al., 1952; Nielsen & Dau, 2009).

Phonemic balancing is also being employed commonly in speech audiometry materials (Boothroyd, 1968; Lau & So, 1988; Yiap Kim Hong, 1984). Arthur Boothroyd

(AB) word lists used the term ‘isophonemic’ instead of phonemic balance, however, the concept is the same. An advantage of using phonemic balance instead of phonetic balance is that it allows for shorter lists while still having phonemic content that is representative of the language (Boothroyd, 1968).

1.1.4 Homogeneity with respect to basic audibility

The homogeneity of the test item to be obtained by choosing the test item that reaches the listener's ear at the same level of audibility when spoken in a similar tone of the voice or adjusting the intensity level during the recording of the test items (Hudgins et al., 1947).

Homogeneity of a word list is of due importance to keep all the test item to be the same in terms of both the perception by the listener and production by the speaker as it is to believe that the homogeneity of the test item will increase the precision probability of performance intensity.

The development of word lists in any language should incorporate these criteria to attain a good testing material. If these criteria were employed to prepare a word list then the word list will be familiar, phonemically balanced, and homogenous.

1.2 Speech audiometry test materials available in foreign language

The use of word lists at the early 1940s for speech audiometry testing was the basis for further development of speech audiometry material. PAL Auditory Test No. 9 was a recorded test material developed by Hirsh (1947). It consisted of spondaic words. However, these words did not meet all the essential criteria (section 1.1.1. to 1.1.4) (Hudgins et al., 1947; Young, Dudley, & Gunter, 1982) especially the homogeneity criteria.

Hence, Hirsh et al. (1952) improvised Auditory Test No 9 based on the above mentioned four criteria. The modified material developed by Hirsh et al. (1952) consists of three sets of word lists: CID Auditory Test W - 1, Test W-2 and Test W-22. Following this, there are several studies assessing the homogeneity of the developed word tests and creating sublists to achieve the same (Bilger, Matthies, Meyer, & Griffiths, 1998; Wilson & Strouse, 1999; Young et al., 1982). It was later putforth that psychometric functions could be used to arrive at words that have homogeneity with respect to audibility (Bilger et al., 1998). In 1959, Lehiste & Peterson, developed a set of CNC word lists which were phonemically balanced i.e., the frequency of occurrence of the phoneme in each list will be same. The set was made up of 50 monosyllabic consonant-nucleus-consonant (CNC) in each of the ten lists. Causey et al. (1984) had obtained the normative data of this revised CNC list based on the performance-intensity (PI) functions on individuals with normal hearing sensitivity and individual with hearing impairment by presenting the stimuli between 4 and 40 dB SL intensity levels. The result depicting correct scores at different presentation level was depicted in the PI curve, in that 50% word recognition score was taken as their thresholds while the speech discrimination level was depicted through the level at which the maximum score was obtained. In Mandarin language, a psychometrically equivalent bisyllabic speech discrimination material was developed by Nissen et al. (2005). The speech material consisted of four full lists of 50 words each which were psychometrically equivalent, these lists were further made into eight half lists with 25 words each. Wang et al. (2007) developed bisyllabic speech audiometry material in Mandarin language. The main difference between the material developed by Nissen et al. (2005) is that the one by Wang et al., (2007) was phonetically balanced while the one by Nissen et al. (2005) was not. There were also materials for SRT and SIS available in high quality recordings in a variety of foreign

languages other than English such as Spanish (Christensen, 1995), Italian (Greer, 1997), Japanese (Mangum, 2005), French (Nelson, 2004), and in several Indian languages.

1.3 Speech audiometry materials available in Indian language

India is a multicultural and multilingual country constituting a diverse population. Therefore, having a single common test representing all the languages is impossible. Hence, the need for developing and standardizing test materials has been recognized by the researchers and several materials have been developed in Indian languages. Commonly used tests in Indian languages are given in Table 1.1.

Table 1.1: Speech audiometry word materials in different native languages in India

Language	Stimuli used	Number of lists developed	Author
Indian English	Bisyllabic words	2 lists	Swarnalatha (1972)
Tamil	Monosyllabic words Spondee (Bisyllabic words) PB word list	2 lists 1 list 8 lists	Dayalan (1976) Mahima and Muthuselvi (2017)
Kannada	Bisyllabic words Bisyllabic words	8 lists 21 lists	Yathiraj and Vijayalakshmi (2005) Manjula, Antony, Sharathkumar and Geetha (2015)
Hindi	Monosyllabic words	6 lists	De (1973)
Manipuri	Multisyllabic words	4 lists	Tanuja (1985)
Oriya	Bisyllabic words and Monosyllabic words	2 lists of each	Smeeta (2004)
Bengali	Multisyllabic words	3 lists	Gosh (1988)
Telugu	Paired Bisyllabic words	1 list	Sreedhar, Venkatesh, Nagaraja and Srinivasan (2011)
Malayalam	Bisyllabic words	1 list	Kapur (1971)
Konkani	Monosyllabic words	2 lists	Dias, Devadas and Rajashekhar (2015)
Telugu	Bisyllabic words	4 lists	Kumar and Mohanty (2016)
Marathi	Bisyllabic words	4 lists	Kumar, Mohanty, Ujwane, Huzurbazar (2016)

Even though there is an availability of speech audiometry tests in various native languages of India, several attempts have been made to newly develop or revise some of the speech audiometry material due to numerous reasons. Yathiraj and Vijayalakshmi (2005)

developed eight phonemically balanced word lists in Kannada consisting 25 bisyllabic words in each of the lists. These lists were standardized on individuals with normal hearing sensitivity and also validated on individual with hearing impaired. These lists are used in everyday clinical assessment and this material possesses good test-retest reliability. However, Manjula, Antony, Kumar, and Geetha (2015) later developed and standardized 21 phonemically balanced word lists in Kannada with 25 bisyllabic words in each of the lists so that many conditions can be assessed using different lists without having to repeat any of the lists in research studies.

Sreedhar, Venkatesh, Nagaraja, and Srinivasan (2005) developed a test material in Telugu for estimating the speech recognition thresholds using paired words and compared it with the existing bisyllabic words developed by Padmaja (1987). The researchers have reported that the words in the earlier material were unfamiliar to the listeners and hence, it was difficult for the listeners to repeat back the words. There are a few testing materials in Tamil language. The current study aimed to develop speech audiometry material in Tamil, hence, the existing materials in Tamil have been describe in detail along with the need to develop new test material in Tamil.

1.4 Speech materials in Tamil language

Tamil is a commonly spoken language in Tamil Nadu and Puducherry, which is also a recognized language of Indian constitution and it is of Dravidian origin. Tamil is one of the classical longest surviving languages in Tamil and it dates back to 300 BC. Tamil is "Diglossic" in nature (Matiki, 2010) because the languages have its spoken variety which is the sentamizh (ancient Tamil) and the colloquial Tamil with dialectal variations across the districts of the state. However, the written form follows the classic earlier era of Sentamizh.

Tamil language consists of 12 vowels and 18 consonants, both the vowel and consonants combine to form 216 compound characters. Along with these a special character called “aaytham” is added forming 217 individual Tamil alphabets in the language. The language also has a unique liquid which is not significantly present in the other language sounds “zh” (Vasanthakumari, 1989).

In Tamil, only a few speech audiometry materials have been developed for both children and adult populations. First of which was developed by Dayalan (1976). The test consists of Tamil PB and spondee word lists for adult listeners. The author developed four lists of monosyllabic PB words with 25 words in each list. All the syllables were in CNC combination. Along with this the author also developed one list of spondee words with equal stress on both the syllables in the words and the list consist of 38 spondee words in it. To standardize the word list the developed material was administered on 30 individuals with normal hearing aged 19 and 20 years. The study did not validate the developed material on individuals with hearing impairment.

For children, two speech audiometry materials were developed in Tamil. Boominathan and Yathiraj (1999) developed the picture speech identification test for children in the Tamil language. The lists consist of two lists of phonetically balanced Tamil bisyllabic words with 25 words each. All the words were picturable words and the developed material was standardized on 40 children in the age of 2 to 6 years who were normal hearing. The task given was a forced-choice paradigm with four pictures placed in front of the children and the target words were presented to the children and the children were asked to respond to the target word by identifying the correct picture. This speech audiometry material was also not standardized on children with hearing impairment.

Tamilmani (2002) developed the Early Speech Perception test for children in Tamil language. This test aimed at testing children with hearing aids and cochlear implants. The test has two versions. The lower version consists of syllable categorization in the Tamil language for children aged between 2 to 3 years. The lower version of the test consists of nine monosyllabic, nine bisyllabic and nine trisyllabic words in a picturable form in the word list. The higher version contains the pattern perception test for children aged 3 to 5 years. In this, it consists of three lists with eight polysyllabic words per list. Among the three lists, two lists were presented auditorily and one list iwas presented audio-visually.

Sinthiya and Sandeep (2009) developed and standardized high-frequency speech identification test for adults in the Tamil language. The material consists of three word lists with two word lists containing bisyllabic words and one list with trisyllabic high-frequency words in it. All the words in the word lists contain the phonemes with predominant high frequency energy such as /s/, /ʃ/, /tʃ/, /dz/, /k/ in it. The developed word lists aimed to assess adult with high-frequency sloping hearing loss. However, the developed material was assessed only on individuals with normal hearing not on the individual with high-frequency hearing loss.

Mahima and Muthuselvi (2017) developed and standardized four lists of phonemically balanced word lists in CVCV combination in Tamil and randomized these lists to make a total of eight word lists. The clinical utility was assessed on individual with different degree of sensorineural hearing loss.

1.5 Need of the study

India is a culturally and linguistically diverse country and hence, having a single common assessment material for evaluation of speech perception abilities cannot be accepted. Hence, there is an increasing need to develop a material which is sensitive

culturally and linguistically. Some of the speech audiometry materials available in Indian languages were Indian English (Swarnalatha & Rathna, 1972), Hindi (De, 1973), Kannada (Yathiraj & Vijayalakshmi, 2005), Tamil (Dayalan, 1976), Telugu (Rathna Kumar & Mohanty, 2012) and Malayalam (Kapur, 1971). A few researchers realized the need to modify, revise or newly develop speech audiometry materials across different Indian languages to overcome the limitations of earlier developed materials (Dias, Devadas, & Rajashekhar, 2015; Manjula et al., 2015; Sreedhar et al., 2005). Some of the limitations of existing word lists being inclusion of unfamiliar words, lesser number of test items to assess different conditions, lack of validity on clinical population, lack of validity on usage of test items in noise condition and not considering the effect of dialect variations (Lehiste & Peterson, 1959).

The development of first word list in Tamil language is dated back to late 1970s. This word list comprises of four phonetically balanced lists with 25 monosyllabic Tamil words each (Dayalan, 1976). The validation of the developed material was done only on individuals with normal hearing sensitivity and not on the clinical population. Carhart (1951) recommended that speech audiometry materials should be validated in an experimental setting on a test population to get appropriate test results.

In addition to the not including hearing impaired population, Dayalan (1976) utilised monosyllables for constructing the word lists. The number of frequently occurring familiar monosyllabic words with consonant endings are very less in Tamil. In addition, some of the words in the lists are not in everyday use and hence, not familiar (e.g. /pi:r/, /su:l/, /sa:r/, /ja:n/, /ʋa:r/) to the listeners. The word lists also contain some borrowed words (e.g. /bus, /ha:l/, /tin/) and unparliamentarily words (eg. /pe:i/, /de:i/). Zubick (1983) states that the use of unfamiliar words in a speech audiometry material will affect the accuracy of the testing

procedure which heavily relays on the subject knowledge towards the test items. Hence, it is essential to develop test items which consist of words which are familiar, frequently occurring in the environment and can easily be produced or repeated back by the listener.

The use of monosyllabic words are common for assessing speech recognition scores. Reason being the monosyllables are a minimum meaningful unit of a language and are non-redundant. Nevertheless, in South Indian languages like Tamil, Kannada, Telugu and Malayalam, the availability of familiar monosyllable is very scarce and hence, Kumar and Mohanty (2012) employed bisyllables in their PB word lists in Telugu. With this as a support, Mahima and Muthuselvi (2017) developed a phonemically balanced bisyllabic word list to overcome a few of the shortcoming of earlier developed word list developed by Dayalan (1976).

Mahima and Muthuselvi (2017) developed four lists of 25 words each. After standardisation, the developed four lists were randomized to make eight lists. However, randomizing the word list without accounting for homogeneity of audibility makes the word list lack validity and also the listener might perform better than expected during assessment due to repetition of test items.

Hence, the present study aimed to develop over 20 word lists with familiar words used in an everyday context. Since Tamil is considered as a vowel ending language, this study intends to develop PB word lists using bisyllabic words. The developed words lists will be standardized on a larger number of adults with normal hearing sensitivity. The effectiveness of the word list will be assessed in the clinical population with hearing impairment.

1.5.1 Aim of the study

The aim of the study was to develop and standardize a large set of phonemically balanced bisyllabic word lists in Tamil for assessing speech identification scores in adults with normal hearing sensitivity; and to assess the clinical utility of the developed word lists.

1.5.2 Objectives of the study

- To develop 25 Phonemically Balanced word list in Tamil for adults,
- To standardize and assess the consistency of speech identification scores among different word lists on adults with normal hearing sensitivity,
- To assess the homogeneity of audibility, and
- To evaluate the clinical utility of the developed Phonemically Balanced word lists in adults with hearing impairment.

Method

The present study was carried out with objectives of development and standardization of Tamil phonemically balanced word lists, and assessment of the clinical utility of the developed word lists. The study was structured in three phases. Phase I involved the development of PB word lists in Tamil. Phase II involved standardization of the word lists, and phase III involved assessing the clinical utility on individuals with hearing impairment. A normative research method was followed to conduct the study.

2.1 Phase I: Development of Phonemically Balanced word lists in Tamil

Development of phonemically balanced word lists was done using many steps. The

steps followed were collection of words, familiarity rating, content validation, preparation of phonemically balanced words and recording.

2.1.1 Collection of words

Initially, a pool of 1015 bisyllabic words were collected. These words were collected from various sources including newspapers, magazines, textbooks, novels, storybooks, and dictionary. It was ensured that proper nouns or words creating conflict were not selected in the study.

2.1.2 Familiarity rating

The collected pool of words was subjected to familiarity rating on 20 native Tamil speakers from different socio-economic status and different levels of education. The words were rated using a five-point rating scale in Tamil and the ratings are as follows:

- **5 – Most familiar** (words are well known and used more frequently in conversation)
- **4 – Familiar** (words well known but used less in conversation)
- **3 – Familiar but not used every day** (known words but not used in conversation)
- **2 – Not Familiar** (words heard but meaning not known)
- **1 – Unknown** (words never heard)

The ratings from all the participants were collected and averaged. The words with the average rating of 3 to 5 were considered for the next step. At the end of this exercise, 930 words had a rating of 3 to 5 and hence were considered for content validation.

2.1.3 Content validation

Content validation of the selected words were carried out using the assistance of five experts working in the field of audiology, speech language pathology, linguistics and psychology. The experts were asked to check if those words met the criteria regarding familiarity, absence of emotional overlay, cultural and religious overlay. They were requested to mark these 930 words as highly relevant or not relevant. The responses from each individual were collected and considered if applicable to the present study. The words which were not relevant based on the aforementioned criteria i.e. unfamiliar words, and words relating to social, political, religion and war were excluded from the list. At the end of this process, 170 were considered irrelevant and hence, were excluded. Hence, only a total of 760 words were considered for the preparation of word lists. In order to objectively assess if the elected words are relevant, content validity index (CVI) was computed. The computation includes I-CVI and S-CVI. I-CVI is computed as the number of experts giving a rating of "very relevant" for each item divided by the total number of experts. S-CVI is calculated using the number of items in a tool that have achieved a rating of "very relevant". There are two methods to calculating S-CVI, one is the Universal Agreement (UA) among experts (S-CVI/UA), and the second is the Average CVI (S-CVI/Ave). S-CVI/UA is calculated by adding all items with I-CVI equal to 1 divided by the total number of items, while S-CVI/Ave is calculated by taking the sum of the I-CVIs divided by the total number of items. A I-CVIs of 0.78 or higher and S-CVI/UA and S-CVI/Ave of 0.8 and 0.9 or higher, respectively (Shi, Mo & Sun, 2012) are suggestive of very good content validity. In th present study, The I-CVI ranged between 0.8 to 1, S-CVI/UA and S-CVI/AVG were found to be 0.92 and 0.98.

2.1.3 Preparation of Phonemically Balanced words

Out of 760 words, 625 words were utilised to construct 25 lists of 25 words each. The constructed word lists were phonemically balanced to match the frequency of occurrence of

phonemes in Tamil. The phonemic balancing was performed based on the data on frequency of occurrence of phonemes in Tamil given by Sakkan, (2008). In Sakkan's study, the frequency of occurrence of phonemes in Tamil language was computed from a Tamil corpus which had an aggregated amount of approximately three million words across all genres. Initially, the number of individual phonemes in the 760 words were computed. The computed number of phonemes were compared with the corpus frequency of occurrence. This is done to maintain similar phonemic representation across the lists and also to ensure that the frequency of occurrence of phoneme to be equal to the corpus frequency of occurrence.

2.1.4 Recording

The constructed word lists were recorded in an acoustically treated room (ANSI S 3.1, R2013) using a personal laptop loaded with Adobe Audition version 3.0 software with an installed Motu Micro Book II software. The laptop was connected to a condenser microphone and kept at a distance of 10 cm from the speaker's mouth through an external Motu Micro Book II USB sound card. A sample of 50 words were spoken by seven native Tamil speakers. These recorded sample words were presented randomly to five experts in the field of audiology and five native Tamil speakers across different educational and socioeconomic status. They rated the recorded words in terms of naturalness, clarity, pronunciation, pleasantness in a four-point rating scale with 0 being poor and 3 being the best. The sample words were presented to the listeners in a randomized fashion among the experts and general public. The identity of the speaker was not revealed to the listeners. The response rating was compiled and a female speaker with the maximum rating was chosen for the final word list recording. The speaker was instructed to pronounce the words naturally, clearly in a neutral intonation with a constant vocal effort throughout the recording. The recorded waveforms were digitized with a 16 bit A/D converter at a sampling frequency of 44,100 Hz. Each of the

recorded words was normalized to 0 dB using Adobe Audition version 3.0 software. A calibration tone of 1000 Hz was generated in Adobe Audition version 3.0 software, normalized to 0 dB, and added at the beginning of each of the word lists. The typed word lists in International Phonetic Alphabet and Tamil are enclosed in Appendix 1. The audio recorded version of the stimuli in .wav format along with the calibration tone is enclosed in Appendix 2.

2.2 Phase II: Standardization of word lists

2.2.1 Participants

The recorded word lists were presented in quiet on 100 individuals with normal hearing sensitivity in the age range between 18 to 50 years (mean = 29.48; SD = 8.22), after a routine audiological evaluation. A calibrated dual-channel audiometer (Inventis Piano) coupled with acoustically matched TDH 39 headphones housed in MX- 41 AR ear cushions and B71 bone vibrator was utilized to estimate the pure tone thresholds, speech recognition threshold with Tamil Spondee words and speech identification score with a phonetically balanced word list in Tamil (Dayalan, 1976). A calibrated GSI Tympstar middle ear analyzer was used for obtaining tympanogram and acoustic reflex threshold. The test stimulus was presented using a laptop (64 bit Dell Inspiron 15 3000 Series laptop) and delivered through the same audiometer utilized for hearing testing.

Pure tone air conduction thresholds for each of the participants were established in octave frequencies from 250 Hz to 8000 Hz, using the modified Hughson and Westlake method (Carhart & Jerger, 1959). Bone conduction thresholds were also established using the same method for octave frequencies from 250 Hz to 8000 Hz. The tympanometric measurements were done using a probe tone of 226 Hz at 85 dB SPL to evaluate the status of the middle ear. For acoustic reflex measurement, reflex eliciting tones of 500, 1000, 2000 and

4000 Hz were presented both ipsilaterally and contralaterally to track the acoustic reflex thresholds. A significant change of admittance value of greater than 0.03 ml was considered as the criterion for the presence of reflexes (Cohen and Prasher, 1992). The calibration tone was played and the gain of external stimulus was adjusted such that VU meter deflection was maintained at '0'.

2.2.2 Administration of developed word lists

All the 100 participants listened to all the 25 lists in quiet at 40 dB SL (Ref: PTA). The words were routed through a personal laptop and delivered through Senheisser HDA 200 headphones of a calibrated audiometer. The participants were instructed to repeat the words and the responses were recorded on a scoring sheet. Every correct response was given a score of 1 and a score of 0 was given for incorrect responses or failure to repeat the words. The word lists were also presented at 0 dB SL, 10 dB SL, 20 dB SL and 30 dB SL to 30 out of 100 individuals with normal hearing sensitivity is in order to obtain a psychometric function of performances with the word lists across intensity levels (PI-PB function). The order of presentation of word lists was randomized in order to avoid the order effect. In order to avoid practice effect, the word list was first presented at 0 dB SL and then at 10 dB SL. The testing was done at 20 dB SL and 30 dB SL after a break of five days.

2.3 Phase III: Assessing the clinical utility in individuals with hearing impairment

The individuals with acquired sensorineural hearing impairment consisted of 10 individuals with age ranging from 18 to 55 years (mean = 36.07 ± 9.07 years) in each of the different degrees of hearing loss i.e., mild (40.2 ± 6.98 years), moderate (36.6 ± 7.19 years), moderately-severe (33 ± 11.53 years) and severe (34.5 ± 9.50 years). The ears were selected randomly if the loss was bilateral or the ear having the required degree of hearing loss was selected for the study. If masking was required, the maximum effective masking was

provided in the contralateral ear. The configuration of audiogram was restricted to flat type. The speech identification scores were in agreement with the degree of hearing loss, suggesting a cochlear hearing loss (Duhno, Lee, Klein, Matthews, & Lam, 1995). All the participants had 'A' type tympanogram and reflexes were appropriate to their degree of hearing loss. All the participants had normal speech and language abilities as reported and observed. The participants listened to all the 25 lists in quiet at 40 dB SL (Ref: PTA). The words were routed through a personal laptop and delivered through Senheisser HDA 200 headphones of a calibrated audiometer. The participants were instructed to repeat the words and the responses were recorded on a scoring sheet. Every correct response was given a score of 1 and a score of 0 was given for incorrect responses or failure to repeat the words.

2.4 Analysis

The data were tabulated and statistically analysed in Statistical package for the Social Sciences (SPSS) software version 21. The Shapiro Wilks test of normality revealed that the data obtained from the individuals with normal hearing sensitivity were not normally distributed and the data obtained from the individuals with hearing impairment were distributed normally. Hence, Non-parametric statistics (Friedman test) were carried out for data obtained from the individuals with normal hearing sensitivity and whereas ANOVA and Bonferroni pairwise comparison were done on the data obtained from the individuals with hearing impairment. Cronbach's alpha measures were carried to assess the homogeneity and the intra-class correlation coefficient.To assess the test- retest reliability 10% from individual with normal hearing group were tested again with all the 25 word lists developed. To statistically measure the reliability a Cronbach's alpha measure was measured.

Results

The study aimed at developing and standardising a Tamil word test in individuals with normal hearing sensitivity. The clinical utility of the developed word lists on individuals with hearing impairment was also assessed.

3.1 Development of word lists

A pool of 1015 bisyllabic words in Tamil language were collected through various resources. All the words were subjected to familiarity rating and content validation. After familiarity rating and content validation, 760 words were finalised for the preparation of 25 phonemically balanced word lists. Each developed list has 25 words.

3.2 Standardization of the developed word lists and assessing the consistency of the lists in individuals with normal hearing sensitivity

Twenty five word lists were administered on 100 individuals with normal hearing sensitivity at 40 dB SPL. The number of correctly identified words, here after referred to as speech identification scores (SIS), for each list was calculated. The mean and standard deviation (SD) of the SIS at 40 dB SL are given in Table 3.1.

Table 3.1 Mean and SD of speech identification scores for 25 lists at 40 dB SL obtained on individuals with normal hearing sensitivity

Lists	Mean	SD	Lists	Mean	SD	Lists	Mean	SD
List 1	24.96	0.19	**List 11**	24.97	0.17	**List 21**	24.98	0.14
List 2	24.93	0.25	**List 12**	24.97	0.17	**List 22**	24.94	0.23
List 3	24.96	0.19	**List 13**	24.99	0.10	**List 23**	24.99	0.10
List 4	24.95	0.19	**List 14**	24.95	0.26	**List 24**	24.99	0.10
List 5	24.98	0.14	**List 15**	24.98	0.14	**List 25**	24.99	0.10
List 6	24.98	0.14	**List 16**	24.96	0.19			
List 7	24.95	0.26	**List 17**	24.96	0.19			
List 8	24.97	0.17	**List 18**	24.94	0.23			
List 9	24.98	0.14	**List 19**	24.96	0.19			
List 10	24.94	0.23	**List 20**	24.94	0.23			

Note. Maximum possible score = 25.

For the standardization of the 25 developed word lists, the SIS was obtained at 40 dB SL (ref: hearing threshold) on 100 normal hearing individuals. From the Table 3.1, it can be observed that the minimum and the maximum scores obtained across all the lists in individuals with normal hearing sensitivity are 24 .93 (99.72 %) and 25 (100%). The grand mean average across the lists is found to be 99.77% in individuals with normal hearing sensitivity. Shapiro-Wilks test of normality revealed non-normal distribution of the data and hence, non-parametric measures were used for further analyses. Friedman test was carried out to see whether there is a significant difference in the SIS of individuals with normal hearing sensitivity across 25 words lists. The results of Friedman test revealed no significant difference ($\chi^2 = 28.527$, $p > 0.05$) across the 25 word lists.

To assess the test-retest reliability of the developed word lists, out of 100 individuals with normal hearing sensitivity, ten individual were assessed again with all the word lists after a month. The data were statistically compared using Cronbach's alpha measure to check the reliability of the developed word lists. Cronbach's alpha of ($\alpha = 0.86$) was obtained which denotes that the developed word lists have high test-retest reliability.

3.2.1 Assessment of homogeneity in terms of audibility

To assess whether all the lists are homogenous in terms of difficulty level, across different intensities, a psychometric function was drawn using Performance Intensity-Phonemically Balance function (PI-PB) test. The PI- PB test was carried out on 30 individuals with normal hearing sensitivity across five different sensation levels (0, 10, 20, 30 and 40 dB SL) and psychometric function was established for all the 25 word lists (Figure 3.1).

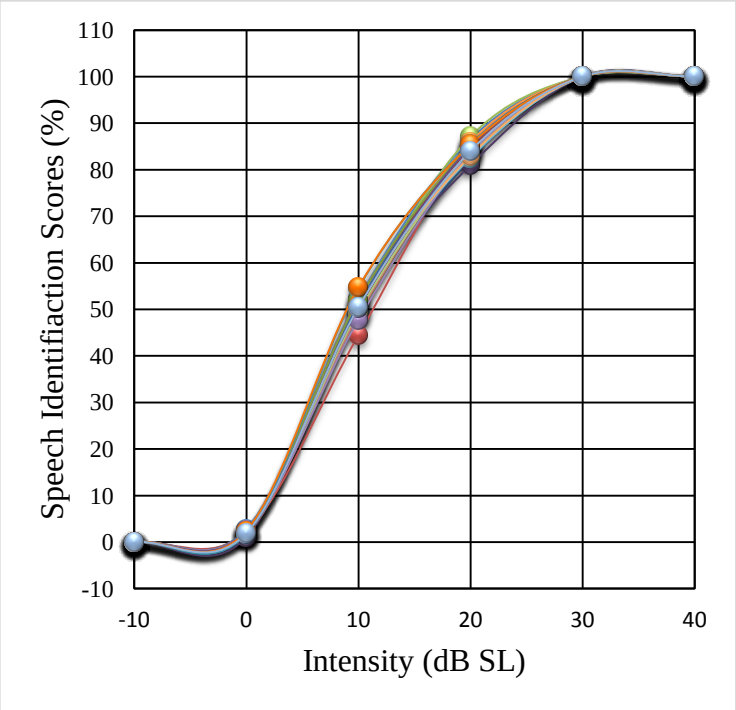

Figure 3.1 Graph representing the psychometric function curves for 25 word lists depicted in different colours

From the Figure 3.1, it is clear that with a gradual increase in intensity level there is a gradual increase in the SIS with a poor score of 0 to 4% at 0 dB SL and a 100% scores after 30 dB SL suggesting that the difficulty decreases as the intensity increases. The same is followed by all the lists indicative of homogeneity across lists.

Homogeneity of audibility was also measured using Cronbach's alpha test. Alisaputri (2006) reported that the measure of Cronbachs alpha value using intraclass coefficient at the 50% and 100% performance level provide information on the homogeneity of the word lists in terms of audibility. In the present study, the 50% percentage score was obtained at 10 dB SL and the ceiling was observed above 30 dB SL. Hence, SIS at these two levels was employed for homogeneity assessment in individuals with normal hearing sensitivity using Cronbach's alpha. The results are given in Table 3.2.

Table 3.2 Results of test of homogeneity in terms of audibility across all the word lists at 10 and 40 dB SL in individuals with normal hearing sensitivity

Group	α – value
Normal (10 dB SL)	0.984
Normal (40 dB SL)	0.987

From Table 3.2, it is evident that all the word lists are found to be in strong agreement in terms of audibility at 10 dB SL. The same results were found even at 40 dB SL.

3.2 Assessment of clinical utility on individuals with different degrees of hearing impairment

To assess the clinical utility of the developed word lists, the word lists were presented at 40 dB SL (ref: threshold of hearing) on 40 individual with hearing impairment with mild, moderate, moderately-severe and severe degree of hearing loss, with ten individuals in each degree of loss. The minimum and the maximum scores obtained across all the lists and all the groups are 14 (56%) and 25 (100%), respectively (Table 3.3). The grand mean average among all the groups and across the lists in the group with normal hearing sensitivity is 24.94 (99.77%), in the group with mild degree of hearing loss is 22.22 (88.88%), in the group with moderate degree of hearing loss is 19.76 (79.04%), in the group with moderately-severe degree of hearing loss is 16.33 (65.32%) and in the group with severe degree of hearing loss

is 14.58 (58.32%).

Table 3.3 Mean and SD of speech identification scores for 25 lists of PB words for all the groups

Groups	List 1		List 2		List 3		List 4		List 5	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Normal	24.96	0.19	24.93	0.25	24.96	0.19	24.95	0.19	24.98	0.14
Mild HL	21.8	1.55	22	1.41	22.3	1.70	22.2	1.55	22.5	1.27
Moderate HL	20.3	1.06	19.6	0.97	19.8	1.40	19.4	1.07	19.7	1.25
Moderately Severe HL	16.9	1.73	16.1	1.73	16.6	1.71	16.1	1.52	16.6	1.58
Severe HL	14	1.25	15.1	1.19	14.4	1.07	14.1	1.85	14.7	1.57
Groups	**List 6**		**List 7**		**List 8**		**List 9**		**List 10**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Normal	24.98	0.14	24.95	0.26	24.97	0.17	24.98	0.14	24.94	0.23
Mild HL	22.5	1.18	21.8	1.03	22.7	1.70	22.4	1.50	22.1	1.66
Moderate HL	19.6	1.71	19.9	1.20	19.9	1.29	19.9	0.99	19.8	1.69
Moderately Severe HL	15.9	1.91	16.7	2.00	16.5	1.84	16.7	2.21	16.6	1.65
Severe HL	14.4	1.07	14.3	1.41	14.9	1.45	14.5	1.78	14.7	1.50
Groups	**List 11**		**List 12**		**List 13**		**List 14**		**List 15**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Normal	24.97	0.17	24.97	0.17	24.99	0.10	24.95	0.26	24.98	0.14
Mild HL	21.9	1.37	22.3	1.49	22	1.56	22.7	1.63	22.4	1.43
Moderate HL	19	1.33	19	1.70	19.9	1.66	19.9	1.29	20.3	1.57
Moderately Severe HL	16	2.10	15.3	3.49	16.8	1.47	16.4	2.06	16.5	1.58
Severe HL	14.3	1.42	14.4	1.58	14.8	1.32	14.5	1.65	14.5	1.08
Groups	**List 16**		**List 17**		**List 18**		**List 19**		**List 20**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Normal	24.96	0.19	24.96	0.19	24.94	0.23	24.96	0.19	24.94	0.23
Mild HL	21.7	1.57	21.6	1.35	21.9	1.66	22.7	1.06	22.3	1.06
Moderate HL	19.9	1.20	20.1	0.99	20.1	0.88	20	1.56	20	1.63
Moderately Severe HL	16.5	1.71	16.4	1.34	16	1.49	16.3	1.64	16.7	0.95
Severe HL	14.6	1.43	14.8	1.40	14.8	1.62	15	1.05	14.5	0.97
Groups	**List 21**		**List 22**		**List 23**		**List 24**		**List 25**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Normal	24.98	0.14	24.94	0.23	24.99	0.10	24.99	0.10	24.99	0.10
Mild HL	22.8	1.40	22.6	0.97	21.9	1.20	22.4	1.50	22	1.15
Moderate HL	19.5	1.90	19.7	1.49	19.3	0.82	19.5	1.18	20	1.25
Moderately Severe HL	15.9	1.52	16.1	1.96	15.8	1.75	16.3	1.34	16.6	1.07
Severe HL	14.7	1.33	14.8	1.62	14.5	1.18	14.6	1.17	14.8	1.23

Note. Maximum possible score = 25.

3.2.1 With-in group assessment of consistency of the lists in individuals with hearing impairment

The normality results using Shapiro-wilks test of normality revealed normal distribution of the data and hence, parametric test were employed for further analysis. A repeated measure ANOVA was carried out to compare the performance of individuals with hearing impairment across each lists and the result of the same is given in Table 3.4.

Table 3.4 Within-Group Comparison of Speech Identification Scores of Individuals with Hearing Impairment across 25 Word Lists.

Groups	F value
Mild	$F_{(24,216)}= 1.118, p > 0.05$
Moderate	$F_{(24,216)}= 1.136, p > 0.05$
Moderately Severe	$F_{(24,216)}= 1.143, p > 0.05$
Severe	$F_{(24,216)}= 0.627, p > 0.05$

It can be seen in the Table 3.4 that there was no significant difference in the performance across the word lists in any of the groups. Therefore, the word lists can be used interchangeably in individuals with hearing impairment for assessing speech identification ability in Tamil language.

3.2.2 Assessment of clinical utility of the developed word lists to different degrees of hearing loss

Between-group comparison was done across the lists to check how the performance of speech identification varied across different degrees of hearing loss using one-way ANOVA. The results of one way ANOVA are given in Table 3.5.

Table 3.5 Between-group comparisons of speech identification scores across 25 lists

Lists	F value	Lists	F value
List 1	$F_{(4,135)} = 729.97$, $p < 0.001$	List 11	$F_{(4,135)} = 649.13$, $p < 0.001$
List 2	$F_{(4,135)} = 741.87$, $p < 0.001$	List 12	$F_{(4,135)} = 350.36$, $p < 0.001$
List 3	$F_{(4,135)} = 656.39$, $p < 0.001$	List 13	$F_{(4,135)} = 632.63$, $p < 0.001$
List 4	$F_{(4,135)} = 688.59$, $p < 0.001$	List 14	$F_{(4,135)} = 507.76$, $p < 0.001$
List 5	$F_{(4,135)} = 719.75$, $p < 0.001$	List 15	$F_{(4,135)} = 720.94$, $p < 0.001$
List 6	$F_{(4,135)} = 703.31$, $p < 0.001$	List 16	$F_{(4,135)} = 655.00$, $p < 0.001$
List 7	$F_{(4,135)} = 665.10$, $p < 0.001$	List 17	$F_{(4,135)} = 852.93$, $p < 0.001$
List 8	$F_{(4,135)} = 564.83$, $p < 0.001$	List 18	$F_{(4,135)} = 680.88$, $p < 0.001$
List 9	$F_{(4,135)} = 523.15$, $p < 0.001$	List 19	$F_{(4,135)} = 752.74$, $p < 0.001$
List 10	$F_{(4,135)} = 531.57$, $p < 0.001$	List 20	$F_{(4,135)} = 952.52$, $p < 0.001$

Lists	F value
List 21	$F_{(4,135)} = 647.10$, $p < 0.001$
List 22	$F_{(4,135)} = 595.69$, $p < 0.001$
List 23	$F_{(4,135)} = 1002.92$, $p < 0.001$
List 24	$F_{(4,135)} = 906.77$, $p < 0.001$
List 25	$F_{(4,135)} = 1043.67$, $p < 0.001$

From Table 3.5, it can be seen that there exists a significant difference in SIS on all the lists across different degrees of hearing impairment. Hence, Bonferroni pair-wise comparison was carried out to further analyse the groups having significant difference. The results of Bonferroni pair-wise comparison are given in Table 3.6. The results revealed a significant difference between all the groups across all the lists.

Table 3.6 Bonferroni Pairwise comparison between groups across different lists

Group (A)	Group (B)	Mean difference (A-B)									
		List 1	**List 2**	**List 3**	**List 4**	**List 5**	**List 6**	**List 7**	**List 8**	**List 9**	**List 10**
Normal	Mild HL	3.16***	2.93***	2.66***	2.76***	2.48***	2.48***	3.15***	2.27***	2.58***	2.84***
	Moderate HL	4.66***	5.33***	5.16***	5.56***	5.28***	5.38***	5.05***	5.07***	5.08***	5.14***
	Moderately Severe HL	8.06***	8.83***	8.36***	8.86***	8.38***	9.08***	8.25***	8.47***	8.28***	8.34***
	Severe HL	10.96***	9.83***	10.56***	10.86***	10.28***	10.58**	10.65***	10.07***	10.48***	10.24***
Mild HL	Moderate HL	1.50**	2.40***	2.50***	2.80***	2.80***	2.90***	1.90**	2.80***	2.50***	2.30***
	Moderately Severe HL	4.90***	5.90***	5.70***	6.10***	5.90***	6.60***	5.10***	6.20***	5.70***	5.50***
	Severe HL	7.80***	6.90***	7.90***	8.10***	7.80***	8.10***	7.50***	7.80***	7.90***	7.40***
Moderate HL	Moderately Severe HL	3.40***	3.50***	3.20***	3.30***	3.10***	3.70***	3.20***	3.40***	3.20***	3.20***
	Severe HL	6.30***	4.50***	5.40***	5.30***	5.00***	5.20***	5.60***	5.00***	5.40***	5.10***
Moderately Severe HL	Severe HL	2.90***	1.00*	2.20***	2.00***	1.90***	1.50***	2.40***	1.60***	2.20***	1.90***
		List 11	**List 12**	**List 13**	**List 14**	**List 15**	**List 16**	**List 17**	**List 18**	**List 19**	**List 20**
Normal	Mild HL	3.07***	2.67***	2.99***	2.25***	2.58***	3.26***	3.36***	3.04***	2.26***	2.64***
	Moderate HL	5.97***	5.97***	5.09***	5.05***	4.68***	5.06***	4.86***	4.84***	4.96***	4.94***
	Moderately Severe HL	8.97***	9.67***	8.19***	8.55***	8.48***	8.46***	8.56***	8.94***	8.66***	8.24***
	Severe HL	10.67***	10.57***	10.19***	10.45***	10.48***	10.36***	10.16***	10.14***	9.96***	10.44***
Mild HL	Moderate HL	2.90***	3.30***	2.10***	2.80***	2.10***	1.80***	1.50***	1.80***	2.70***	2.30***
	Moderately Severe HL	5.90***	7.00***	5.20***	6.30***	5.90***	5.20***	5.20***	5.90***	6.40***	5.60***
	Severe HL	7.60***	7.90***	7.20***	8.20***	7.90***	7.10***	6.80***	7.10***	7.70***	7.80***
Moderate HL	Moderately Severe HL	3.00***	3.70***	3.10***	3.50***	3.80***	3.40***	3.70***	4.10***	3.70***	3.30***
	Severe HL	4.70***	4.60***	5.10***	5.40***	5.80***	5.30***	5.30***	5.30***	5.00***	5.50***
Moderately Severe HL	Severe HL	1.70***	0.90	2.00***	1.90***	2.00***	1.90***	1.60***	1.20**	1.30**	2.20***
		List 21	**List 22**	**List 23**	**List 24**	**List 25**					
Normal	Mild HL	2.18***	2.34***	3.09***	2.59***	2.99***					
	Moderate HL	5.48***	5.24***	5.69***	5.49***	4.99***					
	Moderately Severe HL	9.10***	8.84***	9.19***	8.69***	8.39***					
	Severe HL	10.30***	10.14***	10.49***	10.39***	10.19***					
Mild HL	Moderate HL	3.30***	2.90***	2.60***	2.90***	2.00***					
	Moderately Severe HL	6.90***	6.50***	6.10***	6.10***	5.40***					
	Severe HL	8.10***	7.80***	7.40***	7.80***	7.20***					
Moderate HL	Moderately Severe HL	3.60***	3.60***	3.50***	3.20***	3.40***					
	Severe HL	4.80***	4.90***	4.80***	4.90***	5.20***					
Moderately Severe HL	Severe HL	1.20*	1.30**	1.30***	1.70***	1.80***					

Note: *** = $p < 0.001$, ** = $p < 0.01$, *= $p < 0.05$

3.2.3 Assessment of homogeneity of the word lists in individuals with hearing impairment

Homogeneity in terms of audibility was assessed in individuals with hearing impairment using the Cronbach's alpha. The Cronbach's alpha measured in the individual with hearing impairment are given in the Table 3.7.

Table 3.7 Measure of homogeneity across the word lists among different degree of hearing loss

Group	α – value
Mild Hearing loss	0.955
Moderate Hearing loss	0.966
Moderately severe Hearing loss	0.947
Severe Hearing loss	0.947

From the Table 3.5 it is clear that the developed word lists have a high alpha value. Hence, the developed material is highly homogenous even in individuals with hearing impairment.

Discussion

Researchers have developed word lists in several Indian languages and a few among them have been revised due to numerous reasons (Kapur, 1971; De, 1973; Dayalan, 1976; Tanuja, 1985; Gosh, 1988; Smeeta, 2004; Sreedhar, Venkatesh, Nagaraja and Srinivasan, 2011; Manjula, Geetha, Sharathkumar and Geetha, 2015; Dias, Devadas and Rajashekar, 2015; Kumar and Mohanty, 2016; Kumar, Mohanty, Ujwane and Huzurbazar, 2016; Mahima and Muthuselvi, 2017). The present study aimed to develop over 20 PB word lists in Tamil language and standardize them in normal and clinical population as currently there is no test that has these many lists in Tamil.

4.1 Development and standardization of word lists in individuals with normal hearing sensitivity

SIS of 25 words lists were compared on 100 individuals with normal hearing sensitivity in quiet and the overall mean combining all the 25 word lists was 99.8%. These scores are comparable with that obtained in many other word lists. The mean score of Kannada PB word lists was 98% (Manjula et al., 2015). Mahima and Muthuselvi (2017) reported a mean SIS of 98% for the four PB words lists developed in Tamil. Ullrich and Grimm (1976) administered NU-6 word lists in individuals with normal hearing and reported of 99.7% score at most comfortable level. Whereas Beattic, Edgerton and Svihovccc (1977) assessed CID W-22 and NU-6 test material to evaluate SIS in individuals with normal hearing and obtained approximately a score of 95% at 32 dB SL. The reason for such high scores at most comfortable level in individual with normal hearing sensitivity is the intact auditory system and attention. Hence, above the most comfortable listening level, almost all the individuals with normal

hearing sensitivity will achieve a 100% (Davis & Silverman, 1960) and the same has been found in the present study.

It is very important that consistency assessment is done as the measure of consistency guarantees that the SIS is comparable irrespective of the list used (Wilson & Margolis, 1983). The mean SIS across the lists in the current study is comparable in the group of individuals with normal hearing. This was reflected in the results of Friedman test where there was no significant difference across 25 word lists. This indicates that the SIS obtained with different word lists developed in the current study is comparable and hence, they are interchangeable.

A psychometric equivalency of the lists was also assessed across different intensities. All the sigmoid curves were coinciding for all the lists suggestive of homogeneity of word lists. . The scores at 10 dB SL revealed a score of 50.56% with ceiling in scores above 30 dB SL. Manjula et al. (2015) also obtained a near to 50% score at 10 dB SL and observed a plateau after 30 dB SL when they assessed in individual with normal hearing across different intensity levels. The trend is similar in the study done by Mahima and Muthuselvi (2017) with a celling in the scores after 30 dB SL and near to 50 % scores at 10 dB SL. Even though the PI function curve act as measure to assess the list equivalency of a developed test lists, assessment of homogeneity in terms of audibility will strengthen the consistency of the developed word lists. Hence, the homogeneity of audibility was measured statistically using Cronbach's alpha measures with the support from a study done by Alisaputri (2006). Alisaputri (2006) measured SIS at two dial settings i.e., at 15 dB and 40 dB SL, in Malay language. The homogeneity of audibility of Malay PB word lists was assessed using Cronbach's alpha and the results revealed a high alpha value of 0.81. The results of the study were in agreement to the study done on developing word lists.

Hence, it is to be believed that 25 PB word lists in Tamil developed in the current study is found to be useful to assess SIS in quiet, and the lists are interchangeable during the course of testing as there is homogeneity between the lists in terms of difficulty and audibility.

4.2 Clinical utility of the developed word lists

Evaluation of clinical utility of the 25 word lists on adults with different degrees of hearing impairment showed significant differences in the performance among individuals with hearing impairment of varying degrees. The grand mean SIS was 22.2 (88.8%), 19.76 (79.05%), 16.32 (65.32%) and 14.58 (58.35) for mild, moderate, moderately-severe and severe hearing loss, respectively. The performance reduced as the degree of hearing loss increased. The result of the study is in agreement with that of Manjula et al. (2015), Muthuselvi and Mahima (2017) and Dias et al. (2015).

The possible reason for the l decrement in the performance of SIS as the loss increases is due to the loss of cochlear nonlinearity, decreased frequency selectivity and temporal resolution, increased upward spread of masking and possible presence of dead region as the loss progresses (Plomp, 1994; Moore, Lynch & Stone, 1992; Moore et al., 2000). Because of the aforementioned factors with an increase in the degree of hearing impairment impairs the individual's speech perception abilities (Pekkerinan, Salmivalli, & Suompa, 1990). Hence, 25 PB word lists developed in the present study is sensitive to different degrees of hearing loss and hence, can be administered on clinical population. In addition, the test re-test reliability assessment revealed a high alpha value indicating a strong agreement between the test and re-test scores for all 25 word lists. The results of the study is in agreement with other research findings on the development of word lists revealing a high test re-test reliability measure ($\alpha = < 0.96$) using Tamil PB word list

(Muthuselvi & Mahima, 2017) and in Konkani language also test re-test reliability was measured on 20 individual with normal hearing a strong agreement was established between both the measures (Dias, Devadas & Rajashekhar, 2015).

Summary and Conclusions

Speech audiometry has become an essential component in the audiological test battery. Various speech audiometry materials have been developed in different languages and also revised later to meet the criteria such as familiarity of the words, phonetic/ phonemic balance, number of test items and dialectal variations. The current study focussed on developing multiple PB word lists in Tamil language for adults. The study was structured in three phases. Phase I involved the development of PB word lists in Tamil. Phase II involved standardization of the developed word lists, and phase III involved assessing the clinical utility of the lists on individuals with hearing impairment.

A pool of 1015 bisyllabic Tamil words were sourced and these were subjected to familiarity rating and content validated. After these, 760 words were selected for phonemic balancing and 25 word lists were prepared with each list consisting of 25 words each in it. SIS was assessed on 100 individuals with normal hearing sensitivity using all the 25 word lists at 40 SL. Thirty of these 100 individuals were presented the word lists at different intensity levels to obtain PI- PB function. After which the same lists were validated on individuals with hearing impairment. For validation, 40 individuals with different degree (mild, moderate, moderately-severe and severe) of hearing impairment were included.

The mean SIS in adults with normal hearing sensitivity ranged from 99.72% to 100%. The SIS of adults with normal hearing sensitivity revealed no significant difference ($p > 0.05$)

across the 25 word lists indicating list equivalency. The performance-intensity function in adults with normal hearing sensitivity revealed that SIS score increased as the sensation level increased from 10 dB SL to 40 dB SL for all the lists which is suggestive of homogeneity among all the lists. Mean SIS scores for adults with mild, moderate and severe hearing loss were found to be 88.88%, 79.04%, 65.32%, and 58.32% respectively. A significant decrease in SIS was observed as the degree of hearing loss increased ($p < 0.05$). The developed 25 bisyllabic word list in Tamil has a high test re-test reliability in individuals with normal hearing sensitivity as well as in hearing impairment.

Hence these developed 25 word lists can be utilised for SIS testing in Tamil language for adults during routine audiological evaluation. These developed word list can also be used for assessing hearing aid benefit and for research purpose in normal hearing individuals as well as in clinical population.

References

Aleksandrovsky, I. V., McCullough, J. K., & Wilson, R. H. (1998). Development of suprathreshold word recognition test for Russian-speaking patients. *Journal of the American Academy of Audiology, 9*(6), 417–425. Retrieved from https://pdfs.semanticscholar.org/115e/7d55a09ab1b44336b66bd8f1360bdaa8cf6c.pdf

Ashoor, A. A., & Prochazka, T. (1982). Saudi Arabic Speech Audiometry. *International Journal of Audiology, 21*(6), 493–508. https://doi.org/10.3109/00206098209072761

Bilger, R. C., Matthies, M. L., Meyer, T. A., & Griffiths, S. K. (1998). Psychometric equivalence of recorded spondaic words as test items. *Journal of Speech, Language, and Hearing Research, 41*(3), 516-526.

Boominathan, P., & Yathiraj, A. (1999). *Picture speech identification test in Tamil*. Unpublished Master's Dissertation: University of Mysore.

Boothroyd, A. (1968). Developments in speech audiometry. *British Journal of Audiology, 2*(1), 3–10. https://doi.org/10.3109/00381796809075436

Carhart, R. (1951). Basic principles of speech audiometry. *Acta Oto-Laryngologica, 40*(1–2), 62–71. https://doi.org/10.3109/00016485109138908

Causey, G. D., Hood, L. J., Hermanson, C. L., & Bowling, L. S. (1984). The Maryland CNC Test: Normative Studies. *International Journal of Audiology, 23*(6), 552–568. https://doi.org/10.3109/00206098409081538

Christensen, L. K. (1995). *Performance intensity functions for digitally recorded Spanish speech*

audiometry. Doctoral dissertation, Department of Educational Psychology, Brigham Young Unviserity.

Dias, M. A., Devadas, U., & Rajashekhar, B. (2015). Development of Speech Audiometry Material in Goan Konkani Language. *Language in India*, *15*(2), 268–280. Retrieved from www.languageinindia.com ISSN 1930-2940

Egan, J. P. (1948). Articulation testing methods. *The Laryngoscope*, *58*(9), 955–991. https://doi.org/10.1288/00005537-194809000-00002

Fu, Q.-J., Zhu, M., & Wang, X. (2011). Development and validation of the Mandarin speech perception test. *The Journal of the Acoustical Society of America*, *129*(6), EL267–EL273. https://doi.org/10.1121/1.3590739

Gelfand, S. A. (2009). Essentials of Audiology (3rd editio). Retrieved from https://books.google.co.in/books/about/Essentials_of_Audiology.html?id=_tcPcPTwNQoC

Greer, L. F. (1997). *Performance intensity functions for digitally recorded Italian speech audiometry materials.* Doctoral dissertation, Department of Audiology and Speech-Language Pathology: Brigham Young University.

Han, D., Wang, S., Zhang, H., Chen, J., Jiang, W., Mannell, R., … Zhang, L. (2009). Development of Mandarin monosyllabic speech test materials in China. I*nternational Journal of Audiology*, *48*(5), 300–311. https://doi.org/10.1080/14992020802607456

Harris, R. W., Goffi, M. V. S., Pedalini, M. E. B., Gygi, M. A., & Merrill, A. (2001). Psychometrically equivalent Brazilian Portuguese trisyllabic words spoken by male and

female talkers. *Pró-Fono, 13*, 37–53.

Hirsh, I. J. (1947). Clinical application of two Harvard auditory tests. *Journal of Speech Disorders, 12*(2), 151-158.

Hirsh, I. J., Davis, H., Silverman, S. R., Reynolds, E. G., Eldert, E., & Benson, R. W. (1952). Development Of Materials For Speech Audiometry. *Journal of Speech and Hearing Disorders, 17*(3), 321–337. https://doi.org/10.1044/jshd.1703.321

Hudgins, C. V., Hawkins, J. E., Karlin, J. E., & Stevens, S. S. (1947). The development of recorded auditory tests for measuring hearing loss for speech. *The Laryngoscope, 57*(1), 57–89. https://doi.org/10.1288/00005537-194701000-00005

Lau, C. C., & So, K. W. (1988). Material for Cantonese speech audiometry constructed by appropriate phonetic principles. *British Journal of Audiology*, *22*(4), 297–304. https://doi.org/10.3109/03005368809076467

Lehiste, I., & Peterson, G. E. (1959). Linguistic Considerations in the Study of Speech Intelligibility. *The Journal of the Acoustical Society of America*, *31*(3), 280–286. https://doi.org/10.1121/1.1907713

Lyregaard, P. I. M. M. (Ed. . (1997). *Towards a theory of speech audiometry tests.* In Speech Audiometry (2nd ed., pp. 34 – 62). San Diego, California: Singular Publishing Group, Inc.

Mangum, T. C. (2005). *Performance intensity functions for digitally recorded Japanese speech audiometry materials.* All Theses and Dissertations. 616. Retrieved https://scholarsarchive.byu.edu/etd/616.

Manjula, P., Antony, J., Kumar, K. S. S., & Geetha, C. (2015). Development of Phonemically Balanced Word Lists for Adults in the Kannada Language. *Journal of Hearing Science, 5*(1), OA22–OA30. https://doi.org/10.17430/893515

Martin, F. N., Champlin, C. A., & Perez, D. D. (2000). The question of phonetic balance in word recognition testing. *Journal of the American Academy of Audiology, 11*(9), 489–493.

Matiki, A. J. (2010). A Case Review of Tamil Diglossia. *Language in India*, *10*, 392–397. Retrieved from http://www.languageinindia.com/nov2010/tamildiglossia.pdf

Nelson, A. (2004). *Performance intensity functions for digitally recorded French speech audiometry.* University of Colorado, Boulder, CO.

Nielsen, J. B., & Dau, T. (2009). Development of a Danish speech intelligibility test. *International Journal of Audiology, 48*(10), 729–741. https://doi.org/10.1080/14992020903019312

Nissen, S. L., Harris, R. W., Channell, R. W., Conklin, B., Kim, M., & Wong, L. (2011). The development of psychometrically equivalent Cantonese speech audiometry materials. *International Journal of Audiology, 50*(3), 191–201. https://doi.org/10.3109/14992027.2010.542491

Nissen, S. L., Harris, R. W., Jennings, L.-J., Eggett, D. L., & Buck, H. (2005). Psychometrically equivalent mandarin bisyllabic speech discrimination materials spoken by male and female talkers. *International Journal of Audiology, 44*(7), 379–390. https://doi.org/10.1080/14992020500147615

Nissen, S. L., Harris, R. W., & Slade, K. B. (2007). Development of speech reception threshold materials for speakers of Taiwan Mandarin. *International Journal of Audiology, 46*(8), 449–458. https://doi.org/10.1080/14992020701361296

Kumar, S. B. R., & Mohanty, P. (2012). Speech recognition performance of adults: A proposal for a battery for Telugu. *Theory and Practice in Language Studies, 2*(2), 193–204. https://doi.org/10.4304/tpls.2.2.193-204

Sakkan, T. (2008). A Statistical Study of Tamil Corpus. *South Asian Language Review, 18*(2), 50–78.

Dayalan, S. J. (1976). *Development and Standardization of Phonetically Balanced Test Materials in Tamil Language.* Student Research at AIISH Mysore (Article Based on Dissertation Done at AIISH), I, 81–82.

Shi, J., Mo, X., & Sun Z. (2012). Content validity index in scale development. *Medical Sciences, 37*(2):152-5.

Sinthiya, K., & Sandeep, M. (2009). *High freqency speech identification test in Tamil.* Student Research at AIISH Mysore (Article Based on Dissertation Done at AIISH), VII, 246–255. Retrieved from https://www.aiish.ac.in/images/pdf/08-09aud.pdf#page=250

Sreedhar, J. S., Venkatesh, L., Nagaraja, M. N., & Srinivasan, P. (2005). Development and evaluation of paired words for testing of speech recognition threshold in Telugu : A preliminary report. J*ournal of Indian Speech Language & Hearing Association, 25*(2), 128–136.

Swarnalatha, C. K., & Rathna, N. (1972). *Development and standardization of speech material in English for Indians.* Student Research at AIISH. MYSORE (Article Based on Dissertation Done at AIISH), University of Mysore, Mysore, I, 65–66.

Tamilmani, C. (2002). *Early speech perception test in Tamil*. Independant project: Bangalore university.

Tillman, T. W., & Carhart, R. (1966). *An expanded test for speech discrimination utilizing CNC monosyllabic words: Northwestern University Auditory Test NO. 6* (pp. 1–12). pp. 1–12. Retrieved from https://apps.dtic.mil/docs/citations/AD0639638

Turrini, M., Cutugno, F., Maturi, P., Prosser, S., Leoni, F. A., & Arslan, E. (1993). Bisyllabic words for speech audiometry: a new italian material. *Acta Otorhinolaryngologica*, *13*(1), 63–77. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/8135099

Wang, S., Mannell, R., Newall, P., Zhang, H., & Han, D. (2007). Development and evaluation of Mandarin disyllabic materials for speech audiometry in China. *International Journal of Audiology*, *46*(12), 719–731. https://doi.org/10.1080/14992020701558511

Wilson, R. H., & Margolis, R. H. (1983). *Measurements of auditory thresholds for speech stimuli.* In D. F. Konkle, & W. F. Rintelmann, Principles of speech audiometry (Chapter 5, pp. 79–126). Baltimore: University Park Press.

Wilson, R. H., & Strouse, A. (1999). Psychometrically equivalent spondaic words spoken by a female speaker. *Journal of Speech, Language, and Hearing Research*, *42*(6), 1336-1346.

Yathiraj, A., & Vijayalakshmi, C. (2005). *Phonemically balanced word list in Kannada*.

Developed in Department of audiology, AIISH, Mysore.

Yiap Kim Hong. (1984). Disyllabic Malay word lists for speech audiometry. *Medical Journal of Malaysia*, *39*(3), 197–204.

Young, L. L., Dudley, B., & Gunter, M. B. (1982). Thresholds and psychometric functions of the individual spondaic words. *Journal of Speech and Hearing Research, 25*(4), 586-593.

APPENDIX 1

S.NO	List 1		List 2		List 3		List 4		List 5	
1	கீற்று	kiṭrU	சூழல்	sUl̪əl	துணி	ṭ̪Uɳɪ	புதர்	pUɖ̪əɾ̪	சடை	səɖ̪aɪ
2	வளம்	vələm	திகில்	ɖ̪ɪgɪl	துறை	ṭ̪Uɾ̪aɪ	விலை	vɪlaɪ	நத்தை	nəṯ̪aɪ
3	ரம்பம்	rəmbəm	மடை	məɖ̪aɪ	வினை	vɪnaɪ	பாசி	pa:sɪ	வீரர்	viɾ̪əɾ̪
4	தலை	ṭ̪əlaɪ	பயிர்	pəjɪr	பயம்	bəjəm	சித்தாள்	sɪṯ̪a:l	நகம்	nəgəm
5	தச்சன்	ṭ̪əʧən	குல்லா	gUl̪a:	மழை	məl̪aɪ	நேயர்	nejəɾ̪	வெப்பம்	vɛppəm
6	நாணம்	na:ɳəm	தாயம்	ɖ̪a:jəm	மாடு	ma:ɖ̪U	கத்தி	kəṯ̪ɪ	தரம்	ṭ̪a:ɾ̪əm
7	வாசல்	va:səl	புள்ளி	pul̪ɪ	நெடில்	nɛɖ̪ɪl	மல்லி	məlɪ	சீட்டு	siṭ̪U
8	தமிழ்	ṭ̪əmɪl̪	கப்பம்	kəppəm	சோளம்	soləm	ரூபாய்	ɾ̪uba:j	கொல்லன்	kɔlən
9	நண்பன்	nənbən	மேதை	meɖ̪aɪ	கனல்	kənəl	மோகம்	mogəm	சிப்பி	sɪppɪ
10	கண்மாய்	kəɳma:j	வங்கி	vəngɪ	துச்சம்	ṭ̪Uʧəm	முட்டை	mUṭ̪ṭ̪aɪ	கட்டம்	kəṭ̪əm
11	செடி	ʧɛɖ̪ɪ	வீடு	viɖ̪U	நலம்	nələm	சேனை	senaɪ	குட்டி	kUṭ̪ɪ
12	கனா	kəɳa:	காளை	ka:l̪aɪ	மிதி	mɪɖ̪ɪ	புகை	pUgaɪ	யூகம்	jugəm
13	சண்டை	səndaɪ	புஞ்சை	pUnʤaɪ	கஷ்டம்	kəʃṭ̪əm	மங்கை	məngaɪ	பள்ளம்	pəl̪əm
14	காற்று	ka:ṭrU	விந்தை	vɪnɖ̪aɪ	குளிர்	kUl̪ɪr	தோசை	dosaɪ	சுழி	sUl̪ɪ
15	பேதை	peɖ̪aɪ	துண்டு	ṭ̪UnɖU	தீங்கு	ṭ̪ingU	ரயில்	ɾ̪əɪl	மன்னன்	məɳ̪ən
16	பொம்மை	bɔm̃aɪ	கண்டம்	kəɳɖ̪əm	புலன்	pUlən	கம்பம்	kəmbəm	பானம்	pa:nəm
17	கோழி	kol̪ɪ	நெற்றி	nɛṭ̪ɾɪ	தினை	ṭ̪ɪnaɪ	வேட்டி	veṭ̪ɪ	திடல்	ṭ̪ɪɖ̪əl
18	காடை	ka:ɖ̪aɪ	சிரி	sɪɾ̪ɪ	பூச்சி	puʧɪ	கூட்டு	kuṭ̪U	குறள்	kUɾ̪əl
19	யுத்தம்	jUdʰəm	செவி	sɛvɪ	ராகம்	ra:gəm	சிற்றுர்	sɪṭ̪rur	தயிர்	ṭ̪əjɪɾ̪
20	பள்ளி	pəl̪ɪ	நேற்று	neṭ̪rU	சிரம்	sɪrəm	நெறி	nɛɾ̪ɪ	லுங்கி	lUngɪ
21	வடை	vəɖ̪aɪ	மணி	mənɪ	மையம்	maɪəm	தணல்	ṭ̪ənəl	சவால்	səva:l
22	கதை	kəɖ̪aɪ	பேச்சு	peʧU	வெற்றி	vɛṭ̪ɾɪ	வள்ளல்	vəl̪əl	பூமி	bumɪ
23	மரம்	məɾ̪əm	முனை	mUɳ̪aɪ	வானம்	va:nəm	அனல்	ənəl	மறை	məɾ̪aɪ
24	சில	sɪlɛ	குலம்	kUləm	குடல்	kUɖ̪əl	புதர்	pUɖ̪əɾ̪	துளை	ṭ̪Ulaɪ
25	யானை	ja:naɪ	ரதம்	ɾ̪əɖ̪əm	சபா	səba:	விலை	vɪlaɪ	தோணி	ṭ̪oɳɪ

S.NO	List 6		List 7		List 8		List 9		List 10	
1	மிகை	mɪgaɪ	சுண்டல்	sUnɖəl	கிளை	kɪlaɪ	சரண்	səɻən	கூந்தல்	kunɖəl
2	கோடை	koɖaɪ	மௌனம்	məUnəm	சொத்தை	sɔt̪aɪ	மயிர்	maɪɪr̪	பிறர்	pɪɻər̪
3	நிரை	nɪraɪ	காயம்	ka:jəm	ரத்தம்	ɾət̪əm	கவி	kəvɪ	காரம்	ka:ɻəm
4	கோதை	koɖaɪ	வேந்தன்	venɖən	தண்ணீர்	t̪əɳiɾ̪	புதிர்	pUɖɪr̪	வெள்ளம்	vɛl̂əm
5	கோபம்	kobəm	சூழல்	sUl̪əl	வெல்லம்	vɛl̂əm	சூளை	sulaɪ	கதி	kəɖɪ
6	வேளாண்	vela:n	துளி	t̪Ulɪ	முழம்	mUl̪əm	சின்னம்	sɪɳəm	ரேகை	regaɪ
7	கொள்ளை	kɔl̂aɪ	பணம்	pəɳəm	தளம்	t̪ələm	கால்வாய்	ka:lva:j	நெடி	nɛɖɪ
8	வேம்பு	vembU	நகை	nəgaɪ	முகாம்	mUga:m	கோழை	kol̪aɪ	படை	pəɖaɪ
9	சாயம்	sa:jəm	சிமிழ்	sɪmɪl̪	யாகம்	ja:gəm	பேரன்	perən	சமம்	səməm
10	தறி	t̪əɻɪ	ஞானம்	ɳa:nəm	சரம்	səɻəm	நலன்	nələn	செயல்	sɛjəl
11	மைனா	maɪna:	சாலை	sa:laɪ	வடு	vəɖU	மதி	məɖɪ	பொதி	pɔɖɪ
12	மடல்	məɖəl	பீடம்	piɖəm	குயில்	kUjɪl	முற்றும்	mUt̪rUm	மைந்தன்	məɪnɖən
13	வண்ணம்	va:ɳəm	கரை	kəɻaɪ	செல்வம்	sɛlvəm	நங்கை	nəŋka:j	நாணல்	na:nəl
14	சினை	sɪnaɪ	புறா	pUɻa:	கும்பம்	kUmbəm	சினம்	sɪnəm	கொலை	kɔlaɪ
15	தட்டை	t̪ət̪aɪ	வண்டு	vənɖU	கதிர்	kəɖɪr̪	பலம்	bələm	வன்மம்	vənməm
16	நந்தி	nənɖɪ	சுள்ளி	sUl̂ɪ	சீப்பு	sippU	தென்றல்	t̪ɛndrəl	பட்டம்	pət̪əm
17	கோப்பை	kopaɪ	வேலை	velaɪ	மன்னர்	məɳəɻ	கணை	kənaɪ	பாலை	pa:laɪ
18	சிலிர்	sɪlɪr	நாட்டம்	na:t̪əm	பாண்டி	pa:nɖɪ	தளிர்	t̪əlɪr	கொள்கை	kɔlgaɪ
19	சிறை	sɪɻaɪ	பித்தம்	pɪt̪əm	முறம்	mUɻa:m	வயல்	vaɪəl	கோர்வை	korva:j
20	யுக்தி	jUkt̪ɪ	சத்து	sət̪U	நிறை	nɪɻa:ɪ	பசி	pəsɪ	சுற்றம்	sUt̪ɾəm
21	மதம்	məɖəm	கொக்கு	kɔk̂U	சோலை	solaɪ	பொடி	pɔɖɪ	தேனீ	t̪enɪ
22	முழு	mUl̪U	முதல்	mUɖəl	தங்கை	t̪əŋkaɪ	கெண்டை	kɛnɖaɪ	துளிர்	t̪Ul̪ɪr̪
23	பாம்பு	pa:mbU	பறை	pəɻaɪ	போட்டி	pot̪ɪ	தொடை	t̪ɔɖaɪ	செழி	sɛl̪ɪ
24	லிங்கம்	lɪngəm	முகில்	mUgɪl	நாடு	na:ɖU	தொண்டு	t̪ɔnɖU	சட்டம்	sət̪t̪əm
25	ராசி	ɻa:sɪ	தேரை	t̪eɻaɪ	பனி	pənɪ	முகம்	mUgəm	மனை	mənaɪ

S.NO	List 11		List 12		List 13		List 14		List 15	
1	நோம்பு	nombU	வெள்ளி	vɛl̂ɪ	பலன்	pələn	தொண்டை	ʈɔnɖaɪ	தேங்காய்	tenga:j
2	சிகை	sɪgaɪ	தோன்று	ʈonɖrU	களி	kəlɪ	சுழல்	sUl̪əl	மகள்	məgəl
3	விளை	vɪlaɪ	கபம்	kəbəm	தென்னை	ʈɛn̂aɪ	கனி	kənɪ	தோகை	ʈogaɪ
4	புயல்	pUjəl	கிளி	kɪl̪ɪ	பசை	pəsaɪ	வாலி	va:lɪ	மூன்று	munɖrU
5	திசை	ɖɪsaɪ	பணை	pəɳaɪ	சாவி	sa:vɪ	மகம்	məgəm	பெயர்	pɛjəɾ
6	தேமல்	ʈeməl	மேகம்	megəm	தீட்டு	ʈiʈ̂ʌ	பனை	pənaɪ	படம்	pəɖəm
7	செய்யுள்	sɛjjUl	சேட்டை	seʈ̂aɪ	புழு	pUl̪U	கரி	kəɾɪ	யானம்	ja:nəm
8	பன்னிர்	pəɳ̂iɾ	சூலை	sulaɪ	தெரு	ʈɛɾU	சரி	səɾɪ	குடம்	kUɖəm
9	துன்பம்	ʈUnbəm	குனி	gUnɪ	யோகம்	jogəm	துகில்	ʈUgɪl	நெய்தல்	nɛjɖəl
10	சுத்தம்	sUʈ̂əm	மயில்	maɪɪl	போற்றி	poʈ̂ɾɪ	மந்தை	mənɖaɪ	தலம்	ʈələm
11	குலை	kUl̪aɪ	நிகர்	nɪgəɾ	வசி	vəsɪ	நெகிழ்	nɛgɪl̪	குரல்	kUɾəl
12	ரகம்	ɾəgəm	பிறை	pɪɾaɪ	திரி	ʈɪɾɪ	சாபம்	sa:bəm	செம்மல்	sɛm̂əl
13	கொண்டை	kɔnɖaɪ	வரன்	vərən	மகிழ்	məgɪl̪	பலி	pəlɪ	தொழில்	ʈɔl̪ɪl
14	கேணி	keɳɪ	தோட்டா	ʈo ʈ̂a:	கோடி	koɖɪ	திட்டம்	ʈɪʈ̂əm	சூரன்	surən
15	குளம்	kUl̪əm	விசை	vɪsaɪ	தொடர்	ʈɔɖəɾ	திணி	ʈɪnɪ	பன்மை	pənmaɪ
16	நரை	nəɾaɪ	சிலை	sɪlaɪ	கன்னி	kən̂ɪ	காசி	ka:sɪ	வெண்பா	vɛnpa:
17	முறை	mUɾaɪ	சுடர்	sUdəɾ	குமிழ்	kUmɪl̪	களம்	kələm	வண்ணான்	vən̂a:n
18	பறி	pəɾɪ	பக்தி	bəkʈɪ	பிணி	pɪnɪ	புளி	pUl̪ɪ	பிள்ளை	pɪl̂aɪ
19	மாந்தர்	ma:nɖəɾ	கட்டில்	kəʈ̂ɪl	கோட்டை	koʈ̂aɪ	சீற்றம்	siʈɾəm	வெள்ளை	vɛl̂aɪ
20	மலை	məlaɪ	மின்னல்	mɪn̂əl	செம்மை	sɛm̂aɪ	நபர்	nəbəɾ	குடில்	kUɖɪl
21	தசை	ʈəsaɪ	பழம்	pəl̪əm	மாற்றம்	ma:ʈɾəm	பன்றி	pənɖrɪ	தட்டு	ʈəʈ̂U
22	வண்டி	vənɖɪ	தன்மை	ʈənmaɪ	வதம்	vəɖəm	வெயில்	vɛjɪl	சனி	sənɪ
23	குழாய்	kUl̪a:j	துக்கம்	dUk̂əm	ஞாலம்	ɳa:ləm	தாய்மை	ʈa:jmaɪ	சேர்க்கை	serk̂aɪ
24	வினா	vɪna:	துயர்	ʈUjəɾ	நீளம்	niləm	விடை	vɪɖaɪ	சான்று	sa:nɖrU
25	பீடா	biɖə	நுரை	nUɾaɪ	நஞ்சு	nənʤU	முயல்	mUjəl	நிலம்	nɪləm

S.NO	List 16		List 17		List 18		List 19		List 20	
1	மனம்	mənəm	மக்கள்	məkˆəl̩	நிகழ்	nɪgəl̠	மூர்க்கம்	muɾ̩kˆəm	தேர்தல்	terɖəl
2	கூடம்	kuɖəm	கட்டை	kəʈ̩aɪ	தெப்பம்	ʈ̠eppəm	நொடி	nɔɖɪ	பண்ணை	pəɳ̩aɪ
3	தடை	ʈ̠əɖaɪ	கோணம்	koɳəm	விழி	vɪl̠ɪ	தளிர்	ʈ̠əl̩ɪɾ̩	பூனை	punaɪ
4	மதில்	məɖɪl	குயில்	kUjɪl	யுகம்	jUgəm	சிக்கல்	sɪkˆəl	மொழி	mɔl̠ɪ
5	நாற்று	na:ʈ̩rU	தாரம்	ʈ̠a:ɾ̩əm	கலம்	kələm	கொய்யா	kɔjjə	சூறை	sura:j
6	பூட்டு	puʈˆU	பிசின்	pɪsɪn	மூட்டு	muʈˆU	கடை	kəɖaɪ	கம்மாய்	kəm̃a:j
7	சித்தர்	sɪʈˆə̩ɾ̩	தோப்பு	ʈ̠oppU	பூட்டு	puʈˆU	முட்டாள்	mUʈˆa:l̩	காடு	ka:ɖʌ
8	கிழி	kɪl̠ɪ	தாளம்	ʈ̠a:l̩əm	கடை	kəɖaɪ	கறை	kə̩ɾ̩aɪ	புதை	pUɖ̩aɪ
9	சர்க்கார்	sərka:ɾ̩	மயில்	maɪɪl	தானம்	ɖ̩a:nəm	தூரம்	duɾ̩əm	தண்டல்	ʈ̠əɳɖ̩əl
10	சேவல்	sevəl	நிலை	nɪlaɪ	கன்று	kənɖ̩rU	வழி	vəl̠ɪ	சுளை	sUl̩aɪ
11	பண்டம்	pəɳɖ̩əm	பீடி	biɖ̩ɪ	நரி	nəɾ̩ɪ	நாளை	na:l̩aɪ	காலை	ka:laɪ
12	புலி	pUlɪ	வலம்	vələm	தொய்வு	ʈ̠ojvU	சிறு	sɪɾ̩U	விறல்	vɪɾ̩əl
13	வேந்தர்	veɳɖ̩ə̩ɾ̩	சேட்டை	seʈˆaɪ	சாணம்	sa:nəm	ரொட்டி	roʈˆɪ	சட்டை	səʈˆaɪ
14	சம்பா	səmba:	பிழை	pɪl̠aɪ	மேற்கு	meɾ̩kˆU	பொய்மை	pɔjmaɪ	துயர்	ʈ̠Ujəɾ̩
15	வேட்டி	veʈˆɪ	சத்தம்	səʈˆm	சின்னம்	ʧɪɲ̊əm	செவ்வாய்	sɛvva:j	வயம்	vəjəm
16	கேடு	keɖ̩U	குறை	kUɾ̩aɪ	தொட்டில்	ʈ̠ɔʈˆɪl	மணல்	mənəl	கனல்	kənəl
17	தேக்கம்	ʈ̠ekˆəm	தினம்	ɖ̩ɪnəm	கொள்ளி	kɔl̩ˆɪ	பல	pələ	வெறி	vɛɾ̩ɪ
18	குறி	kUɾ̩ɪ	களம்	kələm	சளி	səl̩ɪ	பதம்	pəɖ̩əm	நகர்	nəgər
19	பிணம்	pɪnəm	நாவல்	na:vəl	சிப்பாய்	sɪppa:j	பீங்கான்	pinga:n	தொகை	ʈ̠ɔgaɪ
20	மாலை	ma:laɪ	காட்சி	ka:ʈ̠ʧɪ	முல்லை	mUlˆaɪ	தானம்	ɖ̩a:nəm	நெஞ்சம்	nɛnʤəm
21	தக்கை	ʈ̠əkˆaɪ	தோற்றம்	ʈ̠oʈ̠rəm	வீரம்	viɾ̩əm	சிப்பாய்	sɪppa:j	செம்மை	sɛm̃aɪ
22	நேரம்	nerəm	மேசை	mesaɪ	மறு	məɾ̩U	தீனி	ʈ̠inɪ	கள்ளி	kəl̩ˆɪ
23	யாளி	ja:l̩ɪ	வனம்	vənəm	தலா	ʈ̠əla:	வேங்கை	veng aɪ	படி	pəɖ̩ɪ
24	மூளை	mul̩aɪ	சுரி	sUɾ̩ɪ	தாயார்	ʈ̠a:ja:ɾ̩	சாயல்	sa:jəl	பேரூர்	perur
25	ரசம்	ɾ̩əsəm	மேடை	meɖ̩aɪ	பிடி	pɪɖ̩ɪ	தயை	təjəj	மலர்	mələ̩ɾ̩

S.NO	List 21		List 22		List 23		List 24		List 25	
1	காலம்	kaːləm	மறை	məɻaɪ	புள்ளி	pUl̪ɪ	நன்று	nənd̪rU	சாறு	saːɻU
2	நிலா	nɪlaː	சேனை	senaɪ	கரி	kəɻɪ	ரகம்	ɻəgəm	கன்னி	kən̪ɪ
3	நீளம்	niɻəm	கோடி	koɖɪ	தடி	t̪əɖɪ	நஷ்டம்	nəʃt̪əm	சோர்வு	soɻvU
4	மாயம்	maːjəm	பயிர்	paɪɪr̪	கரு	kəɻU	கொடு	kɔɖʌ	பண்டம்	pənd̪əm
5	மூட்டை	mut̪aɪ	கூர்மை	kuɻmaɪ	ரோமம்	ɻomə̆m	வளி	vəl̪ɪ	பய்யன்	paɪjəm
6	பன்னீர்	pən̪ir	வெண்மை	vɛnmaɪ	குழை	kUl̪aɪ	குடை	kUɖaɪ	மூடி	muɖɪ
7	பொருள்	pɔruɻ	நயம்	naɪəm	துயர்	t̪Ujəɻ	மாதம்	maːd̪əm	கோவில்	kovɪl
8	சணல்	səṇəl	திடம்	t̪ɪɖəm	சிற்பம்	sɪrppəm	செய்தி	sɛjd̪ɪ	தரம்	t̪əɻəm
9	சக்கை	səkˆaɪ	ரொக்கம்	ɻɔkˆəm	சினம்	sɪnəm	தென்னை	t̪ɛnnaɪ	கிழி	kɪl̪ɪ
10	சுக்கு	sUkˆʌ	பற்று	pət̪ɻU	வன்மை	vənmaɪ	பசு	pəsU	முறம்	mUɻəm
11	மொட்டை	mɔt̪aɪ	பொது	pɔd̪U	மடை	məɖaɪ	கன்னம்	kənnəm	சொத்து	sɔt̪ʌ
12	சொந்தம்	sɔnd̪əm	கண்கள்	kənkəɻ	நுங்கு	nUnkU	பகல்	pəgəl	கலை	kəlaɪ
13	குறில்	kUɻɪl	சின்னம்	sɪnnəm	கள்ளம்	kəl̪əm	சொள்ளு	sɔl̪U	தயை	t̪aɪaɪ
14	வரம்	vəɻəm	நிழல்	nɪl̪əl	முத்தம்	mUt̪əm	சுற்றம்	sUt̪ɻəm	தூண்டில்	t̪und̪ɪl
15	கள்ளம்	kəl̆əm	தரை	t̪əɻaɪ	பந்து	pənd̪U	தேர்வு	t̪eɻvU	கீரி	kirɪ
16	பழி	pəl̪ɪ	சுடு	sUɖU	பீடை	piɖə̆i	விழா	vɪl̪aː	கோலம்	koləm
17	சட்டி	səṭ̪ɪ	சிலர்	sɪləɻ	சிதை	sɪd̪aɪ	துலாம்	t̪Ulaːm	பணி	pənɪ
18	தனி	t̪əṇɪ	துணை	t̪Uṇaɪ	கதர்	kəd̪ər	மடம்	məd̪əm	நீச்சல்	niʧ̆əl
19	தோற்று	t̪oṭ̪ɻU	மூளை	muɭaɪ	சன்னம்	sənnəm	மாரி	maːɻɪ	பாடம்	paːd̪əm
20	கூம்பு	kumbʌ	தடம்	t̪əɖəm	வர்ணம்	vərṇəm	சுயம்	sUjəm	விண்மீன்	vɪnmim
21	தையல்	t̪aɪəl	பூர்த்தி	puɻt̪tɪ	பலா	pəlaː	மேகம்	megəm	நேர்மை	nermaɪ
22	தப்பு	t̪əppʌ	சாக்கு	saːkˆʌ	வலை	vəlaɪ	குணம்	gUṇəm	பாளை	paːl̪aɪ
23	தவில்	t̪əvɪl	வலி	vəlɪ	கயம்	kaɪəm	லாபம்	laːbəm	தூளி	t̪ul̪ɪ
24	மடி	məd̪ɪ	கேப்பை	keppaɪ	நிறம்	nɪɻəm	பயன்	pəjən	கனம்	kənəm
25	வாய்க்கால்	vaːjkˆaːl	வள்ளல்	vəl̆əl	சாட்டை	saːt̪aɪ	பதில்	pəd̪ɪl	மதி	məd̪ɪ