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# Development and Validation of Phonetically Balanced Speech Perception Test in Urdu Language

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## Development and Validation of Phonetically Balanced Speech Perception Test in Urdu Language

**Purpose:** The tool of speech or language assessment is required to be linguistically and culturally appropriate for the individual being tested. Testing in native language is essential if an audiologist or speech and language therapist wants to test the speech perception capacities of an individual and to use the data for further planning and monitoring of the therapeutic efforts. Numerous speech perception tests are available in different international and regional languages. But in Urdu language, no such tool is available to the clinicians to check the speech perception abilities of hearing impaired individuals. Therefore, this study was designed to: (1) estimating the frequency of occurrence of Urdu consonants; (2) developing a speech perception test in Urdu Language for children with hearing impairment; and (3) establishing the reliability and validity of the test.

**Methods:** This study was carried out in three stages. In stage I, structural attributes of the test were planned. During stage II, firstly mean phonetic occurrence of each consonant in Urdu language was calculated. Secondly, a pool of most common image-able Urdu words was generated from which a 25 word-list for identification task was created. Finally, the speech perception test was finalized after establishing its content validity. In stage III, reliability and validity of the test was established through a pilot study conducted via randomly selected 100 normally hearing and 30 hearing impaired subjects.

**Results:** The Urdu speech perception test is a non-verbal, norm referenced test. Content, predictive and construct validity was established. Split half reliability of the test was 0.798 and test-retest reliability was 0.881 which was found to be significant at  $\alpha = 0.05$  and  $\alpha = 0.01$  level of significance respectively. Inter-scorer reliability was 0.598 which was significant at  $\alpha = 0.10$  level.

**Conclusions:** The Urdu speech perception test is a reliable, validated and linguistically appropriate non verbal tool to check the speech perception abilities of children with hearing impairment.

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### ABSTRACT

**Purpose:** The tool of speech or language assessment is required to be linguistically and culturally appropriate for the individual being tested. Testing in native language is essential if an audiologist or speech and language therapist wants to test the speech perception capacities of an individual and to use the data for further planning and monitoring of the therapeutic efforts. Numerous speech perception tests are available in different international and regional languages. But in Urdu language, no such tool is available to the clinicians to check the speech perception abilities of hearing impaired individuals. Therefore, this study was designed to: (1) estimate the frequency of occurrence of Urdu consonants; (2) develop a speech perception test in Urdu language for children with hearing impairments; and 3) establish the reliability and validity of the test. **Methods:** This study was carried out in three stages. In stage I, structural attributes of the test were planned. During stage II, mean phonetic occurrence of each consonant in Urdu language was calculated. Then a pool of the most common image-able Urdu words was generated from which a 25 word-list for identification task was created. Finally, the speech perception test was finalized after establishing its content validity. In stage III, reliability and validity of the test was established through a pilot study conducted via randomly selected 100 normally hearing and 30 hearing impaired subjects. **Results:** The Urdu speech perception test is a non-verbal, norm referenced test. Content, predictive and construct validity was established. Split half reliability of the test was 0.798 and test-retest reliability was 0.881 which was found to be significant at  $\alpha = 0.05$  and 0.01 level of significance. Inter-scorer reliability was 0.598 which was significant at  $\alpha = 0.10$  level. **Conclusions:** The Urdu speech perception test is a reliable, validated and linguistically appropriate non verbal tool to check the speech perception abilities of children with hearing impairment.

**Keywords:** hearing impairment, phonetic balance speech perception test, Urdu language.

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## INTRODUCTION

Speech perception refers to how an individual understands what is heard by the person. It is a skill that helps us to differentiate between the sounds, words, and syllables spoken by the speaker. The impact of hearing loss on an individual depends on the extent to which a person's speech perception is affected. The improvement in speech perception is considered as a primary goal of management of individuals with hearing impairment. Speech perception testing is not only used to provide information about the individual's speech perception ability but is also used for effective selection, planning, implementation, and evaluation of the rehabilitation process.<sup>1</sup> The speech language pathology and audiology professionals have tools to identify hearing loss at birth and to fit sensory devices soon thereafter. However, professionals are limited in age appropriate behavioural tests required to assess auditory perceptual performance.<sup>2</sup> Without testing, professionals cannot accurately know what the person can and cannot hear.

Different kinds of materials have been developed by investigators, but speech testing material needs to be linguistically appropriate for the person being tested. Moreover, factors like the age, cognitive level, level of complexity of material, and competing noises present in the environment should be given due importance.<sup>3,4</sup> The work of researchers have supported that the accuracy of test results depends upon familiarity or subject's knowledge of the test material. Testing in non-native language may yield an inaccurate low score.<sup>5</sup> It is difficult and inappropriate to assess primary speech perception ability in English when a person's native language is not English. For example, several speech tests have been developed in other languages including Mandarin Chinese, Russian, Arabic, and the Ilocano PB word recognition test.<sup>6-9</sup> Standardized speech audiometric materials and tests in different Indian regional languages have also been developed, such as Konkani, Marathi, PB word list in Telugu.<sup>10-12</sup> A review of literature by the co-authors did not find any speech perception test developed in Urdu Language.

Urdu, the national language of Pakistan, is spoken by more than 10 million people in Pakistan and 60,290,000 people in the world.<sup>13</sup> The books on Urdu literature and grammar are available. But little research has been done on its acoustic properties, and resources available for research in Urdu language are also limited.<sup>14</sup> The main criteria for selecting a material of any speech test is the phonemic structure of the language.<sup>15</sup> In Urdu language phonemes, there is still a controversy regarding the total number of consonants (i.e. 36, 37 and 42 consonants).<sup>16</sup> The notion of using a phonetically balanced word list for the word recognition test is not new, and many phonetically balanced word lists have already been developed in different languages, as mentioned earlier. Previous reports by researchers have commented that the notion of arriving at any phonetically balanced word list in its true sense is impossible as the frequency of occurrence of phonemes may vary with the change in the topic.<sup>17</sup> The estimation of at-least most frequently occurring phoneme may satisfy the tester with the assumption that the individual is exposed to the most frequently occurring material for testing. Keeping in view the little research done on phonemic characteristics of Urdu language and the trend of using phonetically balanced word-list in speech testing, the current study has three primary aims: I) to estimate the frequency of occurrence of Urdu consonants in spoken language; II) to develop a phonetically balanced speech perception test for children with hearing impairment; and III) to establish reliability and validity of the test.

## METHODS

The study was carried out in three different stages: determining the conceptual framework of the test, developing the test, and finally pilot testing the test.

### Stage I: Determination of the Structure of the Test

The test included four separate sections to check the four listening sub skills of the children.<sup>18</sup> The four skills were detection, discrimination, identification, and comprehension. It was planned to check the detection of environmental sounds and isolated phonemes of Urdu language. Skills of gross discrimination based on supra-segmental differences and fine discrimination based on consonantal differences were checked separately. The study involved the creation of a phonetically balanced word list for the task of identification having mono and bi-syllabic words. For the comprehension section, it was planned to ask some general and personal questions from the respondents to estimate their comprehension capabilities.

### Stage II: Development of a Phonetically Balanced Urdu Speech Perception Test

The stage of development of the test was further sub-divided into four phases: 1) estimation of the frequency of occurrence of consonants in spoken Urdu language, 2) the familiarity check of image-able Urdu words, 3) preparation of the phonetically balanced word list for identification section of the test, and 4) finalization of the contents of the test and content validation.

*The estimation of the frequency of occurrence of consonants in spoken Urdu language*

To develop the phonetically balanced speech perception test, the frequency of occurrence of each Urdu consonant was estimated. Consonant analysis by Raza was based on phonemic principles -- the way that a phoneme should be spoken in a word, so it was not used by the researcher.<sup>19</sup> The focus of the current study was on the acoustic characteristics of speech and thus phonetic occurrence. The way phonemes are actually uttered by the speakers was used. For this purpose, three speech samples of 15 minutes each were recorded by the researcher and/or participant teacher. The recordings were made with the help of an audio recorder on a mobile phone after taking informed consent of the participants.

- a) Sample A consisted of 10 short spoken extracts of 1 to 2 minute spoken by 3 to 4 adult speakers with varying age range and gender. These spoken speech samples were recorded by the researcher for five consecutive days as conveniently found in the surroundings. The timings for the recording of the speech samples were randomly selected i.e. 11:00 am and 6:00 pm. The obtained speech sample consisted of up to 670 words in total.
- b) Sample B was recorded by a volunteer playgroup teacher of a local mainstream school after getting permission from the head of the school. Recording was done when children were freely talking with each other as well as with the teacher in the class room. As a result, a speech sample of 680 words was obtained.
- c) Sample C of 800 words was a recorded conversation between parents, teachers, and children at a parent-teaching meeting in the same local school. After getting the consent of the teacher and the parents, the recording was done by the researcher while participating in the conversation.

All audio speech samples were played back and transcribed for further analysis in order to calculate the frequency of occurrence of each Urdu consonant in words. A list of 26 Urdu consonants was prepared in which the aspirated Urdu consonants were taken jointly with their phone and /k/ was taken with /q/. Tallies were made against the list of consonants for each recorded and transcribed sample. The mean occurrence of each consonant was calculated by using the total occurrence of each consonant in all three sample divided by three. Finally, the weighted mean occurrence for the 25 word-list of all these Urdu consonants was calculated with the help of formula,  $\bar{X} \times 25/716$ , where 716 is the average number of words calculated for three spoken samples.

*The familiarity check of image-able Urdu words*

A pool of familiar Urdu words was created for the selection of words for the identification task of the test. For this purpose, a list of image-able words was created by choosing vocabulary words from five randomly selected Urdu readers for toddlers. Common nouns belonging to the categories of body parts, fruits, vegetables, animals, and birds were chosen from the books. A few action words, pronouns, adjectives, and counting from one to ten were also added in the list. As a result, a list of 168 image-able words was obtained and arranged alphabetically.

A three-point Likert scale questionnaire was developed to rate the familiarity of these words from very familiar to not familiar word. Twenty five native Urdu speakers of age range 35 to 45 years were selected by snowball sampling technique to rate the familiarity of these words. It was ensured that all selected native speakers belonged to the different districts of Punjab. All words that were rated as not familiar by these native speakers were excluded from the list. Finally, the pool of image-able Urdu word list consisted of 136 words. From the pool, 25 words were required to be selected for the identification task.

*Preparation of the phonetically balanced word list for identification section of the test*

For the identification task, a list of 25 words was prepared from the pool of common image-able Urdu words. It contained 12 monosyllabic and 13 bi-syllabic words. It was ensured while choosing the words from the pool that the target word list has exactly the same weighted occurrence of each Urdu consonant as calculated earlier in phase 2. Although the practice of equating the frequency of occurrence of consonants with the calculated frequency is not common, it was done to ensure the presence of consonants with the same frequency and proportion as found in everyday life.<sup>8,9,12,15</sup>

*Finalization of the contents of the test and content validation.*

A questionnaire for the audiologists, speech language therapists, and Urdu Language experts was prepared to check the content validity of the proposed test. Three professionals of each mentioned category of experts were contacted to comment on the appropriateness of the task and relevance of each item with the task. It was recommended by the professionals to exclude the non-speech sounds from the detection section of the test. A revision in the comprehension section was also made by changing everyday sentences with the sentences based on information carrying words, in the light of expert opinion. As a result of the changes, all four sections of the test were requiring only the non-verbal responses from the respondents. After incorporating the

recommendations of the professionals, the Urdu speech perception test (USPT) was finalized as a non verbal test. The non-verbal response method may help the clinicians to take the test of individuals with limited expressive language skills.

The USPT consisted of four sections: detection, discrimination, identification, and comprehension of the speech stimuli. The detection section was limited to the detection of low and high frequency isolated phonemes, selected on the basis of most frequently occurring sounds. There were three vowels and seven Urdu consonants covering the low and high frequency area of speech banana. The respondent was simply required to raise his or her hand on the reception of any sound stimuli. Both gross and fine discrimination skill assessed by the discrimination section of the test. The 10 items of gross discrimination were selected on the basis of stress, intonation, and duration differences. The respondent was required to indicate nonverbally that the two sound stimuli were the "same" or "different." The fine discrimination section consisted of 10 paired items, selected on the basis of minimal perceptual differences (i.e. having the same phonic and supra-segmental features and differing only in one consonant). There were seven mono-syllabic paired words and three bi or tri-syllabic paired words in the list. The respondent was required to indicate non-verbally which of the three stimuli is different from others -- first, second, or third. The 25 word-list for the identification task was having 12 monosyllabic and 13 bi-syllabic words. The respondents were required to point to the picture of the word spoken by the tester. For the comprehension task, five sentences were generated on the basis of 1 to 4 information carrying words. The respondents were required to choose and show the item(s) as asked by the tester. Each item of the test carries one mark; hence, it is a test with 60 total marks. All of the above delineated structural attributes of the USPT are summarized in Table 1.

**Table 1:** Structural attributes of Urdu speech perception test, showing the detail of four levels of listening. All four skills are depicted in the context of their linguistics properties, acoustics contents, required response type and item details.

<b>Content</b>	<b>Detection</b>	<b>Discrimination</b>		<b>Identification</b>	<b>Comprehension</b>
<b>Linguistics</b>	Sounds in isolation	Supra segmental, vowels in mono, bi and tri-syllabic words	Consonants in mono and bi-syllabic words	Mono and bi syllabic words	Questions carrying up-to 4 information carrying words
<b>Phonetic Balance</b>	No	No	No	Yes	No
<b>Acoustics</b>	Vowels and consonants	Vowel versus vowel, Vowel versus word, Mono versus mono and bi-syllabic words. Tri versus tri and bi-syllabic words differing only in vowels.	Words differing only in consonants at all positions in words	Words in isolation	Speech with natural intonation
<b>Response</b>					
<b>Set</b>	Closed 2-choice	Closed 2-choice	Closed 3-choice	Closed choice	Closed choice
<b>Method</b>	Yes/no response	Same/ different response	Pick the add one out	Point to the picture	Choose from the given objects and follow command
<b>Number of items per list</b>	10	10	10	12+13=25	5 Sentences
<b>Number of list</b>	1	1	1	1	1

### STAGE III: Validation of the Test

A pilot study was conducted for the purpose of establishing reliability and validity of the USPT.

#### *Selection of the subjects for the pilot test*

First of all, a few nearby institutes were selected on the basis of convenience of the researcher. A letter of interest was delivered to them explaining the researcher's intent and expected benefits of the study. After seeking the permission from the head of the institute, the requirements and method of testing children enrolled in their school were explained to the authorities. A note on the

school diaries of the children between 4 to 14 years of age was written to obtain consent of the parents. One hundred normally hearing subjects from a local mainstreamed co-education school were randomly selected for speech perception testing. Ten subjects were randomly selected from each age group from 4 to 14 years age range. Selected subjects from each age group were having equal representation of both genders. Similarly, 30 hearing impaired subjects were randomly selected from a local special education institute for individuals with hearing impairment. It was ensured that two profoundly impaired subjects and one severely profound subject using bilateral digital hearing aid was included in each age group.

#### Administration of the test

Two volunteers were selected to work with the researcher for collecting speech perception scores of normally hearing as well as hearing impaired subjects. Two testers (the researcher and one of the volunteers) decided to take the test of the selected subjects during school hours. The volunteers were given orientation to the purpose and procedure of testing and provided with the written guidelines. The first 10 tests by volunteers were also monitored by the researcher for any discrepancy in the procedure of testing. The live voice of the volunteers was also monitored for uniformity. All sound stimuli were presented only once, in a closed room of the institute. The distance between the tester and subject was 8 to 10 feet. Data analysis was done to establish construct as well as predictive validity, split half, test- retest and inter-scorer reliability.

### RESULTS

The number of Urdu consonants included in the list was 44. /ʔ/ was omitted because of its deletion pattern found in speech samples of native Urdu speakers. The 44 consonants and the omitted one thus make a total of 45 consonants. These 45 consonants are the same as mentioned in Urdu phonetic inventory published by Centre for Language Engineering.<sup>16</sup> It was noted during the consonant analysis of the Urdu speech samples that

1. The phoneme /h/ at the middle and especially at the final position tended to be omitted or replaced by a vowel or diphthong by the speakers.
2. The phoneme /ʒ/ mostly tended to be substituted by a diphthong by Pakistani Urdu speakers in everyday life.
3. The high frequency of the phonemes like /k/, /v/, /s/, /h/, /m/, /n/, /r/ etc was due to the presence of excessive functional words in every day Urdu speech.
4. Frequency of /r/ was the highest at the final position among three positions in words.
5. The phenomenon of language code switching was prevailing because various English words (e.g. car, gate, pen) were being used by the native speakers in their every day routine instead of the Urdu vocabulary words for these concepts.

The tallies made in each category of consonant in each sample were used to estimate the frequency of occurrence of the consonants of Urdu language. Mean frequency of occurrence of each Urdu consonant was calculated by using the formula,  $\bar{X} = \Sigma X/n$ . Then the weighted frequency of occurrence of each consonant was calculated by using the formula,  $\bar{X} \times 25/ N$ . Here N stands for the average number of total words of all three speech samples. The summary of the frequency of occurrence of consonants along with their aspirated sounds in the spoken speech sample, their mean frequency, and weighted frequency in 25 word-list is given in the Table 2.

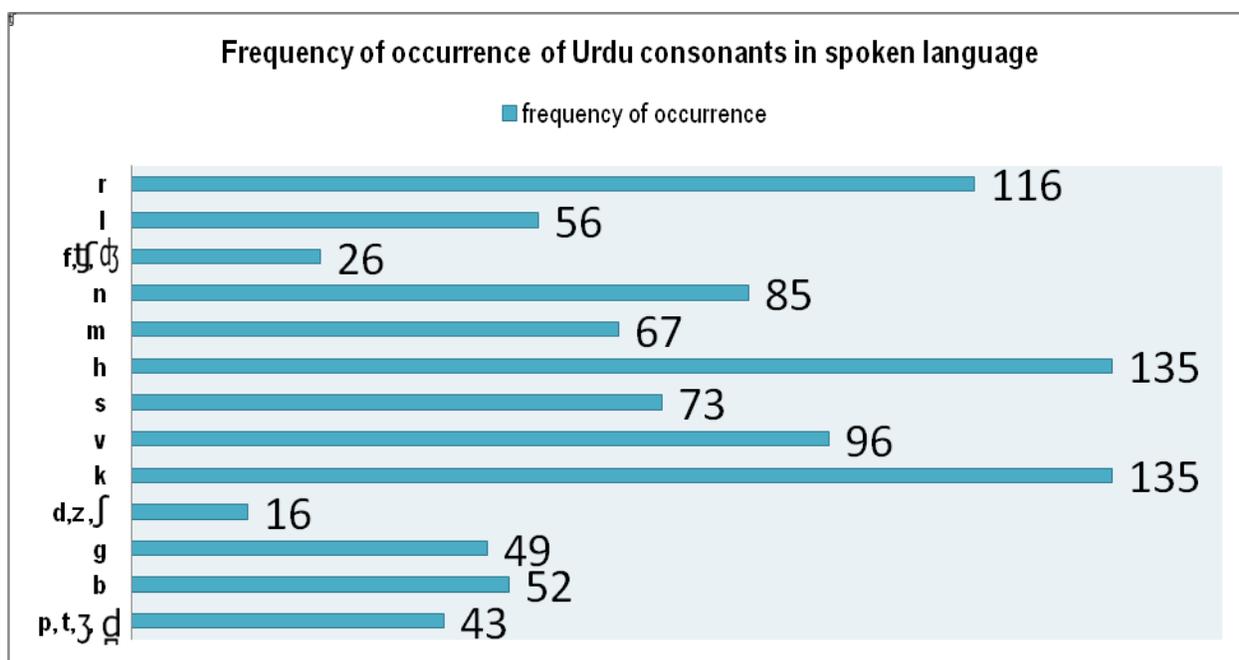
**Table 2:** The mean frequency of occurrence of Urdu consonants in recorded speech samples and finally estimated in 25 word-list with the help of weighted average formula

	Sounds (IPA symbols)	Sample A	Sample B	Sample C	Mean occurrence ( $\bar{X}$ )	Occurrence In 25 word list (A)
1.	/p/+p <sup>h</sup>	34	41	54	43	1.50
2.	/b/+b <sup>h</sup>	37	56	62	52	1.80
3.	/t/+t <sup>h</sup>	16	58	58	44	1.53
4.	/d/+d <sup>h</sup>	16	14	18	16	0.55
5.	/k/+k <sup>h</sup> +q	95	133	179	135	4.71
6.	/g/+g <sup>h</sup>	35	65	48	49	1.71
7.	/f/	12	39	35	29	1.01
8.	/v/	89	72	126	96	3.35
9.	/ʃ/+ʃ <sup>h</sup>	3	4	21	9	0.31
10.	/ʒ/+ʒ <sup>h</sup>	35	32	50	39	1.36
11.	/s/	58	69	94	73	2.54

12.	/z/	6	21	19	15	0.52
13.	/ʃ/	7	8	36	17	0.59
14.	/ʒ/+ʒʰ	39	63	32	45	1.57
15.	/h/	129	105	171	135	4.71
16.	/m/+mʰ	74	49	74	67	2.33
17.	/n/+nʰ	87	69	100	85	2.96
18.	/ŋ/	1	3	4	2	0
19.	/tʃ/+tʃʰ	16	20	35	24	0.83
20.	/dʒ/+dʒʰ	27	19	28	25	0.87
21.	/l/+lʰ	59	46	62	56	1.95
22.	/r/+rʰ	91	137	121	116	4.05
23.	/x/	5	3	5	4	0
24.	/ʁ/	7	0	1	3	0
25.	/ʁ/+ʁʰ	7	8	5	7	0.24

Average number of words (N) = 670+680+800/3 = 716  
 Formula for estimation of occurrence of consonant in word-list of 25 words (A) = Mean frequency of occurrence of a consonant (X̄) × 25/ N

The presentation of frequently occurring consonants of the Urdu language is better projected with the help of the Figure 1. The graphic representation of the frequency of occurrence of Urdu consonants makes it evident that the consonants with highest frequency were voiceless i.e. /k/, /h/ and /r/. Next were the voiced consonants /v/, /m/, /n/ with the exception of a voice less /s/.



**Figure 1:** The most frequently occurring consonants that should be given preference in auditory training lessons for the children with hearing impairment

For standardization, raw scores of normally hearing as well as hearing impaired subjects were converted into standard scores and percentile ranks. For this purpose, the raw scores obtained by the normally hearing subjects as well as the subjects with hearing impairment were tabulated against their frequency distribution first and then converted into percentile ranks and standard scores. Frequency distribution of the speech perception raw scores, percentile ranks and z scores obtained by 100 normally hearing subjects is depicted in the table 3. The same measures for subjects with hearing impairment are provided in the table 4.

**Table 3: The Speech perception raw scores of 100 normally hearing subjects, their percentile ranks and z scores**

Raw scores out of total score of 60	Frequency of the raw score by the volunteer	Frequency of the raw score by the researcher	Percentile ranks $p2 = 2 \left( \frac{n+1}{100} \right)^{th}$ Value of array	Standard score $z = X - X^- / S.D$
45	0	1	0.01 <sup>th</sup>	27.4
46	0	0	1.01 <sup>th</sup>	30.37
47	0	0	1.01 <sup>th</sup>	33.39
48	0	3	3.03 <sup>th</sup>	36.41
49	3	2	4.04 <sup>th</sup>	39.43
50	1	0	9.09 <sup>th</sup>	42.45
51	1	1	10.10 <sup>th</sup>	45.47
52	4	1	12.12 <sup>th</sup>	48.49
53	6	5	16.16 <sup>th</sup>	51.51
54	1	1	29.29 <sup>th</sup>	54.53
55	4	4	37.37 <sup>th</sup>	57.55
56	7	11	55.55 <sup>th</sup>	60.57
57	5	7	67.67 <sup>th</sup>	63.59
58	9	6	82.82 <sup>th</sup>	66.61
59	5	5	92.92 <sup>th</sup>	69.63
60	4	3	99.99 <sup>th</sup>	72.65

**Table 4: The Speech perception raw scores of 30 subjects with hearing impairment, their percentile ranks and z scores**

Raw scores out of 60	Frequency of the scores	Percentile ranks	Standard score
0	3	1 <sup>st</sup>	38.30
2	1	3 <sup>rd</sup>	40.10
3	2	16 <sup>th</sup>	41.009
4	1	23 <sup>rd</sup>	41.91
5	2	26 <sup>th</sup>	42.81
6	1	32 <sup>th</sup>	43.71
7	1	36 <sup>th</sup>	44.61
9	1	39 <sup>th</sup>	46.42
10	1	42 <sup>nd</sup>	47.32
11	4	46 <sup>th</sup>	48.23
12	2	60 <sup>th</sup>	49.13
13	1	64 <sup>th</sup>	50.03
16	2	68 <sup>th</sup>	52.74
17	1	75 <sup>th</sup>	53.64
19	1	78 <sup>th</sup>	55.45
24	2	81 <sup>st</sup>	59.96
25	1	87 <sup>th</sup>	60.86
29	1	91 <sup>st</sup>	64.47
42	2	94 <sup>th</sup>	76.21

The mean speech perception scores of normally hearing as well as hearing impaired subjects were calculated for each age group. Each age group was of one year age from 4 to 14 years thus forming the 10 groups of age range. These mean scores were used to get the evidence of predictive and construct validity of Urdu Speech Perception Test.

#### Predictive Validity

The mean scores of normally hearing as well as hearing impaired subjects were calculated for each age group from 4 to 14 years age range and plotted together in the form of bar chart. This bar chart shown in Figure 2 gave the evidence of the predictive validity of the USPT as the mean scores of subjects with hearing impairment in each age group were far below the scores of normally

hearing subjects. Moreover there was also the striking difference in the scores of subjects with severe and profound impairment. Thus the subjects predicted to differ in test performance actually did so.

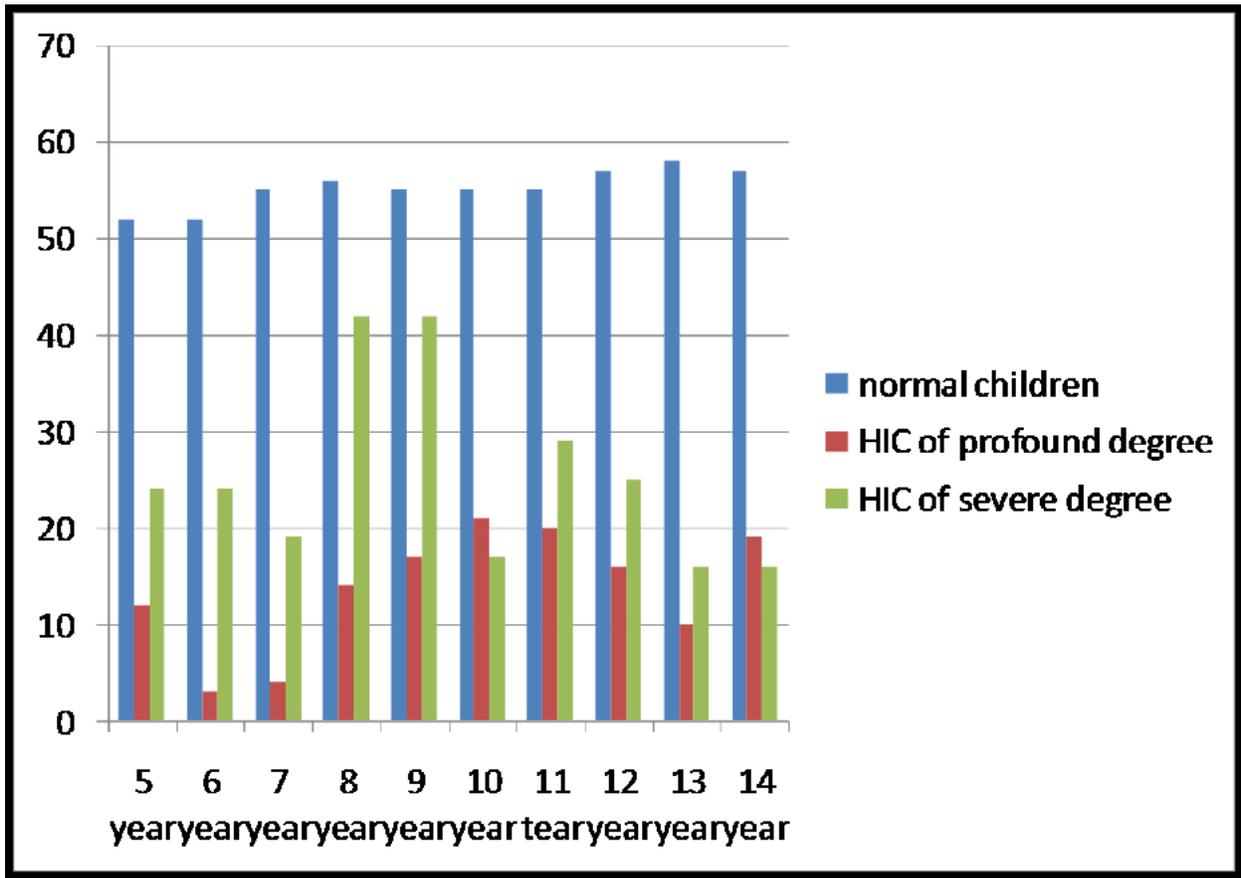


Figure 2. Mean scores of normally hearing and hearing impaired subjects

**Construct Validity**

The line graph was plotted against the mean scores of normally hearing subjects in each age group to get insight about the pattern of scores. The slope of line graph showed slow but gradual increase. The line graph shown in Figure 3 gave the evidence of construct validity of the test i.e. scores of the subjects in each age group improved with the increase in age of the subjects.

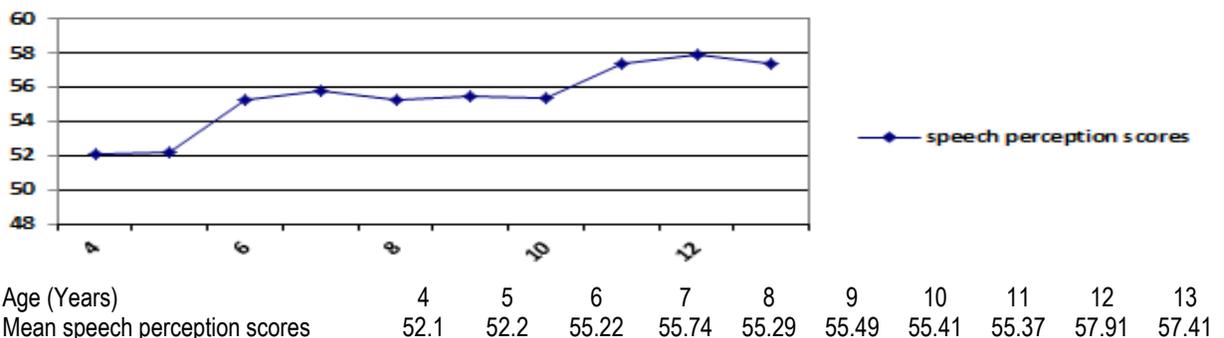


Figure 3. Evidence of construct validity

### Split Half Reliability

The correlation of the scores of even and odd numbered items was 0.662. The correlation coefficient using Spearman's Brown prophecy was 0.798, which is quite high. A t-test to check the significance of the relationship at  $\alpha=.05$  with n-2 degrees of freedom was 3.745 which fell in the critical region. Thus there was enough evidence to support the claim that there is a significant positive correlation between the split half scores of the speech perception test.

### Test-retest Reliability

A retest of ten randomly selected subjects after the interval of 3 months was taken. The gap between tests is assumed to be appropriate as the differences in speech perception skills are not likely to occur in three months duration. The correlation between test-retest scores of ten children was found to be 0.881. A t-test was administered and the correlation between scores was significant at  $\alpha=.05$ ,  $\alpha=.02$ , and  $\alpha=.01$  with n-2 degrees of freedom.

**Inter-scorer Reliability** It inter-scorer reliability was calculated using scores of the same ten children tested by both testers. Spearman's formula was used to calculate the correlation which was found to be 0.0598, indicating a moderate correlation. The significance of the correlation was checked by applying a t-test which was found to be significant at 0.10 level, but not at 0.05 level. This moderate level of reliability indicated the need of strengthening the instruction manual to be used by the tester. Moreover, the use of recorded sound stimuli was indicated and planned for further study.

## DISCUSSION

First of all, the phenomenon of phonetic balance of Urdu language is discussed. Considering that English phonetically balanced words are mono-syllabic, it was planned to do the analysis of only monosyllabic words. But at the initial stage of data analysis when 700 mono syllabic words were extracted from 1200 words, it was revealed that 80% of these words were functional words having no meaning independently. Personally, the researchers did not consider it justifiable to ignore the main content words of the language during analysis. The review of test developed in different regional languages revealed that they have not preferred mono syllabic words.<sup>9, 12</sup> So, it was decided to take all speech samples as a whole having combination of mono, bi, tri, and multi syllabic words. As a whole speech sample was taken, it was cumbersome and a challenge for the researcher to do the vowel analysis in addition to consonant analysis. A detailed analysis of acoustic and phonemic characteristics of all Urdu phonemes may help in further standardization of the tool.

As far as the total number of Urdu consonants is concerned, there were 45 Urdu consonants, but the frequency of occurrence was estimated against 26 items only. It was done to have a cumulative effect of the phoneme by adding the allophones. The number was reduced by taking the aspirated and non aspirated sounds jointly, adding /q/ with /k/, and totally ignoring /ʔ/ as the speakers tend to pronounce it as a vowel instead of consonant.

The following deletion rules as observed and mentioned by the researcher are in line with the previous research.<sup>20</sup>

- Deletion of /h/ at the phonemic boundary
- Deletion of the glottal stop/?/
- Deletion of /n/ and nasalization of vowel
- Deletion of aspiration
- In phonemic inventory, /q/ exist, but is mapped into /k/ by Urdu speakers

The deletion rule for /h/ and /j/ is further supported by another recent study.<sup>21</sup>

The frequency of Urdu alphabets, calculated by Khan et al was of no use to the researcher as they were based on Urdu alphabets. The 10 alphabets with the highest frequency in Khan's study were /r/, /n/, /v/, /m/, /t/, /l/, /s/, /d/, /k/, /b/ and the ten phonemes with the highest frequency in current study are /r/, /n/, /v/, /m/, /l/, /s/, /k/, /b/, /g/, /h/. Therefore, eight sounds matches in terms of their frequency of occurrence in every day speech.<sup>22</sup> Information about the most frequently occurring consonants and deletion rules may influence the speech and hearing clinicians in determining their assessment and therapeutic goals.

The procedure of exploring the phonetic description of Ilocano language, finding the commonness of words, and finally the construction of word-list matches with the methodology of the current study. But the procedure to get a phonetically balanced word-list is different.<sup>9</sup> In order to make a list of the phonetically balanced word list for identification task, the researcher chose only those words from the pool of familiar image-able words that fulfill a specific condition. The condition was that the total frequency of occurrence of the consonants in the full list would be approximately equivalent to the weighted frequency calculated in phase 2 of stage 2. As a result, the list for the identification task was not only had the most frequently occurring consonants

but also had the same proportion of the consonants (e.g. /k/ is five times and /r/ is four times present in the list). The treatment satisfied the basic assumption of benefit obtained from phonetically balanced test material that the subjects were exposed to and reflected the same proportion as found in everyday life. Extensive work on the phonemic characteristics of Urdu language may strengthen the future research in the area of tool development in national and regional languages.

As far as the selection of words for the test is concerned, the phenomenon of core vocabulary of any language is very important. Mukati has developed the Urdu core vocabulary of 976 words drawn from 10,301 words. Comparison of the core vocabulary with the pool of familiar words revealed that the selected image-able words were not present in the core vocabulary. Still, the weight-age of noun, verb, and adjective in the core vocabulary corresponds with the researcher's selection of words.<sup>23</sup> Similarly, the comparison between the list of medium vocabulary Urdu isolated words developed by Ali et al and the pool of most familiar words of the current study was made. It was revealed that only counting from one to ten, few nouns, pronouns, and adjectives were the same. The rest of words were different. This difference was due to the presence of more abstract nouns in the list by Ali rather than the concrete image-able nouns of the current study.<sup>24</sup> The use of image-able words was a pre-requisite when response mode for non-verbal identification task was "point to the picture."

The content pattern of the Urdu speech perception test is also in line with Speech Perception Instructional Curriculum and Evaluation (SPICE). SPICE is an auditory training curriculum that can help the speech language pathologists to evaluate the student's speech perception abilities, plan auditory skills instruction, measure and record student progress, and report to parents and other professionals. Only the word identification segment of USPT is different from SPICE.<sup>25</sup>

Psychometric review of language tests for preschool children revealed that a test is considered norm referenced if it describes the detail of normative samples, test norms showing mean and standard deviation and derived scores like standard scores, percentile ranks etc., in addition to establishing its validity and reliability. USPT is an attempt to be in line with the criteria delineated in the review and is thus may be considered as a norm referenced test.<sup>26</sup>

For establishing reliability and validity of the USPT, a pilot study was conducted with 130 subjects. The study may be replicated by increasing the number of both normally hearing children and hearing impaired subjects. The standard scores and percentile ranks may help the researcher in establishing concurrent validity of the test. Future research studies to convert it into a battery may help the professionals to screen and diagnose the hearing loss at early childhood. Further, Standardization of the USPT is also recommended by controlling the confounding variables like live voice, dialectal differences, verifying the normal hearing via objective tests, the concurrent validity, item analysis etc.

## CONCLUSION

The Urdu Speech Perception Test is a non-verbal, reliable, and valid tool to assess analytic as well as synthetic auditory skill areas of children with hearing impairment in Urdu language. It can be used as a screening, diagnostic, and monitoring tool like other international speech perception tests that have been developed in recent years.

## DECLARATION OF INTEREST

The authors report no declaration of interest.

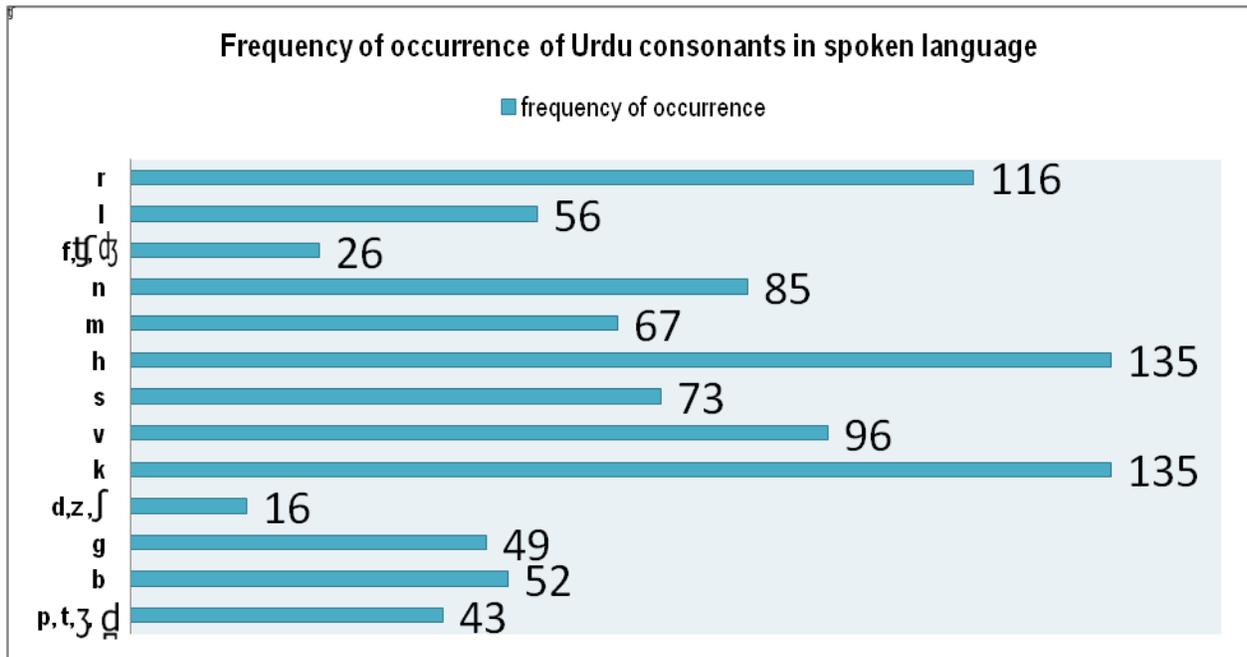
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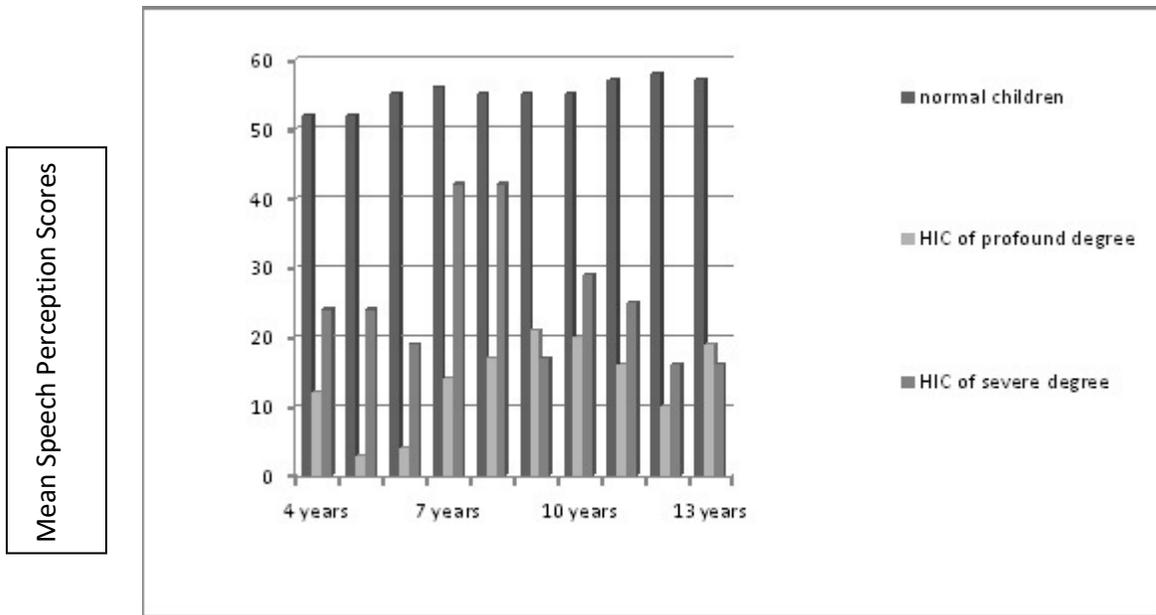
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Figure 1: It explains the frequency of occurrence of Urdu consonants in spoken language. It highlights the most frequently occurring consonants that should be given preference in auditory training lessons for the children with hearing impairment



**Figure 2:** Evidence of predictive Validity of Urdu speech perception test is shown with the help of varying length of bars of the mean scores. Black colored bar represents mean scores of normally hearing subjects (n = 100) and grey colored bars represent mean scores of hearing impaired subjects. (n = 10 severely impaired subjects and 20 subjects with profound hearing loss).



**Figure 3:** Evidence of the construct validity of Urdu speech perception test is shown with the help of slightly increasing slope of line graph of mean scores of normally hearing subjects in each age group. n = 100.

