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Language in India www.languageinindia.com **ISSN 1930-2940 Vol. 15:5 May 2015**
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Development of Binaural Fusion Test in Malayalam

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Abstract

Objective: APD has been referred to as dyslexia for the ears. The objectives of the present study were Develop a binaural fusion test in Malayalam for different age groups in children. The study also aimed at assessing the gender and age effect on the test developed.

Materials and Methods: A group of 60 school going children between the age group of 7 to 12.11 years were divided into 6 groups. A total of 300 CVCV words that are commonly used in Malayalam were selected from sources such as dictionary, newspapers and textbooks and story books suitable for the age group selected. A 10 point rating scale was used to judge the words, with 1 being 'least suitable ', 5 being 'average' and 10 being 'the most suitable' and the familiarity check was done at 4 levels. The finalized 80 CVCV words were divided into 4 lists of 20 words each by random numbering.

Results and Discussion: The results from the present study indicate a better performance in children with increasing age. This could probably be attributed to the characteristic of central nervous system characterised by an intrinsic "redundancy"—that is, an extensive interaction of its structures that is responsible for the resistance of the system to exhibit deficits on standard auditory testing in the presence of a lesion. The present study developed a test material which can be used for assessing the auditory processing in children.

Key Words: Auditory Processing, Central auditory processing disorder, Binaural.

Introduction

Central Auditory Processing Disorder in school aged children can lead to or be associated with difficulties in learning, speech, language (including written language involving reading and spelling), social, and related functions (Bellis & Ferre, 1999; Chermak & Musiek, 1997; Katz, 1992). The prevalence of APD can be estimated at 5-7% with a 2:1

ratio between boys and girls (Chermak and Musiek, 1997; Bamiou, Musiek and Luxon, 2001). Shivashankar and Gururaj (1993) reported that 26.9% of 54 children with scholastic problems had auditory profiles matching those of children with (C) APD. In a sample of 3,120 school children aged 8 to 15 years screened using the Screening Checklist for Auditory Processing, 3.2% had suspected (C) APD (Muthu Selvi, 2009; Muthu Selvi & Yathiraj, 2010). Children with learning disability may have auditory and or visual processing problems (Kraus & McGee, (1994).

Auditory processing abnormalities have been seen across spectrum of disorders like, Attention deficit hyperactive disorder, Dyslexia, Learning disabilities etc. Assessment of auditory processing in children has been a challenge over time. Test battery for auditory processing includes both behavioural and electrophysiological measurements. Electrophysiological tests measure and detect the site of lesions or dysfunction along the central auditory nervous system but behavioural tests are more useful in understanding the nature of perception in individuals. Some of the behavioural tests used in assessing the auditory processing abilities are Dichotic Speech Test (Muziek & Pinheiro, 1985), Temporal Ordering Tasks (Jerger & Jerger, 1971), Monoaural Low Redundancy Speech Tests (Pinheiro, 1977), Binaural Interaction Tests (Matzkar, 1959). Shivaprasad (2006) developed a Binaural Fusion Test in English for children in the age group 7-12 years. Thamanna Khurana (2009) developed Binaural Fusion Test in Kannada in the age group 7-11.11years. Binaural Fusion Test in Hindi was developed by Mhatre (2011).

India being a multi language country and most children are exposed to only their mother tongue predominantly until they start their schooling. There are all possibilities that even a normal child may manifest characteristics of those of auditory processing deficit children, if the child is not competent in the stimuli presenting language. Thus it is important to have these central auditory processing tests in various languages for (1) early identification and (2) to identify the children with real auditory problems and not those who manifest due to lack of knowledge of the language. The present study is aimed at one of those exercises where, a Binaural Fusion Test is developed in Malayalam language and can be used clinically as an assessment tool to assess for the presence of any auditory processing disorder in Malayalam speaking children between 7-12.11 years of age. Identifying individuals with auditory processing disorder at young age could help in structuring the rehabilitation

program. The prevalence of children with auditory processing disorder warrant further deeper understanding of the problem.

Materials and Methods

The objectives of the present study were to develop a Binaural Fusion Test in Malayalam and establish a normative data for different age groups in children. In the second phase, the study also aimed at assessing gender effect, age effect, familiarity effect and auditory memory on the developed test.

Participants

A group of 60 school going children between the age group of 7 to 12 years were the participants in the present study. The children were divided into 6 groups; 7-7.11years (Group-1); 8-8.11years (Group-2); 9-9.11years (Group-3); 10-10.11years (Group-4); 11-11.11years (Group-5); 12-12.11years (Group-6). The gender ratio was maintained to the maximum possible extent.

Inclusion and Exclusion criteria

The children who were native speakers of Malayalam, should not have auditory processing disorder as indicated by the Screening Checklist For Auditory Processing (SCAP) (Yathiraj & Mascarenhus, 2003) , showed normal hearing (PTA < 15dB HL), normal speech perception (SIS > 95%) no middle ear pathology ('A' Type tympanogram with present ipsi and contra lateral acoustic reflexes), normal cochlear function (presence of OAE's), normal nerve conduction (identifiable auditory brain stem responses at normal latencies) were included in the study. Children who had any history of middle ear problems, neurological problems, and family history of neurological or psychological illness were excluded from the study.

Development of Test Material

Word selection

A total of 300 CVCV words that are commonly used in Malayalam were selected from sources such as dictionary, newspapers and textbooks and story books suitable for the age group selected. Form the total 300 words list, 80 words were selected from for the study on familiarity and picturization. The familiarity and picturization check for the 300 CVCV words

was done at 4 levels involving speech pathologist, school teachers, parents and age matched school children. A 10 point rating scale was used to judge the words, with 1 being 'least suitable ', 5 being 'average' and 10 being 'the most suitable'

Level 1: Five Native Malayalam speaking speech pathologists rated the words list on a 10 point rating scale as mentioned above. The words which scored 5 and above on the rating scale were considered for the next level of familiarization.

Level II: Ten school teachers, distributed among classes of the selected age group were considered for evaluating the words. The word list at this level for rating were those words which had a score of 5 or above in level 1. A cut off score of 7 was considered for this level.

Level III: Fifteen parents of the school going children in the selected age group were asked to rate the words list. A cut off score of 9 was considered for this level.

Level IV: A list of 100 words was selected from the first 3 levels. At the final stage to ensure the picture matching ability of the selected study group, age matched school children was asked to match the words with the picture selected for the words. The finalized 80 CVCV words were divided into 4 lists of 20 words each by random numbering.

Picturization of the words

The picturization for the word was done at 3 levels to study the effect of similarity and auditory memory task (forced choice method).

(a) Screening list was to assess the subject's auditory skills and also to rule out any processing disorder. Subjects were instructed to do a simple task of repeating the words heard. This list was also used to assess any phonological processing disorder upon which subjects were excluded from the study.

(b) List I had four pictures that were presented for every target word and the task of the subject was to point to the target picture on auditory perception. Of the four pictures, one was the target picture, one was that of a rhyming word to the target word, one word of the same lexical category and the last one was a random picture.

(c) List II had 2 pictures that were presented for every target word. Of the two pictures, one was that of the target and the other was that of a similar sounding word (Homophone).

Recording of the Test Stimulus

The stimuli were recorded in the sound treated room by a native female Malayalam speaker. The inter stimulus interval was approximately 6 sec and inter-trial interval was examiner controlled. A low pass band of 500-700Hz and a high band pass of 1800-2000Hz were used to filter the recorded words using Goldware Digital Audio Editor Software. A calibration tone of 1 KHz presented prior to the test material for VU meter setting. From a subjective standpoint the words from each channel were clear, easily understood, and judged as occurring simultaneously (perceived dichotically) by listeners.

Administration

The developed audio file was routed from a laptop through a calibrated clinical audiometer (GSI-61) via External A and External B routing channels. The test was administered at 40dB SL with reference to speech reception threshold. The low pass and high pass stimulus were interchanged with right and left ear to respectively for all the lists. The tested administration followed in the order - List I- List II and List III. The test materials were administered under two conditions.

Condition 1: Right Ear- High Pass; Left ear-low pass

Condition 2: Right Ear -Low pass; Left ear-High pass. Each correct response was given a score of one and a wrong response a score of zero.

Figure 1: Graphical illustration binaural presentation for condition 1

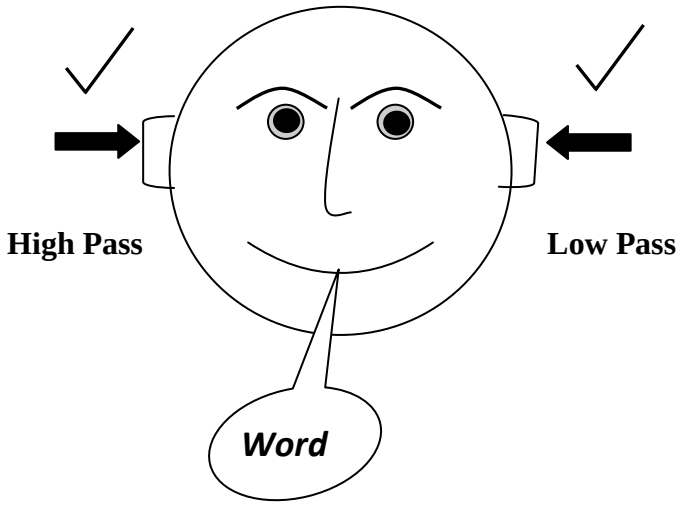
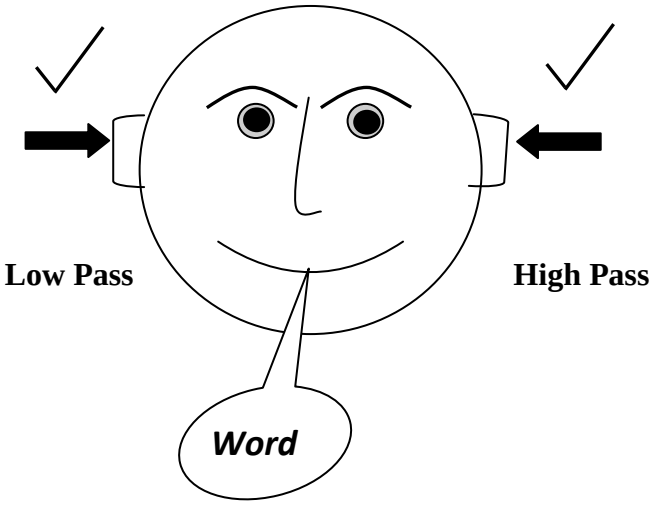


Figure 2: Graphical illustration binaural presentation for condition 2



Results and Discussion

1. **Ear effect**

The mean pure tone average, speech recognition threshold, speech discrimination and speech perception in noise were compared between the right and the left ear. Wilcoxon Signed Rank test did not show a statistically significant difference between scores of the two ears for any of the parameters tested.

2. **List 1 and List 2 (Descriptive)**

Table 1 shows the descriptive scores for list 1 and list 2. The table gives the mean and standard deviation across age groups.

Table 1: Mean and Standard deviation for list 1 and list 2

Age	List 1				List 2			
	Condition 1		Condition 2		Condition 1		Condition 2	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
7.00 to 7.11	18.70	0.67	18.90	0.56	19.00	0.81	19.30	0.48
8.00 to 8.11	19.30	0.48	19.70	0.67	19.30	0.82	19.70	0.48
9.00 to 9.11	19.80	0.42	19.80	0.42	19.70	0.48	19.80	0.42
10.00 to 10.11	19.70	0.48	19.80	0.42	19.90	0.31	19.70	0.48
11.00 to 11.11	19.70	0.48	20.00	0.00	19.90	0.31	20.00	0.00
12.00 to 12.11	19.90	0.31	20.00	0.00	20.00	0.00	20.00	0.00

3. Condition effect

Under Binaural Fusion Test a part of stimulus (high pass) would be presented to one ear and the other part (low pass) to the other ear. The two lists used in the present study were administered under two conditions. ***Condition 1***- high pass to right ear, and low pass to left ear, ***Condition 2***- high pass to right ear, and low pass to left ear. The two conditions under which the lists (1 and 2) were administered were compared across groups. Wilcoxon Signed Rank test showed no statistically significant difference between the two conditions across all the groups for both the lists.

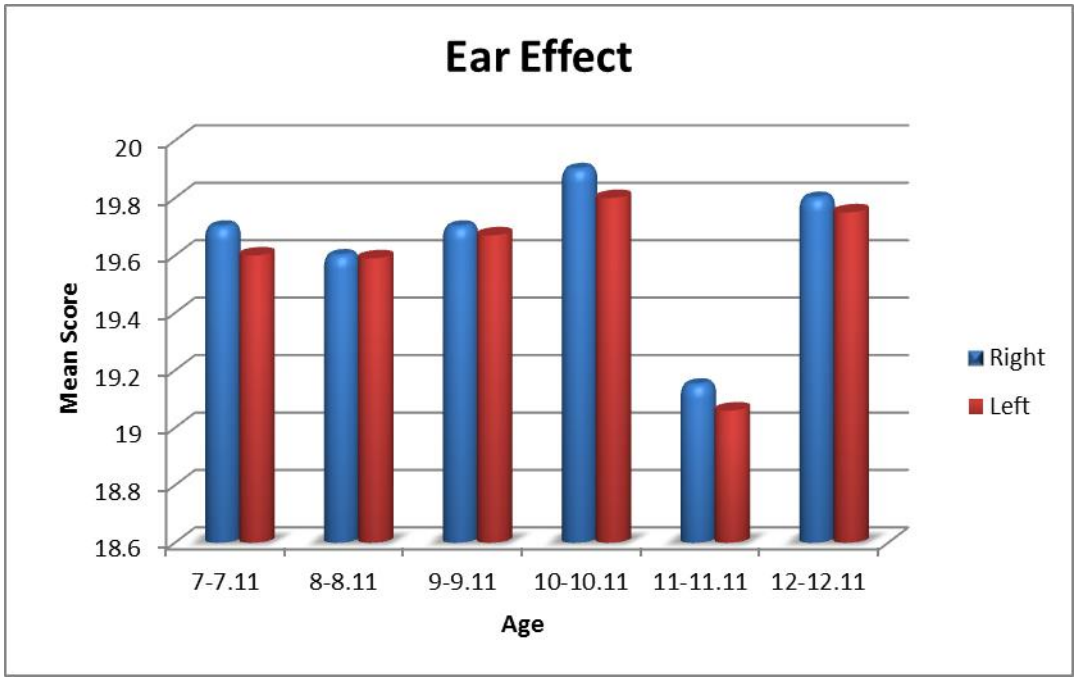
Results are in agreement with the literature, which shows there was no significant difference in presentation mode i.e. high passes signal in the left ear and low pass signal in the right ear or vice versa in Binaural Fusion Test (Plakke et al, 1981; Roush et al, 1984; Shivaprasad, 2006).

Table 2: Wilcoxon signed rank test for Condition 1 Vs condition 2 for list 1 and list 2

	List 1		**List 2**	
	Z	**Sig(p)**	**Z**	**Sig(p)**
7.00 to 7.11	-0.63	0.52	-1.13	0.25
8.00 to 8.11	-1.15	0.24	-1.41	0.15
9.00 to 9.11	0.00	1.00	-0.57	0.56
10.00 to 10.11	-0.44	0.65	-1.00	0.31
11.00 to 11.11	-1.73	0.83	-1.73	0.83

12.00 to 12.11	-1.00	0.31	0.00	1.00

Figure 3: Graphical representation for 2 conditions on mean scores



4. Between Lists Comparison

The comparison for List 1 and list 2 were compared for both conditions. The two lists (1 and 2) were compared across groups. Wilcoxon Signed Rank test showed no statistically significant difference between the two lists across all the groups for the lists (1 and 2) under both the conditions Similar findings were reported by Khurana (2009) & Shivaprasad (2006), indicating that the two phonetically balanced lists were equal in perceptual difficulty.

5. Between Groups Comparisons

The results of Kruskal-Wallis test for the significance of difference of mean performance (Table 3) showed significant difference for both list 1 and list 2. The evaluation showed the performance of the children in the group showed difference with age.

Table 3: Kruskal-Wallis test for list 1 Vs list 2 across groups

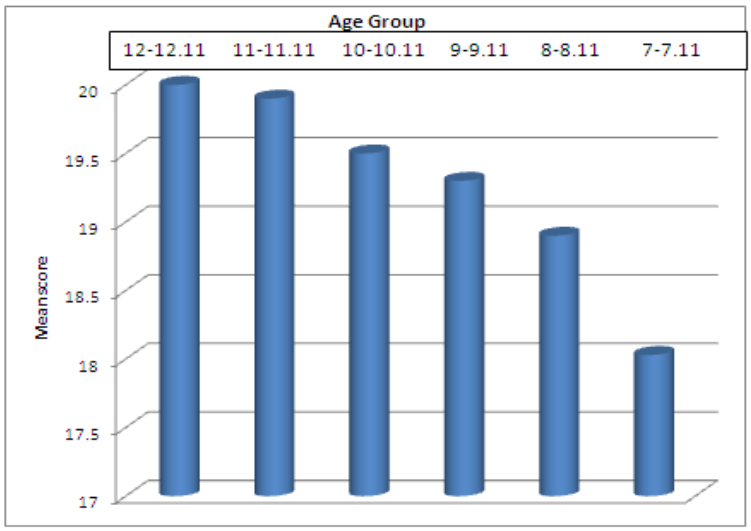
	Chi Square	DF	Sig(p)
List 1	44.27	5	0.00
List 2	32.15	5	0.00

Since the Kruskal-Wallis test showed a significant difference in the performance across groups, a further analysis to find the difference between groups individually was carried out using Mann Whitney U test. The results (Table 4) showed that age group 7-7.11yrs was a significantly different from all other age groups and those scores of 8-8.11yrs was significantly different from 11-11.11yrs and 12-12.11 years. 9-9.11yrs was also found to be significantly different from 12-12.11years.

Table 4: Mann Whitney U test for list 1 Vs list 2 between groups

Age group	L1			L2		
	MU	**Z**	**P**	**MU**	**Z**	**P**
7-7.11 vs. 8-8.11	106.00	-2.79	0.00	153.00	-1.35	0.17
7-7.11vs. 9-9.11	075.00	-3.71	0.00	124.50	-2.20	0.02
7-7.11 vs. 10-10.11	067.50	-3.93	0.00	100.00	-3.00	0.00
7-7.11 vs. 11-11.11	045.00	-4.65	0.00	076.00	-3.96	0.00
7-7.11 vs. 12-12.11	030.00	-5.20	0.00	076.00	-3.96	0.00
8-8.11 vs. 9-9.11	0167.0	-1.05	0.29	167.00	-1.00	0.31
8-8.11 vs. 10-10.11	157.50	-1.38	0.16	135.00	-2.04	0.04
8-8.11 vs. 11-11.11	129.00	-2.47	0.01	099.00	-3.41	0.00
8-8.11 vs. 12-12.11	110.00	-3.35	0.00	099.00	-3.41	0.00
9-9.11 vs. 10-10.11	190.00	-0.35	0.72	167.00	-1.07	0.28
9-9.11 vs. 11-11.11	160.00	-1.56	0.11	129.50	-2.62	0.00
9-9.11 vs. 12-12.11	140.00	-2.62	0.00	129.50	-2.62	0.00
10-10.11 vs. 11-11.11	170.00	-1.23	0.21	160.00	-1.74	0.08
10-10.11 vs. 12-12.11	150.00	-2.36	0.01	160.00	-1.74	0.08
11-11.11 vs. 12-12.11	180.00	-1.43	0.15	200.00	0.00	1.00

Figure 4: Effect of age on mean scores



The results from the present study indicate a better performance in children with increasing age. This could probably be attributed to the characteristic of central nervous system characterised by an intrinsic "redundancy"—that is, an extensive interaction of its structures that is responsible for the resistance of the system to exhibit deficits on standard auditory testing in the presence of a lesion. In children, myelination and maturation continue until 10–12 years of age. The young brain has an inherent ability for plasticity: the forebrain sensory representations may change in response to altered receptors, sensory environment, or use and learning (Bornstein,S & Musiek, 1984). Windham et al. (1986), Shivaprasad (2006), Thamanna Khurana (2009), (Stollman et al, 2004) reported similar findings.

6.Gender Effect

The mean scores were compared between the males and females of the participant groups for list 1 and list 2. Mann Whitney U test (Table 5) did show statistically significant difference for list 2 only. Children in the age group of 7 to 7.11 and 8 to 8.11 showed a gender difference, while other groups did not show any difference.

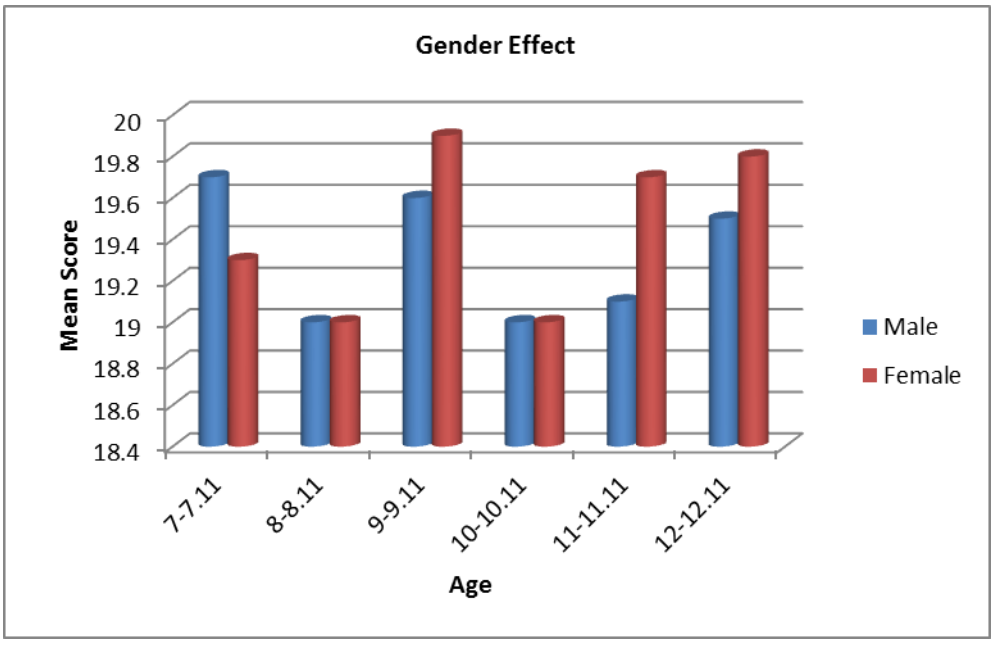
The results from the present study are contradicting the previous reports in the literature. This could probably attribute to the differential developmental pattern reported for males and females.

Young girls in the age range of 1-5 years are more proficient in language skills, produce longer utterances and have longer vocabularies than that of boys (Ruble and Martin, 1998). However, even though there appears to be a gender difference in verbal abilities favouring females, this difference is relatively small (Hyde, 1988, cited in Plotnik, 1999). Jennifer Krizman (2012) found that, to the fast acoustic components of speech, female responses are generally earlier and more robust than male responses.

Table 5: Mann Whitney U test for Males vs. Females

	List 1			List 2		
	MU	Z	Sig(p)	MU	Z	Sig(p)
7.00 to 7.11	26.00	-2.07	0.03	15.50	-2.78	0.005
8.00 to 8.11	47.50	-0.21	0.83	13.00	-3.09	0.002
9.00 to 9.11	50.00	0.00	1.00	29.00	-1.84	0.06
10.00 to 10.11	45.00	-0.50	0.61	45.00	-0.50	0.61
11.00 to 11.11	40.00	-1.45	0.14	45.00	-1.00	0.31
12.00 to 12.11	50.00	0.00	1.00	45.00	-1.00	0.31

Figure 5: Effect gender on mean scores



Normative data for the test material developed

Since there was no statistically significant difference between the two conditions and the two lists used in the present study, the average data from list one and list two for

condition 1 was considered as normative data. The raw scores and the percentage of correct responses are given below (Table 6).

Table 6: Normative data for binaural fusion test (Malayalam)

	Mean	**SD**	**(%)**
7.00 to 7.11	18.70	0.67	93.5
8.00 to 8.11	19.30	0.48	96.5
9.00 to 9.11	19.80	0.42	99.0
10.00 to 10.11	19.70	0.48	98.5
11.00 to 11.11	19.70	0.48	98.5
12.00 to 12.11	19.90	0.31	99.5

Cut-off Value

An additional analysis was performed to help in differentiating abnormal and normal scores based on application of a cutoff score. The cutoff was calculated at±2SD below the mean scores of the normal controls (Musiek, 1983). This score was determined by rounding of the values and considering the 2.5% steps measurement scale of the test.

Table 7: Cut off scores across age groups.

	Mean	**2SD**	**Corrected (%)**
7.00 to 7.11	18.70	3.58	85
8.00 to 8.11	19.30	2.4	90
9.00 to 9.11	19.80	2.1	90
10.00 to 10.11	19.70	2.4	95
11.00 to 11.11	19.70	2.4	95
12.00 to 12.11	19.90	1.5	95

The cut off scores are very important clinically. The testing environment, heterogeneous population and the calibration errors would account for more false positive and false negative responses. Hence, a 2SD below the normative data obtained are set as cut off scores for clinical use of the test.

Conclusion

The results from the present study are in agreement with previous findings in the literature. The developed test material follow the same trend as described in literature for various Binaural Fusion Test. Thus, the developed Binaural Fusion Test (Malayalam) can be used clinically as an assessment tool to assess for the presence of any auditory processing disorder in Malayalam speaking children between 7years to 12.11 years of age.

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APPENDIX-A

BINAURAL FUSION TEST IN MALAYALAM- WORDLIST

LIST – I			LIST – II		
Word	**IPA**	**Score**	**Word**	**IPA**	**Score**
പാവ	/pa:va/		മഴ	/maʒha/	
കാക്ക	/ka:kka/		പെട്ടി	/pettɪ/	
തത്ത	/t̪at̪a/		കുട്ടി	/kuʈʈɪ/	
സാരി	/sarɪ/		കോഴി	/ko:ʒhɪ/	
ചായ	/tʃa:ja/		ചക്ക	/tʃʌk̚ha/	

നായ	/na:ja/		മീശ	/mi:ʂa/	
പൂച്ച	/pu:tʃa/		ദേശ	/d̪ɔ:ʂa/	
ചവെി	/tʃevi:/		തേണി	/t̪ɔ:ɳɪ/	
മുടി	/mʊdɪ/		മുട്ട	/mʊʈʈa/	
മാല	/ma:ɭa/		വര	/vaɾa/	
തൊപ്പി	/tɔppɪ/		മണി	/mʌɳɪ/	
കുട	/kuɖa/		പുഴു	/pʊʒhʊ/	
പുലി	/puɭɪ/		ചട്ടി	/tʃʌʈɪ/	
വള	/va!a/		പള്ളി	/paɭɭɪ/	
പച്ച	/patʃa/		മൂങ്ങ	/mʊ:ŋa/	
നീല	/ni:ɭa/		പനെ	/pe:na/	
മാങ്ങ	/ma:ŋa/		ചാവി	/tʃa:vɪ/	
മശേ	/me:ʃa/		വായ	/va:ja/	
പശു	/paʃu/		വടി	/vadɪ/	
കത്തി	/kʌθɪ/		വട	/vada/	

LIST – III			LIST – IV		
Word	**IPA**	**Score**	**Word**	**IPA**	**Score**
തല	/ΘΛɭΛ/		നഖം	/nakʰam/	
താലി	/t̪a:ɭɪ/		ഭാവം	/ba:vəm/	
ജോലി	/jɔ:ɭɪ/		ഭൂതം	/bʊ:t̪əm/	
ഗുരു	/gʊrʊ/		ഞണ്ട്	/ɲɲʌnd̪ə/	
പാറ	/pa:ra/		മുറ്റം	/mʊttəm/	
വാവ	/va:va/		വട്ടം	/vaʈʈam/	
മല	/maɭa/		മഘേം	/me:kʰam/	
വല	/vaɭa/		പാലം	/pa:ɭam/	
തങ്ങേ	/Θæŋa/		പണം	/paɲəm/	
കിളി	/kɪɬɪ/		പഴം	/paʒham/	

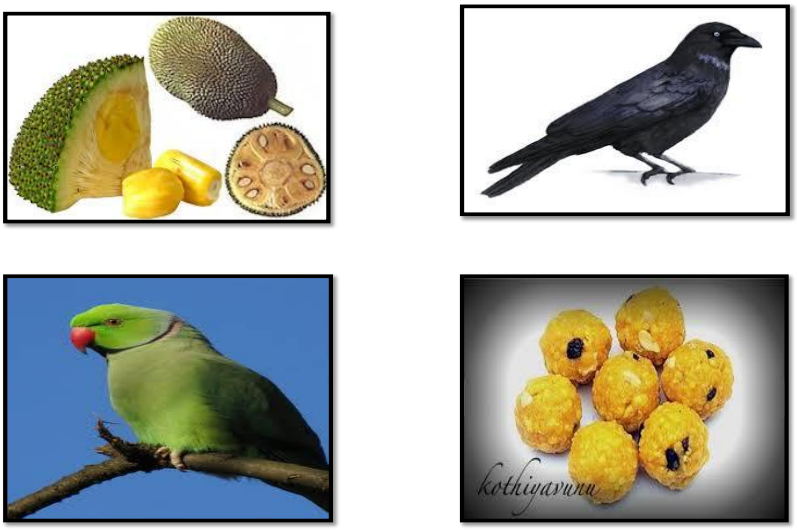
താടി	/t̪a:dɪ/		പന്ത്	/pant̪ə/	
പടി	/padɪ/		പാത്രം	/pa:t̪ram/	
ഭൂമി	/bʊ:mɪ/		മുഖം	/mʊkʰəm/	
കട	/kaɖa/		ചിത്രം	/tʃɪθrəm/	
വാഴ	/va:ʒha/		ചുണ്ട്	/tʃʊndə/	
വീണ	/vi:ɳa/		ബോധം	/bɔ:ɖ̪əm/	
കുപ്പി	/kʊppɪ/		ഭക്തി	/bakθɪ/	
പീലി	/pi:ɭɪ/		തണ്ട	/t̪andə/	
കീരി	/ki:rɪ/		ചന്ത	/tʃənθə/	
മഞ്ഞ	/maɲɲa/		തോക്ക്	/t̪̻ɔ:kʰə/	

APPENDIX-B

BINAURAL FUSION TEST IN MALAYALAM STIMULUS BOOK

LIST-I (1 & 2)

1.



2

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