Development and Standardization of Dichotic Rhyme Test in Bangla

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Abstract: The Dichotic listening tests is a behavioral test battery for assessment of hemispheric function, inter-hemispheric transfer of information, and development and maturation of auditory nervous system in children and adolescents. It might also help in the identification of lesions of the central auditory nervous system. The present study aimed to develop one such test and to collect normative data on Bangla speaking normal hearing individuals. The test material was developed using 25 pairs of CVCV rhyming words that differ only in initial consonants. These stimuli were made similar in total duration and imposed on to stereo tracks and aligned in such a way that there was no onset delay between the two. Normative data was taken from sixty young normal hearing native speakers of Bangla. Analysis of results revealed that there is a significant (p< 0.05) right ear advantage present for the dichotic stimuli for both the male and female participants.

Keywords: Dichotic; behavioral; hemispheric; rhyming

INTRODUCTION

Central auditory processing disorder (CAPD) refers to conditions that affect one’s auditory information processing, caused by the breakdown at any level of the complex neural pathways beyond the cochlea, despite normal hearing in the peripheral auditory system. Patients with CAPD often experience unusual difficulties in understanding speech under less than optimal listening conditions such as in noisy backgrounds, reverberant environments, with distorted or rapid speech, and with competing speech. Some children with CAPD also have language and learning disabilities, most probably resulting from inefficient use of auditory information. CAPD is defined as poor performance in one or more of these six behavioral phenomena: i) sound localization and lateralization; ii) auditory discrimination; iii) auditory pattern recognition; iv) temporal aspects of audition, including temporal integration, temporal discrimination (e.g. temporal gap detection), temporal ordering, temporal masking; v) auditory performance in competing acoustic signals, including dichotic listening; and vi) auditory performance with degraded acoustic signals.

It is estimated that APD occurs in 2 to 3 % of children with a 2:1 ratio among boys and girls. Problems of co-occurring disorders often complicate the identification of APD as a separate identity. Due to this, there are not many studies quoting the incidence and prevalence rates of APD. APD can be caused due to a lesion anywhere in the central auditory nervous system (CANS). Throughout the CANS, there are many points where decussating of fibers takes place which increases the internal redundancy of the central auditory nervous system. There are many disorders which are often associated with APD. These include Learning Disabilities, psychological disorders, disorders of cognition, Attention Deficit Disorder, articulation disorders etc.

Behavioural tests for assessing APD:

Over the years, many researchers have attempted to assess the functioning of the CANS by the use of various tests designed to assess the auditory system in competent environment. The hypothesis was that an abnormally functioning central auditory system will be unable to perform at par with normal central auditory mechanism under such circumstances. The authors have used Dichotic rhyme test amongst the various central auditory test battery test materials to assess the same.

Dichotic Rhyme test:

Dichotic Rhyme test was introduced and modified to assess Binaural integration of an individual. This test is sensitive to interhemispheric transfer of information. This test is useful from 8yrs of age to adults.
Dichotic Rhyming Test was composed of rhyming, CVC words, each beginning with one of the stop consonants (p, t, k, b, d, g); each pair of words differs only in the initial consonant. Pairs are almost perfectly aligned and fusion takes place, so listener repeats just one of the two words presented.\(^5\) Rhyming activities have been reported important in developing phonemic awareness which in turn is a good predictor of reading writing skills. Hence, an attempt has been made in this study to develop a Dichotic Rhyme Test in Bangla which would serve as a screening test for Auditory Processing Skills. Thus, the present study attempts to investigate auditory perception of rhyming words among adult native Bangla speakers.

**METHODOLOGY**

*Participants:*

Sixty individual aged 18-25 years (Mean Age 22.31 years, SD 3.5) agreed to participate in this study. 30 male and 30 female were selected for the study.

*Inclusion Criteria:*

All individuals were native speakers of Bangla. All the participants were right-handed because the dichotic testing results of left-handed subjects are less reliable due to their greater variability, and were therefore excluded from this study. Right-handedness was confirmed through the Edinburgh Handedness Inventory\(^20\), which is a simple 10-item questionnaire that provides a quantitative assessment of handedness. Individuals selected for the present study scored ≤ 20 on the questionnaire to ensure the subjects’ right-handedness.

The 60 selected test subjects also had normal hearing. All participants had normal otoscopy results with a clear external ear canal, a healthy tympanic membrane, and no signs of structural abnormalities. Tympanometric results were within normal limits, and all individuals were healthy at the time of testing with no illness that might have affected hearing performance. Pure tone audiometry was used to assess the individuals’ hearing. Each test subject had air conduction thresholds of ≤ 20 dB HL at 250-8000 Hz and bone conduction thresholds were within 10 dB of the air conduction thresholds at 500-4000 Hz indicating no air-bone gap was present.

The participants had no signs of suspected CAPD. All subjects were required to answer five questions about their auditory skills in daily lives. The corresponding skills are listed beside the screening questions in Table 1. These skills are listed\(^7\) and when an individual has difficulties in one or more of the skills, CAPD is suspected.

For each of the questions, subjects were asked to choose the most suitable answer out of four options which described their best auditory ability based on their daily life experiences. The four options were almost never, occasionally, frequently, and almost always. Subjects, who answered almost never, or occasionally in one or more of the situations, were suspected of having CAPD, and therefore excluded from the study. The questions and the answering formats were modified and adapted from Amsterdam Inventory for Auditory Disability and Handicap (AIADH). AIADH is a self-assessment tool to measure auditory disability in daily life.\(^20\)

After identification of the participations, the research was carried in stages. The Phase I included development and validation of the test material. In Stage II the normative data of the test material was obtained. In the final Phase III, the utility of the test material was resoluted.

**Phase I: The Development of Test material:**

**Selection of Words:**

A test material for the study were consist of bisyllabic words in which each words had syllable structure as CV.CV consisting of /p, t, k, b, d, g/ in initial position. Members of each pair differed from each other only in the initial consonant and the members of pair differed only on one phonetic feature (either voicing or place of articulation). The words were selected from different sources like standard Bangla dictionary, text books (below Vth standard). Approximately 30 pair words were collected for the purpose.

**Familiarity of the Test Items:**

To establish familiarity of the test items, 30 adults native speakers of Bangla, were instructed to rate the words according to the frequency of occurrence. The subjects were asked to rate the words on a five point scale of familiarity from 0-5 i.e. most familiar, quite familiar, familiar and unfamiliar and very unfamiliar respectively.
words that scored more than or equal to 2 were selected for the construction of the test material. Of all 30 rhyming pairs, 25 pairs had an average rating of more than two on five point rating scale and were considered for the test material. Rest five pairs were discarded as the familiarity was very poor.

**Recording of the material:**
The recording was done in a sound treated room where the noise levels . To maintain the amplitude of the words across the lists in a constant level the Adobe Audition (version 3.0) software was used for normalization of the words. The inter stimulus interval of the words was set to 4 seconds and a 1 kHz tone for 2 seconds was inserted prior to each list. The recorded material was burnt on a CD.

**Instrumentation:**
The 60 subjects were tested in a double room Audiological testing suite at the Department of Audiology, in AYJNIHH, ERC using the MAICO MA 53 Dual Channel Diagnostic Audiometer. The stimulus (both pure tones and speech) were delivered monaurally through the Telephonics TDH-39 supra-aural headphones. Prior to data collection, the equipment was calibrated using ANSI (2004) specifications. A Calibrated Immittance (GSI 38) meter was used to assess the status of middle ear. A computer with Praat (version 5.2) and Adobe Audition (version 3.0) software was used to record and normalize the material. A CD BURNER (Nero Express) was used to transfer the material onto a CD. A CD player (Sony CD player) was used to play the recorded material.

**Test environment:**
The test room was double room set up and quiets enough to meet the current ANSI standards for background noise. 

**Procedures:**
Before the initial testing began, directions were read to the test subjects explaining the dichotic listening task, and all test subjects were familiarized with the dichotic listening procedure by presenting practice word pairs. The practice set consisted of a 10-item dichotic word set. All dichotic word pairs were presented to the listener at 50 dB HL through audiometer routed to head phones. The participants initially had to match the loudness of the calibration tone between the ears. Then the test stimuli were presented dichotically, with no lag between ears. The participants were instructed to write down the words they heard and also not to guess any word of the pair. The testing was conducted in a double-wall sound booth with the equipment calibrated according to the American National Standards Institute. The audiometer’s speech signal calibration tone was recalibrated before every new listening condition used.

**Scoring:**
Each correct response was marked as 1 and incorrect responses marked as 0 i.e. the responses was marked either 0 or 1. Responses were scored in terms of single correct, double correct ear scores. The raw score will be then converted to percentage as below

\[
\text{Total score} (\%) = \frac{\text{Total number of correct responses} \times 100}{\text{Total number of words presented}}.
\]

**Statistical analysis:**
The raw data was subjected to statistical analysis from which statistics such as mean, standard deviation were calculated. Repeated measure of ANOVA for ears with independent factor as gender was used to evaluate the main effect and the relation between gender and ear. Independent and paired t-test were also used to reveal the significant difference between genders and within genders.

**RESULT AND DISCUSSION**
The aim of this study was to develop normative for dichotic rhyme test in Bangla on young adults in order to utilize the test for screening for Auditory Processing skills. Variables of subject’s ear (right ear versus left ear) and gender (male versus female) of subjects were studied to evaluate its effect on the rhyme word recognition scores of the subjects. An experimental, multi-factorial research design was employed.

The first objective of the present study was to develop and validate a rhyming words list for Dichotic Rhyme test comprising of familiar Bangla words. A Bangla rhyming word list was developed comprising CVCV syllables. To ascertain the test-retest reliability, 15 subjects, who fulfilled the criteria of subject selection for the study were randomly selected. Those subjects were tested on the dichotic rhyme test on two occasions separated by an interval of 2 to 4 weeks. Their performance on both tests was correlated using Pearson’s r for the ear specific scores obtained. This was done in order to check the reliability of the scores. A good correlation of \( r = 0.453 \) was obtained (at \( p = 0.05 \)). Test-retest reliability was then calculated and the scores were found to be reliable at \( p = 0.05 \).

**Table 3:** Test-retest score of the dichotic rhyme word

<table>
<thead>
<tr>
<th></th>
<th>Retest of Rhyming word</th>
<th>Significance (p value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total score Pearson Correlation</td>
<td>0.453*</td>
<td>0.012</td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.05 level (2 tailed).
Check to counterbalance transducer asymmetry:

In order to ensure that there was no inherent output bias in the earphones used, 15 subjects were tested. They were first tested with the right earphone on the right ear and the left earphone on the left ear. In the same test session, they were then tested with the right earphone on the left ear and the left earphone on the right ear. Their ear specific scores were correlated using Pearson’s r value.

A high degree of correlation was obtained of $r = 0.387$ (at $p = 0.05$). Thus, it was ascertained that the outputs from the two earphones were balanced.

If we consider the right ear and left ear scores, the ordinate is found very close to line obtained. Therefore, it can be concluded that the right ear as well as left ear scores were reliable rather than the standardized value of these scores.

This diagram represents the fit of the distances with the data. The scatter plot is a plot of fit between the scaled input data (horizontal axis) against the distances (vertical axis). It is important to examine the scatter of the objects along a perfect diagonal line running from the lower left to the upper right to assess the fit of the data to the distances. Ideally, when there is a perfect fit, the disparities and the distances will show a straight line of points. As the points diverge from the straight line, the fit or accuracy of the map decreases. If here we consider the entire coordinate, then we found increasing trends among them which means if we draw straight line the point or coordinate will be very close to that line which concludes that the scores were reliable.

The Rhyme word list was then standardized and administered on the participants. Thus the final Rhyme word list developed and used in this study has been enclosed in Appendix II.

**The second objective of the present study was**

To compare the rhyming words recognition scores of the right ear and the left ear of the participants. The overall

![Table 4: Test-retest ear specific scores of the dichotic rhyme word by changing the headphone](image)

<table>
<thead>
<tr>
<th>Retest of Rhyming word</th>
<th>Significance (p value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total score Pearson Correlation</td>
<td>0.387*</td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.05 level (2 tailed).

**Euclidean distance model**

![Figure 5: Euclidean distance model for reliability](image)
performance of the participants was reported under following headings.

*Comparison of ear correct scores within gender:*

The results were analyzed by calculating the mean, standard deviation and the range. Analysis was done to obtain information on ear correct scores (Total number of correct responses for the right ear or the left ear plus the double correct scores.) and double correct scores (Scores obtained when participant correctly responded both the stimuli presented to the two ears) and it can be seen from the table, the mean scores for the right ear were better than the left ear scores for both the males and females. For the male right ear, the mean value was 18.33, whereas the standard deviation was 2.249. For the female right ear, the mean value was 15.70, whereas the standard deviation was 0.466. For the male left ear, the mean value was 7.47, whereas the standard deviation was 2.874. For the female right ear, the mean value was 10.87, whereas the standard deviation was 0.860.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Ear</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>Significant level (2 Tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>Right</td>
<td>18.33</td>
<td>2.249</td>
<td>16.299</td>
<td>0.001</td>
</tr>
<tr>
<td>Male</td>
<td>Left</td>
<td>7.47</td>
<td>2.874</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>Right</td>
<td>15.70</td>
<td>0.466</td>
<td>27.046</td>
<td>0.001</td>
</tr>
<tr>
<td>Female</td>
<td>Left</td>
<td>10.87</td>
<td>0.860</td>
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</tbody>
</table>

Maximum Score = 50

Ear correct scores were examined for gender differences. A 2 X2 repeated measures analyses of variance was performed with gender (2 levels: Male, Female) as between group factor and ear (2 levels: Right and Left) correct scores the within-group factors. Results indicate a significant right ear advantage for both male and female.

From this table we can check the variability between two groups. For left ear the within group variability is greater. But between groups variability is greater for left ear also.

*Components of ear correct scores across gender:*

Ear correct scores were used for statistical analysis. Left ear and right ear correct scores were analyzed for differences in both males and females. The average values of raw data (ear correct scores) for both males and females are depicted in the figure 7 and figure 8.

*Comparison of ear correct score across gender:*

From the graph it can be observed that, there is large difference between right and left ear correct score for males, but less difference for the same in female subjects. It also observed that on right ear scores there is greater difference obtained for males and females.

From the table 6 we concluded, there exists significant difference (P* <0.05) between ear for males and females. Over all scores from right ear are been higher than from left ear. This indicates the stimulus processed through right ear has been superior to left ear. This called Right
Ear Advantage (REA). These results obtained from the present study are consistent with the result of studies conducted on western population using dichotic rhyme test.\textsuperscript{16}

Here the mean equality is being checked. The null hypothesis was $H_0$ which means the mean of male and female right (left) ear scores were equal. The alternative hypothesis $H_1$ depicts they were not equal. The $F$ test statistics is first checked for the overall significance of the model. High values of $F$ gave evidence against the acceptance of the null hypothesis. If we compare this computed

### Table 6: Comparison Within and across gender for the ear correct scores

<table>
<thead>
<tr>
<th></th>
<th>Sum of squares</th>
<th>Df</th>
<th>Mean square</th>
<th>$F$</th>
<th>Significance</th>
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<tbody>
<tr>
<td><strong>Right ear score</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between groups</td>
<td>104.017</td>
<td>1</td>
<td>104.017</td>
<td>39.440</td>
<td>.000</td>
</tr>
<tr>
<td>Within Groups</td>
<td>152.967</td>
<td>58</td>
<td>2.637</td>
<td></td>
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<tr>
<td>Total</td>
<td>256.983</td>
<td>59</td>
<td></td>
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<td><strong>Left ear score</strong></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Between groups</td>
<td>173.400</td>
<td>1</td>
<td>173.400</td>
<td>38.543</td>
<td>.000</td>
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<tr>
<td>Within Groups</td>
<td>260.933</td>
<td>58</td>
<td>4.499</td>
<td></td>
<td></td>
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<tr>
<td>Total</td>
<td>434.333</td>
<td>59</td>
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**Figure 7:** Ear wise scores of male versus female

**Figure 8:** The mean value of ear correct scores of males and females
<table>
<thead>
<tr>
<th></th>
<th>Levene's Test for Equality of Variances</th>
<th>t-test for Equality of Means</th>
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<tr>
<td></td>
<td>Std. Error</td>
<td>95% Confidence Interval of the Difference</td>
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<td></td>
<td>Sig.</td>
<td>n</td>
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<td></td>
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<td></td>
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<tr>
<td></td>
<td>F</td>
<td>Sig. t</td>
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<tr>
<td>Right ear score</td>
<td>Equal variances</td>
<td>62.260</td>
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<tr>
<td>Left ear score</td>
<td>Equal variances</td>
<td>31.381</td>
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Table 7: Independent Samples Test
or calculated F statistics with that in the statistics table, with degrees of freedom 58 and 31, the tabular will be lower. That means the null hypothesis is being rejected and concludes that there is difference in the pattern in male and female ear correct scores.

The t statistics for individual significance testing is checked. For the right ear in both the cases t values were greater than 3. Then the null hypothesis is accepted. In addition, for left ear t values are less than 1, therefore the null hypothesis is rejected. From this, we came to the conclusion that for both male and female the right ear is performing better than left ear.

PET and fMRI studies also have shown that during dichotic listening test, there is increase in regional cerebral blood flow to the contra lateral auditory corticies.\textsuperscript{18–25} The dichotic listening procedure has also been criticized for lack of sensitivity. Specifically, although the estimates of the right-handed population that are left hemisphere specialized for speech perception is fairly accurate (85–89%) based on the results of the dichotic listening procedures, it has been pointed out that the tests underestimate the proportion of the population (95.5%) predicted from clinical studies.\textsuperscript{6} Perhaps part of this discrepancy is because dichotic tasks are generally well performed, making differences between the two ears small.\textsuperscript{3} Just as ear advantages on the dichotic listening task have been employed as an indication of cerebral specialization for speech perception, manual asymmetries on movement tasks have been used as an indication of contralateral hemispheric dominance for movement organization. Manual asymmetries on tasks such as rhythmic finger and limb tapping,\textsuperscript{25} transfer of training and accuracy and timing of rapid aiming movements have all been used as indices of cerebral specialization for movement organization and production. The results of these studies indicate that, for the righthanded individual, the left hemisphere plays a dominant role in movement organization. Although the left hemisphere has been suggested to have this executive role in movement organization, it must be remembered that it is the motor areas of the contralateral hemisphere that deliver the final movement directives to the distal musculature of the limbs. The purpose of the present study was to test a methodology that combines a dichotic listening and manual asymmetry paradigm. It was developed to be sensitive to cerebral specialization for both speech perception and movement organization.

A dichotic methodology involving a manual response was used.\textsuperscript{6} The participants were required to monitor dichotic consonant–vowel pairs and instructed to press a button with a cued hand when they perceived a target syllable in either ear. 89% of the right-handed and 63% of the left-handed participants demonstrated a right ear versus left hemisphere advantage in reaction time. These laterality percentages are similar to estimates of cerebral specialization for speech perception utilizing traditional dichotic methodologies.\textsuperscript{10} However, like many of the earlier studies employing the dichotic listening procedure; the laterality effects using\textsuperscript{7} procedures are still susceptible to attentional influences. Specifically, the participants may have demonstrated a right side advantage because they typically focus their attention to their dominant, right side\textsuperscript{15} that may make them more sensitive to information presented to the right ear. The methodology developed for the present study avoids the pitfalls associated with attentional biases and lateralized limb control by combining the selective dichotic listening paradigm with a rapid two alternative aiming task. Specifically, the participants were presented verbal target information, either monaurally or dichotically, and were required to focus their attention on the information presented to one of their ears and then make a rapid aiming movement to the target cued in that ear. By using factorial combinations of ear and hand, specific predictions were made about ear and hand advantages based on the time taken for within and between-hemisphere communication. These predictions were based on the assumption that communication between centers within the same hemisphere is faster and more efficient than communication between the two hemispheres. For example, it was shown that right- and left-handed reaction times are shorter when the visual information is presented in the same visual field as the reacting hand.\textsuperscript{12} For most right-handed individuals, the left cerebral hemisphere plays a special role in both speech perception and the organization and control of voluntary movement. Thus, if the target information is presented dichotically, and the participants are instructed to pay attention to the right ear while responding with the right hand, they should enjoy a reaction time, and perhaps a movement time advantage as compared with conditions involving other ear-hand pairings.

III. Double correct scores across gender:

When the subject repeats both stimuli presented to both ears, one double correct score was given. These double correct scores obtained in both males and females are depicted graphically as, from the graph, one can notice a difference on double correct score obtained from males and females. But the amount of double correct scores is always less than either ear (Right or Left) correct score, and also constitutes a very less portion to identification score. This reflects the difficulty involved in processing two temporarily equated rhyming words simultaneously. This difficulty could be due to precise alignment of the two members of a pair. Subjects generally reports only one, although presented with two words, with slightly more than 50% of all words recognized being those presented to right ear.\textsuperscript{19,27} The result of the difference between males and females evaluated using independent samples t-test is displayed in the following table.
Scores | Gender | Mean | SD | t-value | Significance level (2-tailed) |
<table>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Double correct ear scores</td>
<td>Male</td>
<td>8.91</td>
<td>6.93</td>
<td>2.41</td>
<td>0.021 (p&lt;0.05)</td>
</tr>
<tr>
<td></td>
<td>Females</td>
<td>3.98</td>
<td>6.31</td>
<td></td>
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</tbody>
</table>

From the table one can understand that, there is significant difference (P < 0.05) between males and females on double correct score. But the variability in double correct score was high in both genders.

**SUMMARY AND CONCLUSIONS**

The aim of this study was to develop normative for dichotic rhyme test in Bangla on young adults in order to utilize the test for screening for Auditory Processing skills. Variables of subject’s ear (right ear versus left ear) and gender (male versus female) of subject were studied to evaluate its effect on the rhyme word recognition scores of the subjects. An experimental, multi-factorial research design was employed.

Sixty individual (Male-30, Female-30) ages 18-25 years were recruited. All individuals were native speakers of Bangla. With right-handed because the dichotic testing results of left-handed subjects are less reliable due to their greater variability. The 60 selected test subjects also had normal hearing. All participants had normal audiometry results with a clear external ear canal, a healthy tympanic membrane, and no signs of structural abnormalities. Tympanometry results were within normal limits, and all individuals were healthy at time of testing with no illness that might have affected hearing performance. Pure tone audiometry was used to assess the individuals hearing. Each test subject had air conduction thresholds of ≤ 20 dB HL at 250-8000 Hz and bone conduction thresholds were within 10 dB of the air conduction thresholds at 500-4000 Hz indicating no air-bone gap was present. No signs of suspected CAPD.

The test involved identification of bi-syllabic words that were dichotically presented in which each words had syllable structure as CVCV, consisting of /p,t,k,b,d,g/ in initial position. Member of each pair differed from each other only in the initial consonant and the members of pair differ only on one phonetic feature (either voicing or place of articulation). There were total 50 stimuli. The subject taken for developing normative values were and the test was performed. Responses were scored in terms of single correct, double correct ear scores. The raw data was subjected to statistical analysis using repeated measures ANOVA and also t-test to explore ear effect.

The results revealed that there was a significant difference between the performance obtained with the dichotic presentation in right ear and left ear for both male and female participants. Though Right ear advantage was seen in both male and female participants, there was also significant difference was present for the performance right ear and left ear between male versus female participants. Secondly, male had greater mean ear correct scores as compared to females for both right and left ear. Thirdly, male had greater double correct scores than females.

In conclusion the findings of the present study on Bangla speaking population are same with the findings of western population. Before using for clinical assessment, the test material developed as a part of present study has to be further studied.

**Limitations of the study:**

Among the limitations include the subject’s individual perception of loudness which was not assessed monaurally. Thus, any individual enhanced perception of loudness at one ear with respect to the other was not controlled. Secondly, most subjects recorded their responses on the response sheet while the stimulus was being presented even though they were instructed to record them during the inter-stimulus interval. Moreover the individual’s speed of writing was not considered. Only 10 seconds were provided for writing down the 2 digits in each set. Also, the sample size was limited. There was no separate list for practice items. Lastly, the fatigue of the subject was not considered.

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**REFERENCES:**


