NORMATIVE DATA FOR ADULTS ON DICHOTIC CV TEST - REVISED: CD VERSION.

Reg.No.02SH0010

AN INDEPENDENT PROJECT SUBMITTED *IN* PART FULFILLMENT
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NAIMISHAM CAMPUS, MANASAGANGOTHRI, MYSORE.

JUNE 2003

Dedicated To

Dimma & Thakuma

With Love

CERTIFICATE

This is to certify that this Independent Project entitled **"NORMATIVE DATA FOR ADULTS ON DICHOTIC CV TEST-REVISED:CD VERSION."** is a bonafide work in part of fulfillment for the degree of Master of Science (Speech & Hearing) of the student **(Register No.02SH0010).**

Dr. M. Jayaram
Director
All India Institute of
Speech and Hearing,
Mysore.

Mysore

June 2003

CERTIFICATE

This is to certify that this Independent Project entitled **"NORMATIVE DATA FOR ADULTS ON DICHOTIC CV TEST-REVISED:CD VERSION."** has been prepared under my supervision and guidance. It is also certified that this has not been submitted earlier in any other University for the award of any diploma or degree.

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DECLARATION

This Independent Project entitled **"NORMATIVE DATA FOR ADULTS ON DICHOTIC CV TEST-REVISED:CD VERSION."** is the result of my own study under the guidance of **Dr. Asha Yathiraj,** Reader & H.O.D., Dept. of Audiology, All India Institute of Speech and Hearing, Mysore, and not been submitted in any other University for the award of any degree or diploma.

Mysore,

June, 2003 **Reg. No. 02SH0010**

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INTRODUCTION

Speech understanding is a complex process that includes detection of isolated acoustic sounds and words, but also integration of sounds, words and sentences into meaningful units. Speech processing involves the peripheral sense organ as well as a number of cognitive factors such as working memory capacity, selective attention and speed of information processing.

Central Auditory Processing function is an important consideration in the communication process. Optimal functioning of the Central Auditory Nervous System (CANS) is critical to the recognition and discrimination of even most simple, non-verbal stimuli as well as of highly complex stimuli such as spoken language (Bocca & Calearo, 1963; Bellis, 1996).

Central Auditory Processing has been defined by the ASHA Task Force on Central Auditory Processing (ASHA, 1999, cited in Medwetsky, 2002) as :- "Central Auditory Processes are the auditory system mechanisms and processes responsible for the following behavioural phenomena :- sound localization and lateralization; auditory discrimination; auditory pattern recognition; temporal aspects of audition, including temporal resolution, temporal masking, temporal integration and temporal ordering; auditory performance decrements with competing acoustic signal; and auditory performance decrements with degraded acoustic signal."

Central Auditory Processing Disorder (CAPD) has been defined as a disorder in function of central auditory structures, characterized by impaired ability of Central Auditory Nervous System (CANS) to manipulate and use acoustic signal, including difficulty in understanding speech-in -noise and localizing sounds.

Individuals with CAPDs are a heterogenous group. That is Central Auditory Nervous System (CANS) break down differ widely across individuals, resulting in presenting symptoms and severities that also differ.

CAPD is assessed through the use of special tests designed to assess the various auditory functions of the brain. Using a test battery approach, audiologists can determine if a CAPD is present and if so, the specific nature of the difficulties.

Central auditory processing (CAP) testing can trace its origin to site of lesion. During the 1950s it became apparent to researchers that some patients were presenting with "hearing problems" in everyday situation even though they had no audiometric evidence of hearing loss.

A Central auditory processing test battery needs to encompass the following goals: -

- Determine if a CAPD problem exists, and if so, determine the severity and the nature of the various underlying difficulties.
- Provide findings and interpretations that guide recommendations for management of the problem.

Among various CAP test batteries, dichotic speech testing is one which has been primarily used to measure hemispheric asymmetry (Kimura, 1961a, cited in Musiek & Pinheiro, 1985) or to indicate brainstem dysfunction (Kimura, 1961b, cited in Musiek & Pinheiro, 1985). Kimura (1961a, cited in Musiek & Pinheiro, 1985) is considered to be responsible for the initial introduction of dichotic speech tests into the field of central auditory assessment.

Some dichotic speech tests which are used clinically are:-

- Dichotic Digit Test, (Kimura, 1961a, cited in Musiek & Pinheiro, 1985)
- Dichotic Consonant-Vowel Test (Shankweiler & Studdert-Kennedy, 1976)
- Staggered Spondaic Word Test (Katz, 1962)
- Dichotic Rhyme Test (Wexler & Halwas, 1983)
- Competing Sentence Test (Willeford, 1968, cited in Willeford & Burleigh, 1985)
- Synthetic Sentence Identification with Contralateral Competing Message (Jerger, 1970, cited in Musiek & Pinheiro, 1985).

Aim of the study:

The aims of the study are as follows:

- To establish normative data on adults for the CD-version of the "Dichotic CV test -Revised" developed by Yathiraj (1999).
- To compare the present study with that of Puranik (2000) who obtained norm on adults using a tape -recorded version of the same test.
- To compare the scores obtained by males with that of females.

*Need **for** the study:*

The necessity for the present study was felt since normative data is required to interpret the resultsrobtained on deviant population and to make accurate diagnosis. A person can be identified as having a problem, only if performance differs from that of the normal population.

Norms have been established for the taped version of the test by Puranik (2000). However, as the clarity of the CD version of the test would be better, there are chances of getting better scores, when compared to a tape. Hence, the same norms as a tape recorded test cannot be used, when the test is administered through a CD.

Further, a CD does not wear out with time. Hence it would be preferred to a taped version. In almost all fields CDs are replacing tapes due to their inherent advantages. This is happening in the field of Audiology also. This makes it necessary to have a CD version of the test.

REVIEW

Central Auditory Processing is considered as a function of the central auditory nervous system. It includes sound localization, binaural processing, speech perception, auditory discrimination, auditory vigilance, auditory memory, auditory closure, fracturing ability and auditory contour recognition. Central Auditory Processing Disorder (CAPD) is not a label for a unitary disease entity, but rather a description of functional deficits (ASHA, 1996, cited in Chermak & Musiek, 1997).

In order to assess auditory processing and its disorders, various tests have been evolved. These tests have been categorized in a variety of ways. Broadly, the test for CAPD can be classified as behavioural and electrophysiological tests (Bellis, 1996).

Behavioural tests:

Recognising the insensitivity of traditional auditory tests in assessing the Central Auditory Nervous System (CANS), researchers developed behavioural tests composed of low redundancy material to elucidate CANS dysfunction (Bocca, Calearo & Cassinari, 1954). Continuing efforts to develop tests sensitive to lesion of the CANS led to measures that incorporated binaural interaction tasks and dichotic presentations (Katz, 1962, cited in Katz, 1994; Berlin, Lowe-Bell, Jannetta & Kline, 1972; Musiek, 1983a). Temporal ordering and sequencing tasks were incorporated later (Musiek & Pinheiro, 1985).

ASHA Committee on Disorders of Central Auditory Processing (ASHA, 1996, cited in Chermak & Musiek, 1997) divided central tests into monotic, dichotic & binaural tests. Katz (1994) further classified these tests as non-speech based, monosyllabic, spondaic and sentence procedures.

Central tests are categorized by Baran and Musiek (1991, cited in Bellis,1996) in the following manner:

Dichotic speech tests, temporal ordering tasks, monaural low-redundancy speech tests and binaural interaction tests. These tests are further sub classified as given below:-

Dichotic speech tests

- Dichotic digit test
- Dichotic consonant-vowels test
- Staggered spondaic word test
- Competing sentence test
- Synthetic sentence identification tests with contralateral competing message
- Dichotic rhyme test

Temporal test

- Frequency pattern
- Duration pattern

- Psychoacoustic pattern
- Discrimination test

Monaural low redundancy speech test

- Low pass filtered speech
- Time compressed speech
- Time compression plus reverberation
- Synthetic sentence identification test with ipsilateral competing message.
- Speech-in-noise

Binaural interaction test:

- Rapidly alternating speech perception
- Binaural fusion (band pass filter)
- Binaural fusion (consonant-vowel-consonant)
- Interaural just noticeable difference

Willeford and Burleigh (1985) added electrophysiological test as part of the evaluation procedure that can be used to assess central auditory processing problems. Electrophysiological tests objectively measure the physiologic response to auditory stimulation. Various electrophysiological tests are:-

- Auditory Brainstem responses
- Middle Latency Evoked Responses
- P300
- Mismatch Negativity

Though there are a host of tests available for the evaluation of auditory processing problems, in this review of literature only information about dichotic speech tests are included.

DICHOTIC SPEECH TESTS

The term 'dichotic' refers to auditory stimuli that are presented to both ears simultaneously with the stimulus presented to each ear being different (Katz, 1994). Dichotic speech testing, introduced by Broadbent (1954, cited in Musiek & Pinheiro, 1985) requires the presentation of different speech signals to each of the ears. Musiek and Pinheiro (1985) considered two major kinds of dichotic listening tasks: Binaural integration and binaural separation.

Binaural integration requires the subject to respond to the stimuli presented to both ears. According to Musiek and Pinheiro (1985) the three types of binaural integration tests are:

- Dichotic Digits
- Dichotic Consonant -Vowels
- Staggered Spondaic Words

In a binaural separation tasks, the subject responds to only the words presented to a designated ear and ignores the other words in the opposite ear. The tests that involve binaural seperation, according to Musiek and Pinheiro (1985) are:-

- Dichotic Rhyme Test
- Competing sentence test
- Synthetic Sentence Identification with Contralateral Competing Message (SSI-CCM)

All these dichotic speech tests have clinical value in the detection of various central auditory processing disorder.

Dichotic Digit Test (DDT)

One of the most common dichotic tests in use today is the DDT. Kimura (1961a, cited in Musiek & Pinheiro, 1985) first utilized triads of digits presented dichotically for the assessment of central auditory function. A revised version of Kimura's procedure was introduced by Musiek (1983a) in which two digits from 1 through 10 (excluding 7) are presented to each ear simultaneously. The listener is required to repeat all four digits heard. Since digits are extremely familiar, the stimuli carry little linguistic loads and thus require minimal mental efforts to process.

The digits are presented at 50 dBSL in reference to the subject's spondee threshold or pure tone average. Forty digits (20 pairs) are presented to each ear. The subject repeats all the digits heard in any order (free recall). A percentage correct score is derived for each ear. This version of the dichotic digits requires a little time to administer and is easily scored (Musiek, 1983a).

Dirks (1964) administered the DDT on normal adult subjects and found a right ear (left hemisphere) superiority of 2-6% for verbally reporting of the digits. Similar findings were reported by Speaks (1975, cited in Musiek & Pinheiro, 1985).

In another study, Musiek (1983b) used pairs of digits presented dichotically and found that normals obtained 90% scores, or more on the DDT. He suggested a detailed central auditory nervous system (CANS) examination if the scores were less than 80%. He reported that the test was relatively unaffected by peripheral hearing loss.

Rodriguez, Sarno and Hardiman (1990) reported decrease in performance with advancing age. They administered the DDT on normal hearing, cognitively intact elder adults. They scored less than 90% on the dichotic digit test. However, a significant REA was observed. Their results indicated that CAPD can occur without a concomitant decline in peripheral sensitivity, cognitive function on linguistic competence.

The DDT has been shown to be sensitive to brainstem and cortical lesions (Musiek, 1983a) as well as to lesions of the corpus callosum. This test yields fairly high scores in individuals who have no auditory processing problems.

Dichotic CV Tests

A more difficult task than DDT is the dichotic consonant-vowel test developed by Berlin, Lowe-Bell, Jannetta and Kline (1972). In this test, stimuli consists of six

CV segments (pa, ta, ka, ba, da, ga). Single CV segments are presented to each ear using a dichotic paradigm and the listener is asked to choose both segments heard from a printed list. Although the test is very lightly linguistically loaded its difficulty lies in the high degree of similarity among the CV segments as well as close acoustical alignment of the stimuli (Niccum, Ruben & Speaks, 1981).

Berlin, Lowe-Bell, Cullen, Thompsons and Loovis (1973) introduced the "lag" procedure using CVs Berlin and his colleagues studied the effect of lagging the CV presented to one ear in reference to the other. Onsets were at 15, 30, 60 and 90 msec lags, and the presentation level was 78 dBSPL (re: 1kHz). Subjects usually responded in a free recall strategy, indicating the appropriate CV through either visual, written or selection from multiple choices (Berlin et al. 1973; Niccum et al. 1981; Porter, Trondle & Berlin, 1976).

Berlin et al. (1973) found a right ear advantage (REA) on simultaneous dichotic presentation of CV syllables. Between 15-30 msec, the leading ear intelligibility dropped. Beyond 30 msec time separation the intelligibility of lag and lead ears improved. Right ear superiority was still seen at 15 msec delay.

Studdert-Kennedy, Shankweiler and Schulman (1970) investigated the effects of delaying channel during dichotic presentation of pairs of CV syllables differing in the initial consonant. Onset time asynchronies were 0, 5, 10, 20, 25, 50, 70 and 120 msec. REA was present at all conditions except at 120 msec lag. If lag to the LE was

20 msec or more, the left ear outperformed the right ear. With increase in lag time, over all score improved. This they termed as lag effect.

Olsen (1983) also found a REA and a lag effect in adult normal hearing subjects. He noted that there was a high variability among subjects for the dichotic CV tasks. He attributed this to the task being difficult.

Normative data on adults aged 18 to 30 years were obtained by Rajagopal (1996) using dichotic CV material developed by Yathiraj (1994) using an 8 bit computer software. The results were consistent with above studies, demonstrating the presence of REA and lag effect in the adult Indian population too. In her study, she found that scores improved from 0 msec to 90 msec lag.

Using the same material as Rajagopal (1996), Ganguly (1996) obtained norms for children aged 8-17 years. She too, found a REA and a lag effect. She found that children in the age group of 13-17 years performed better than those in the age range of 8-12 years. The difference, however, was not significant.

Puranik (2000) developed normative data on adults in the age range of 18-30 years for the dichotic CV test - revised developed by Yathiraj (1999), using a 16 bit computer software. She used various onset time asynchronies of 0 msec, 30 msec, and 30 msec with lag given to either to the right ear or the left ear. Her results showed a REA across different onset time asynchronies. The scores improved with increase in lag time. This improvement in scores was increased from 0 msec to 30 msec, in both right and left lag conditions. Double correct scores were also found to improve with increase in lag time. The improvement was found to be statistically significant only when the lag time was increased from 30 msec to 90 msec and from 0 msec to 90 msec in the right lag condition. In the left lag condition, she found a statistically significant improvement only when the lag time was increased from 0 msec to 90 msec.

Normative data on children for the dichotic CV test- revised, developed by Yathiraj (1999) was obtained by Krishna (2001) in the age range of 7-11 years. She used a procedure similar to that of Puranik (2000). She reported that the single correct score revealed significant REA both at simultaneity and across different onset time asynchronies. Her findings revealed statistical improvement in scores when the lag increased from 0 to 90 msec in both right and left lag condition. She also reported that overall scores were lower than that obtained on adults by Puranik (2000).

Thus, the dichotic CV in normals show a REA with a lag effect. They also have higher single correct scores which are less variable compared to double correct scores. However, most of the studies have found a high intersubject variability, reflecting upon the difficulty of the dichotic CV task.

The dichotic CV test has been shown to be sensitive to cortical lesions; however, as in many central tests, laterality of dysfunction cannot be determined by the test results (Berlin, Cullen, Berlin, Tobey & Mouney, 1975, cited in Musiek & Pinhiero, 1985; Olsen, 1983).

Staggered Spondaic Words (SSW)

SSW test was first described by Katz (1962, cited in Katz, 1994). SSW is composed of two spondees with a staggered onset. The last half of the first spondee and the first half of the second spondee are presented dichotically, while the remaining spondee segments are presented in isolation to opposite ears.

SSW stimuli are arranged in a manner such that spondaic words are presented in 4 conditions. They include the Right Non Competing (RNC), Right Competing (RC), Left Competing (LC) and Left Non Competing (LNC).

SSW is administered at 50 dBSL (reference PTA or SRT). Stimuli presentation is alternated between left leading and right leading. The listener is required simply to report the words heard. Scores obtained include the Raw SSW Score (R-SSW) which indicates the percentage of errors obtained in each of the 4 conditions (RNC, RC, LC, LNC), percentage of error by ear; and total % of errors. These numbers are converted to the C-SSW score, using a correction chart.

Amerman and Pamell (1980) administered the SSW test on normal hearing adults aged 60-79 years. They found a reduced response accuracy and increased variability in comparison to younger subjects. There was a non-significant correlation between age and SSW scores which suggests minimal change in these central auditory functions tested by the SSW for these subjects. Katz (1968); Katz (1977); Arnst (1981) and Arnst (1982) found that corrected SSW scores increased as a function of age, consistent with the central aging effect reported in literature for older population.

The SSW and dichotic CV test were administered on children aged 6-8 years by Harris, Keith and Novak (1983). Based on their performance on the token test, children were divided into two groups, as those having normal scores and those having below normal scores. They found a significant difference between the two groups on the right competing and the left competing conditions of the SSW. They reported that below average SSW performance indicated delayed maturation of the auditory system in these children.

The SSW has been shown to be sensitive to brainstem and cortical lesions (Katz, 1962, cited in Katz, 1994). In addition the test is relatively resistant to peripheral hearing loss (Arnst, 1982; Katz, 1968) and is simple enough to use with a variety of ages (Katz, 1977).

Dichotic rhyme test (DRT)

The DRT test was introduced by Wexler and Hawles (1983) and modified by Musiek, Kurdziel-Schwan, Kibbe, Gollegly, Baran, and Rintelmann (1989). The DRT is composed of rhyming, consonant- vowel - consonant 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. The stimuli are perfectly aligned so that fusion takes place and the listener most often hears just one of the two words presented.

DRT are administered at 50 dBSL (reference spondee threshold). The test consists of the presentation of 30 pairs of rhyming, CVC words. Due to the close temporal alignment of the stimuli, the listener will typically hear and report to just one word each stimulus presentation, resulting in an individual ear score of near 50%. The scores are expressed in terms of percentage correct per ear.

Musiek et al. (1989) administered the DRT on 115 normal subjects and obtained a mean of 30-73% for the right ear and 27-60% for the left ear. Bellis (1996) reported a study which indicated slightly smaller range of scores than those of Musiek et al. (1989). Bellis (1996) reported normative values of 32-60% per ear. Scores below or above these value should be considered abnormal.

The DRT has been shown to be particularly sensitive to detection of dysfunction in the interhemispheric transfer of information via the corpus callosum (Musiek et al., 1989).

Competing sentence test (CST)

The CST developed by Willeford (1968, cited in Willeford & Bureigh, 1985). The test comprises 25 pairs of simple sentences that are 6 and 7 words in length. The target sentence is present to one ear at a quieter level i.e., 35 dBSL (reference SRT) than the competing sentence, which is presented to the other ear at 50 dBSL (reference: SRT). The subject has to repeat only the target sentence and ignore the competing sentence.

Willeford and Burleigh (1985) used a method where responses were scored as incorrect when the response either included significant intrusions of words from the competing message or if there was no response. They reported normative values in children aged 5 to 10 years. They found a score of 100% in the "strong" (usually right) ear, whereas scores in the "weak" (usually left) ear may range from 0 to 100% improving with increasing age of the child.

Bellis (1996) used a scoring method where responses were scored in terms of quadrants correct. Using this scoring method with 150 listeners between the ages of 8 years to adult, normative values were developed, which showed that the right ear scores on the CST reach adult values by age 9, whereas left ear scores demonstrate a maturation effect only at age 11.

Ivey (1969, cited in Medwetsky, 2002) found that the CST was a very easy task for the subjects and that the right ear showed a slightly better performance than the left ear. All subject in his study got a 100% score on the CST.

Lynn and Gilroy (1975, cited in Willeford & Burleigh, 1985) reported 20 normal subject achieved 100% discrimination scores for the primary message for each ear in the presence of competing sentences in the opposite or non-test ear.

The sensitivity of CST as compared to other dichotic measures in the identification of cortical lesions has been questioned by a number of researcher (Lynn & Gilroy, 1972, 1975, cited in Willeford & Burleigh, 1985; Musiek, 1983b). However it has been suggested that dichotic sentence tasks such as the CST may be valuable in investigating neuromaturation and language processing abilities (Porter & Berlin, 1975; Willeford & Burleigh, 1985).

Synthetic Sentence Identification with Contralateral Competing Message (SSI-CCM)

The SSI-CCM was first described by Jerger and Jerger (1974, 1975). Stimuli for SSI-CCM are 10 third-order approximations of English sentences. The stimuli resemble nonsense sentences, thus lightening the linguistic load of the test. The sentences are presented to the target ear at 30 dBHL while a competing message consisting of continuous discourse are presented to the contralateral ear which is varied from 30 dB HL (0 dB signal to noise ratio [S/N]) to 70 dBHL (-40 dB S/N). The listener is given a list on which all 10 sentences are printed, and he or she is required to identify the sentence heard by number. Score is reported in terms of percentage correct per ear. The CCM score is considered to be either the score obtained in the most difficult condition (-40 dB S/N), or the average of the S/N conditions tested.

Jerger and Jerger (1974, 1975) administred the SSI-CCM on normal subjects. They found that all subjects obtained 100% scores in all message to competition ratio from 0 to 40 dB, varied in 20 dB steps. The SSI-CCM has been found to be useful in differentiating brainstem from cortical pathology (Jerger & Jerger, 1975; Keith, 1977).

Variation on this test included addition of a speech spectrum noise at —6 dB relative in the competing message to fill in the pauses (Martin & Mussell, 1979) and the substitution of a four talker babble in place of the Davy Crockett Story in an effort to eliminate the acoustic windows (Beattie & Clark, 1982).

Thus, there are variety of tests available for assessment of CAPD with various hit rates for specific area dysfunction in CANS. The dichotic CV test in particular assess the central auditory process of binaural integration. Diversity of results may be anticipated, since these tests are sufficiently different in number of aspects to represent rather different linguistic/ auditory tasks, even though they all employ some form of dichotic paradigm. The reviews of literature on dichotic CV test reveals that it is an especially sensitive test for detecting cortical lesions, and is probably one of the most widely used dichotic tests.

METHOD

The present study aimed at obtaining normative data on the "Dichotic CV Test-Revised: CD Version" developed by Yathiraj (1999). Another purpose of the study was to compare the normative data obtained in the present study with that obtained by Puranik (2000) on a tape- recorded version of the same test.

SUBJECTS:

The subjects for the study were 50 normal young adults in the age range of 18 to 30 years, 25 of whom were males and 25 females.

SUBJECT SELECTION CRITERIA:

The subjects selected for the study had:

- No known history of hearing loss
- No chronic otologic problem
- No neurologic problems or trauma to the brain
- No previous experience with dichotic listening tasks
- Right - handedness
- Pure-tone thresholds less than 15 dB in both ears , in the frequency range of 250 to 8000 Hz for air conduction and 250 to 4000 Hz for bone conduction
- Scores on "A common speech discrimination test for Indians" (Mayadevi, 1974) between 90 -100% in both ears, when presented at 40 dBSL
- Ability to read Kannada/English scripts

INSTRUMENTATION:

Preliminary testing was done using the clinical audiometer Madsen OB922 coupled with TDH-39 earphones housed in MX-41/AR ear cushions and the bone vibrator Radio Ear-B-71.

For the dichotic CV test, a CD consisting of the dichotic lists were played on Philips AZ2160V Audio Video CD player. The signal from the player was fed to the tape input of the audiometer Madsen OB 922. The output of the audiometer was given to TDH-39 earphones housed in MX-41/AR ear cushions.

The audiometer was calibrated for air conduction, bone conduction & CD input to conform to ANSI standards (ANSI 1989).

MATERIAL:

The materials used were dichotic consonant-vowels. Five lists were used with each list consisting of 30 standardized pairs of the syllables /pa/, /ta/, /ka/, /ba/, /da/, and / *gal.* The test material was developed by Yathiraj (1999) at the All India Institute of Speech and Hearing, Mysore using the Audiolab software.

The test has the following 5 sub-tests with each consisting of 30 pairs of test items:

1) 0 msec onset, where both syllables were given simultaneously to both ears.
2) 30 msec left channel lag, where the stimulus to the left ear was given with a lag of 30 msec with reference to the right ear.

3) 30 msec right channel lag, where the stimulus to the right ear was given with a lag of 30 msec with reference to the left ear.
4) 90 msec left channel lag, where the stimulus to the left ear was given with a lag of 90 msec with reference to the right ear.
5) 90 msec right channel lag, where the stimulus to the right ear was given with a lag of 90 msec with reference to the left ear.

A calibration tone of 1kHz was recorded prior to each list. The computer generated list was downloaded onto a CD.

PROCEDURE FOR SUBJECT SELECTION:

Puretone audiometry was done for all subjects prior to the dichotic CV test. Only those who got thresholds less than 15 dB in air conduction and bone conduction were administered the dichotic CV test.

The Common Speech Discrimination Test for Indians developed by Mayadevi (1974) was presented monotically to each ear separately. Those who obtained more than 90% scores in each ear were selected. Scores were recorded in a scoring sheet (Appendix B).

PROCEDURES FOR OBTAINING NORMATIVE DATA:

Subjects who passed the selection criteria mentioned above were administered the dichotic CV test. The 1kHz calibration tone was used to adjust the VU meter to "0".

The dichotic stimuli were presented at 50 dB HL through TDh-39 earphones housed in MX-41/AR ear cushions.

The subjects were asked to respond on a multiple choice scoring sheet by marking (v) the two CV's heard among six alternatives. Subjects were asked to guess if they were unsure of the responses.

SCORING:

Responses were scored in terms of single correct and double correct scores. A single correct score was given when the subject reported the syllable presented to any one ear correctly. A double correct score was given when the subject reported the syllables presented to both ears correctly. The scores were recorded on a scoring sheet (Appendix A).

ANALYSIS:

The raw data was subjected to statistical analysis where the mean, range and standard deviation was calculated. The t-test was used to find out significance of difference between the means.

RESULTS AND DISCUSSIONS

The current study was carried out with the aim of determining whether the dichotic CV test - revised: CD version, developed by Yathiraj (1999) is different from the taped version of the same test. The data was collected on 25 females and 25 males and subjected to statistical analysis using the software program SPSS version 10.0.5. The analysis was done for the following parameters:

I) Single correct scores:

(A) Single correct scores at simultaneity

(B) Single correct scores across onset time asynchronies

(a) Comparison between right and left ears at simultaneity

(b) Comparison of single correct scores across lag conditions

II) Double correct scores

III) Male Vs female scores at simultaneity

IV) CD version Vs Taped version

1) **SINGLE CORRECT SCORES**

A) Single correct scores at simultaneity

Table 1: Left ear Vs. Right ear scores at simultaneity.

Ear	Mean	SD	Range	t-Score	Level of Significance
Right	27.68 (92.%)	1.68	23-30	5.47	0.00
Left	25.98 (87%)	2.10	22-30		

Max. Score = 30

Table 1 gives the mean, SD, range and t-scores with the level of significance for the single correct scores at simultaneity. As seen from table 1, the right ear scores are significantly higher than the left ear scores (0.00 level) as simultaneity. Thus, table 1 reveals that there was a significant right ear advantage (REA) in the subjects tested.

Studdert-Kennedy et al. (1970), Berlin et al. (1973), Olsen (1983) and Bingea and Raffin (1986) also reported a REA in normal subjects. Similar results on the Indian population were reported by Rajagopal (1996), Ganguly (1996) and Puranik (2000) and Krishna (2001).

* The REA is seen in normals because the left anterior temporal lobe is closer to the left primary speech area than the right anterior temporal lobe (Berlin et al., 1973). Due to this, there would be lesser "transmission loss" to the left posterior temporal lobe, on the basis of proximity within the area of the brain. As a result, there is more efficient interaction between the shorter pathways, giving rise to a REA.

Kimura (1967, cited in Berlin, Lowe-Bell, Culen, Thompson & Loovis, 1973) theorized that the contralateral pathways are stronger and more numerous than are the ipsilateral pathways. When the dichotic auditory stimuli are presented the ipsilateral pathways are suppressed by the stronger contralateral pathways. She attributed the REA to bilateral asymmetry in brain function. The REA is, therefore, a reflection of the hemispheric dominance.

B) Single correct scores across onset time asynchronies

a) Comparison between right and left ear scores:

Table 2: Right ear Vs Left ear scores at different onset time asynchronies.

Lag time	Ear	Mean	SD	Range	t-Score	Level of significance
30 msec left lag	R	27.34 (91%)	1.98	23-30	5.77	0.00
	L	26.48 (88.%)	1.88	23-30		
30 msec right lag	R	27.78 (93%)	1.71	24-30	3.92	0.00
	L	26.32 (88%)	2.16	23-30		
90 msec left lag	**R**	28.14 (93%)	1.60	23-30	5.77	0.00
	L	26.36 (89%)	2.31	23-30		
90 msec right lag	**R**	28.30 (94%)	1.29	26-30	6.33	0.00
	L	26.02 (87%)	2.28	23-30		

Max. Score = 30

Table 2 depicts the mean, SD, and range of the right and left correct scores at different lag times, along with the t-scores and level of significance. It is evident from the table that the right ear scores were significantly higher than the left ear scores at the two lag times (30 msec and 90 msec) for both the right and left lag conditions. Thus, a REA was seen irrespective of the ear to which the lag was presented. This, findings implies that the right ear advantage is so robust that it is not overcome even with a lag in the opposite ear. This in turn reflects the superiority or dominance of the left hemisphere in processing speech information.

The results of the present study are contradictory to those obtained by Berlin et al,(1973) and Studdert-Kennedy et al. (1970). Berlin et al. (1973) reported that the right ear scores were higher than the left ear scores, only if the lag was to the right ear. Higher left ear scores were obtained if the lag was given to the left ear. Studdert-Kennedy et al. *(1910)* reported that when the left ear lag was greater than 20 msec, the right ear superiority was abolished.

However, Bingea and Raffin (1986) found a REA at all lag times in both right and left ear lag conditions. The present study is also in agreement with Puranik (2000) who found similar results for both right and left ear lag conditions.

b) Comparison of single correct scores across lag condition.

i) Right ear lag:

Table 3 compares the single correct scores at simultaneity and across onset time asynchronies when the lag was given to the right ear. Analysis was done to find out whether there was any significant improvement in the single correct scores in the right lag condition as the lag time increased.

Table - 3: Comparison of single correct scores (raw scores) at simultaneity and across onset time synchronies in the right lag condition.

Lag time	Comparison between lag times	Mean scores	t-Score	Level of significance
Right ear scores	0 msec	27.68	0.38	Not significant
	30 msec	27.78		
	0 msec	27.68	2.45	0.01
	90 msec	28.30		
	30 msec	27.78	2.05	0.01
	90 msec	28.30		
Left ear scores	0 msec	25.98	0.80	Not significant
	30 msec	26.32		
	0 msec	25.98	0.12	Not significant
	90 msec	26.02		
	30 msec	26.32	0.70	Not significant
	90 msec	26.02		

Max score = 30

From table 3 it is evident that there was a statistically significant improvement in scores in the right ear when lag was increased from 0 to 90 msec and 30 to 90 msec. This indicates that as the lag time increased in the right ear, the single correct scores steadily increased in the right ear. The lag had to be large (i.e 90 msec) before a statistical significant score could be seen. However, no such significance was obtained for the left ear scores between any lag conditions.

The above results can be explained on the basis of left hemisphere dominance. As the lag to the right ear is increased, the left hemisphere gets more time to process the syllable going to the right ear, and hence the right ear scores improve in right lag condition. Berlin et. al. (1973) also reported that intelligibility of the right ear improves when the lag is beyond 30 msec in the right ear.

ii) Left ear lag:

Table 4: Comparison of single correct scores (raw scores) at simultaneity and across onset time asynchronies in the left lag condition.

Ear	Comparision between lag times	Mean	t-Score	Level of significance
Right ear scores	0 msec	27.68	0.95	Not significant
	30 msec	27.94		
	0 msec	27.68	**1.73**	Not significant
	90 msec	28.14		
	30 msec	27.94	0.71	Not significant
	90 msec	28.14		
Left ear scores	0 msec	25.98	2.16	0.05
	30 msec	26.48		
	0 msec	25.98	1.06	Not significant
	90 msec	26.36		
	30 msec	26.48	**0.40**	Not significant
	90 msec	26.36		

Max score = 30

Table 4 shows a comparison of single correct scores at 0 msec, 30 msec and 90 msec when the lag was given to the left ear. In the left ear score, a statistically significant improvement was seen when the lag increased from 0 to 30 msec. Except for this, no such significance was found in the left ear when the lag time was increased from 0 to 90 msec and 30 to 90 msec. The right ear score did not improve significantly as the lag was increased in the left ear.

Thus introduction of a lag in a particular ear, did result in an improvement in scores in that ear to some extent. However, this increase in score was not sufficient to overcome the robust right ear advantage, which is evident in table 2.

Bingea and Raffin (1986) also found an increase in the single ear scores as the onset time asynchronies were increased. They too noted that a lag in the left ear did not result in an improvement in the left ear scores in most of their subjects.

II DOUBLE CORRECT SCORES:

Table 5 depicts the mean, SD and range for double correct scores at simultaneity and across onset time asynchronies, along with score in percent. The t-score was calculated to compare the double correct scores at each lag time when it was in the two opposite ears.

Table - 5: Double correct scores at simultaneity and across lag times.

Lag time	Mean	SD	Range	t score	Level of significance
0 msec	23.84 (79%)	3.05	17-30	-	-
30 msec right lag	24.12 (80%)	2.81	20-29	1.869	Not significant
30 msec left lag	24.66 (82%)	3.00	20-30		
90 msec right lag	24.18 (81%)	2.84	20-29	1.123	Not significant
90 msec left lag	24.62 (82%)	3.08	20-30		

Max score = 30

The double correct scores (table 5) are found to have a lower mean value and more variability when compared to the single correct scores (table 4). This implies that it is more difficult to correctly identify both syllables presented dichotically, than to identify any one of the two, which is why the variability in scores was found to be more in the double correct scores. The variability for the double correct scores was less in the right lag conditions when compared to the 0 msec lag condition and the left lag condition. However, when the left lag condition was compared to the right lag condition, at each of the asynchronies, it was found that there was no significant difference in the double correct scores between the left and right lag condition. This was seen for both 30 msec and 90 msec lag conditions. Thus the ear in which the lag was given did not make difference in the double correct scores.

These findings are supported by Bingea and Raffin (1986) who found wide intersubject variability for double correct scores. Puranik (2000) also found the double correct scores to have more variability than the single correct scores. However, she did not find any specific trend when the lag was in the left ear or right ear.

Table - 6: Comparison of double correct scores across different onset time asynchronies and lag conditions.

Lag Ear	**Comparison between lag tmes**	**Mean scores**	**t-Score**	**Level of Significance**
Right	0 msec	23.84	0.79	Not significant
	30 msec	24.12		
	0 msec	23.84	0.85	Not significant
	90 msec	24.18		
	30 msec	24.12	0.16	Not significant
	90 msec	24.18		
Left	0 msec	23.84	2.99	0.05
	30 msec	24.66		
	0 msec	23.84	2.11	0.05
	90 msec	24.62		
	30 msec	24.66	0.12	Not significant
	90 msec	24.62		

Max score =30

Table 6 compares the double correct scores obtained at different onset time asynchronies in the right and left lag conditions.

(i) Right ear lag: The double correct scores improved as the lag to the right ear increased from 0 to 30 msec, 0 to 90 msec and 30 to 90 msec. However, no significant improvement was seen when the lag to the right ear was increased from 0 to 30 msec, 0 to 90 msec and 30 to 90 msec.

(ii) Left ear lag: The double correct scores showed an improvement as the lag to the left ear increased from 0 to 30 msec and 0 to 90 msec. This improvement was significant at 0.05 level. No statistically significant improvement was seen when the lag to left was increased from 30 to 90 msec.

Bingea and Raffin (1986) reported that double correct scores improved significantly in 60% of subjects when lag was increased from 30 to 120 msec. 57% showed significant improvement in scores when lag was increased from 0 to 120 msec and 40 % showed improvement when lag was increased from 0 to 90 msec. An increase in overall double correct scores have also been reported by Berlin et al., (1973), Studdert-Kennedy et al., (1970) and Bingea and Raffin (1986) with increase in lag time.

IIP COMPARISON BETWEEN SCORE IN MALES AND FEMALES:

Table 7: Comparison of single correct scores of males and females at simultaneity.

Ear	Gender	Mean	SD	Range	t-Score	Level of Significance
Right	Female	27.88 (93%)	1.78	23-30	0.83	Not significant
	Male	27.48 (92%)	1.58	24-30		
Left	Female	25.96 (87%)	2.47	22-30	0.06	Not significant
	Male	26.00 (87%)	1.70	23-28		
Right ear minus Left ear scores	Female	1.92	2.70	19-30	0.70	Not significant
	Male	1.48	1.55	17-28		

Max score = 30

Table 8: Comparison of double correct scores of male and female at simultaneity.

	Gender	Mean (%)	SD	t-Score	Level of Significance
Double correct scores	Female	24.32 (81.0%)	2.35	1.112	Not significant
	Male	23.36 (78%)	3.14		

Max score = 30

Table 7 and 8 shows the gender effect of right and left ear single correct scores, difference of right and left ear scores and the double correct scores. None of these parameters were statistically significant even at the 0.05 levels. These indicate that there is no sex difference in the scores between males and females. Jerger, Chmiel, Allen and Wilson (1973) also reported no sex difference in their subjects between the age range of 9 to 49 years. They, however, reported of a difference in both free report and directed report mode in their older subjects (50 -91 years). In this group the difference between mean ear scores were smaller in females therin males. The average differences in ears were almost 30 % for males but only about 10% for females. Their findings in their younger subjects support the results of the present study.

IV) CD VERSION VS TAPED VERSION OF THE DICHOTIC C V TEST.

Puranik (2000) developed normative data on adults for the dichotic CV test - revised developed by Yathiraj (1999). She used a taped version of the test. She studied fifty normal hearing adults in the age range of 18 to 30 years.

Table 9: Comparison between Mean, SD and range of single correct scores (raw scores) obtained in the present study and those obtained by Puranik (2000).

Lag time	**Ear**	**Mean**		**SD**		**Range**		**t-Score**	**Level of Significance**
		I	II	**I**	II	I	II		
0 msec	**R**	27.46	27.68	1.76	1.68	23-30	23-30	0.80	Not significant
	L	25.82	25.98	2.98	2.10	19-30	22-30	0.31	Not significant
30 msec right lag	R	28.06	27.78	1.71	1.71	23-30	24-30	0.81	Not significant
	L	26.16	26.32	2.66	2.16	19-30	23-30	0.33	Not significant
30 msec left lag	R	27.82	27.94	2.24	1.98	17-30	23-30	0.28	Not significant
	L	25.78	26.48	2.87	1.88	17-30	23-30	1.4	Not significant
90 msec right lag	R	28.22	28.30	1.59	1.29	23-30	26-30	0.27	Not significant
	L	26.88	26.02	2.36	2.28	21-30	23-30	2.25	Significant at 0.05
90 msec left lag	**R**	28.36	28.14	1.63	1.60	22-30	23-30	0.68	Not significant
	L	26.02	26.36	2.71	2.31	20-30	23-40	0.67	Not significant

Max. score = 30

I: Puranik (2000)

II: Present study

Table 10: Comparison between means SD and range of double correct scores (raw score) obtained in present study and those obtained by Puranik (2000).

Lag time	**Mean**		**SD**		**Range**		**t-Score**	**Level of Significance**
	I	II	**I**	**II**	**I**	II		
0 msec	23.46	23.84	3.69	3.05	15-30	17-30	0.56	Not significant
30 msec right lag	23.98	24.12	3.73	2.81	15-30	20-29	0.21	Not significant
30 msec left lag	24.36	24.66	3.66	3.00	15-30	20-30	0.04	Not significant
90 msec right lag	25.08	24.18	3.06	2.84	18-30	20-29	1.5	Not significant
90 msec left lag	24.56	24.62	3.29	3.08	16-30	20-30	0.09	Not significant

Max score= 30 I -Puranik (2000)

II-Present study

Table 9 and 10 gives the comparison between the single correct (right and left) and double correct scores respectively, as obtained by Puranik (2000) and in the present study. From table 9 it is clear that the single correct (mean) scores obtained from present study are higher than those obtained by Puranik (2000) in seven of the ten parameters that were compared. The three parameters where the study by Puranik (2000) had higher scores were the right ear 30 msec right channel lag, left ear 90 msec right channel lag and right ear 90 msec left channel lag. However, all but one of these parameters were not statistically significant. There was significant difference observed in left ear 90 msec right channel lag, where the scores obtained by Puranik

(2000) was better than the scores obtained in present study. This was significant at 0.05 level.

The mean double correct scores were marginally higher in the current study compared to that obtained by Puranik (2000) except for 90 msec right channel lag. However as with the single correct scores, these difference in scores were not statistically significant. Similar to the single correct score the SD was higher and the range wider in the earlier study. This is evident from the larger SD and wider range in Puranik's (2000) study

From these findings it can be observed that the CD version of the revised dichotic CV test does not yield statistically significant higher mean scores when compared to the tape version of the test. However, the variability in the test scores reduces with the use of the CD version.

Thus the result of the study can be summarized as:

- There was a significant right ear advantage found at simultaneity and across different onset time asynchronies, both for the single and the double correct scores.
- The single and the double correct scores improved when lag time was increased. No significant difference were observed in the scores of males and females in both single and double correct scores.
- The scores obtained in the present study were less variable and slightly higher compared to those obtained by Puranik (2000).

SUMMARY AND CONCLUSIONS

The present study was carried out with the aim of developing normative data on adults for Dichotic CV Test -Revised: CD Version, developed by Yathiraj (1999). The study also compared the performance of males and females on dichotic CV test at simultaneously. In addition the findings of the present study was compared to that of Puranik (2000) to see if there was any significance difference between a tape and CD version of the test. Puranik (2000) had obtained norms using a taped version of the same test.

Subjects for the study were fifty normal hearing, right handed adults, ranging in age from 18-30 years. None of them had a history of any otologic or neurologic problems. All of them were tested to enable normal hearing prior to the administration of the test. The table involved identification of dichotic nonsense CV syllables presented at simultaneity and across onset time asynchronies. The various onset time asynchronies used were 0 msec, 30 msec, and 90 msec, with the lag given either to the right or the left ear.

Scoring was done interms of single correct and double correct scores. A single correct response refers to correct identification of the syllable presented to the right ear or the left ear. A double correct scores response refers to correct identification of the syllables presented to both the ears.

The raw data was statistically analyzed where the mean, S.D and range was calculated. The t-test was used to check the significance of the difference between mean of different parameters.

The results of the study can be summarised as follows:

I) Single correct scores:

i) Analysis of single correct scores at simultaneity revealed a significant right ear advantage. Right ear advantage was also found across different onset time asynchronies. These finding were consistent with those of Berlin et al (1973), Bingea and Raffin, (1986); Olsen, (1983); Studdert - Kennedy et al (1970); Rajgopal (1996); Ganguly (1996); Puranik (2000) and Krishna (2001) who also reported a right ear advantage for dichotic presentation of CV syllables.

ii) Comparing the single correct responses across the onset-time synchronies, it was found that the scores improved with increase in the lag time. This improvement in scores was significant only when the lag was increased from 0 msec to 90 msec and 30 to 90 msec in right ear in right lag condition and 0 msec to 30 msec in left ear in left lag condition.

II) Double correct scores:

Double correct scores was also found to improve with increase in lag time. The improvement was found to be statistically significant only when the lag time was increased from 0 to 30 msec and 0 to 90 msec in the left lag condition.

In general, the double correct scores were lower than single correct scores at simultaneity as well as across onset time asynchronies. The variability interms of the SD and range was found to be higher in case of double correct scores when compared to the single correct scores.

III) Comparison between scores in Males and females:

The performance of males and females were compared in terms of single correct scores, double correct scores and ear difference at simultaneity. No significant difference was found between the performance of males and females.

IV) Comparison with findings of Puranik (2000)

The scores of the present study were compared with those of Puranik (2000), who developed normative data on adults for dichotic CV material using a taped version of the same test. It was found that scores obtained in the present study were in general higher than those obtained by Puranik (2000), but these improvement in scores is not statistically significant. Scores in the present study were less variable compared to those reported by Puranik (2000) in terms of range. This difference in scores can be attributed to the use of CD version which gives slightly higher scores compared to taped version.

The findings of the present study are comparable to that of studies carried out abroad as well as in India (Berlin et al., 1973; Bingea & Raffin, 1986; Ganguly, 1996; Krishna, 2001; Puranik, 2000; Studdert-Kennedy et al., 1970).

The test can be used to differentiate adults having an auditory processing problem from those who do not, based on the normative data provided in this study.

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APPENDIX A

RESPONSE SHEET

Lag condition

1	PA	TA	KA	BA	DA	GA
2	PA	TA	KA	BA	DA	GA
3	PA	TA	KA	BA	DA	GA
4	PA	TA	KA	BA	DA	GA
5	PA	TA	KA	BA	DA	GA
6	PA	TA	KA	BA	DA	GA
7	PA	TA	KA	BA	DA	GA
8	PA	TA	KA	BA	DA	GA
9	PA	TA	KA	BA	DA	GA
10	PA	TA	KA	BA	DA	GA
11	PA	TA	KA	BA	DA	GA
12	PA	TA	KA	BA	DA	GA
13	PA	TA	KA	BA	DA	GA
14	PA	TA	KA	BA	DA	GA
15	PA	TA	KA	BA	DA	GA
16	PA	TA	KA	BA	DA	GA
17	PA	TA	KA	BA	DA	GA
18	PA	TA	KA	BA	DA	GA
19	PA	TA	KA	BA	DA	GA
20	PA	TA	KA	BA	DA	GA
21	PA	TA	KA	BA	DA	GA
22	PA	TA	KA	BA	DA	GA
23	PA	TA	KA	BA	DA	GA
24	PA	TA	KA	BA	DA	GA
25	PA	TA	KA	BA	DA	GA
26	PA	TA	KA	BA	DA	GA
27	PA	TA	KA	BA	DA	GA
28	PA	TA	KA	BA	DA	GA
29	PA	TA	KA	BA	DA	GA
30	PA	TA	KA	BA	DA	GA

APPENDIX B

SCORING SHEET

Date-

Name: Mother Tongue:

Age / Sex: Other Language(s):

Education: Socio-economic Status:

AUDIOLOGICAL EVALUATION

EAR	FREQUENCY IN Hz								
	250	500	1000	2000	4000	8000	PTA	SRT	PBMax
Rt.									
Lt.									
BC									

Monotic Scores (%):

Right ear: Left ear:

Dichotic Scores (%):

R L	**R L**	**R L**	**R L**	**R L**