DICHOTIC RHYME TEST IN HINDI: A NORMATIVE DATA ON ADULTS

Adarsh

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MAY, 2014.

Dedicated To

My Family & My Guide

CERTIFICATE

This is to certify that this dissertation entitled "**Dichotic Rhyme Test in Hindi:** A normative data on adults'' is a bonafide work submitted in part fulfilment for the Degree of Master of Science (Audiology) of the student (Registration No.: 12AUD001). This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any of the University for the award of any other Diploma or Degree.

Mysore

May, 2014

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CERTIFICATE

This is to certify that this dissertation entitled "**Dichotic Rhyme Test in Hindi: A normative data on adults''** has been prepared under my supervision and guidance. It is also certified that this has not been submitted earlier in other University for the award of any Diploma or Degree.

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DECLARATION

This is to certify that this dissertation entitled "**Dichotic Rhyme Test in Hindi:A normative data on adults**" is the result of my own study under the guidance of Prof.K.Rajalakshmi, Professor in Audiology, Department of Audiology, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier in other University for the award of any Diploma or Degree.

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CHAPTER 1- INTRODUCTION

Central Auditory Processing (CAP) very concisely stated, central auditory processing may be explained as “what the brain does with what the ears hear” (Katz, 1994).

Central auditory processing disorder (CAPD) is a broader term which refers to the abnormal way of auditory information processing by brain and it can be seen in a variety of disorders. Individuals with APD usually have normal structure and function of the outer, middle and inner ear (peripheral hearing). Being normal structurally however do not allow individuals with CAPD to enjoy those complex acoustic signals like speech, rather ends up in uneasy effort to recognize and interpret sounds. This rare scenario is believed to be an outcome of abnormal auditory processing at the level of central auditory nervous system may or may not be associated with such abnormal processing by other sensory system as well.

Auditory processing disorder can be developmental or acquired. The root cause of CAPD can be drawn as ear infections, head injuries or neuro-developmental delays that affect processing of auditory information. Individuals with abnormal auditory processing eventually face threats to their foundation of listening which can be read as difficulty in sound localization and lateralization, auditory discrimination, auditory pattern recognition, temporal aspects of audition, auditory performance in competing acoustic signals and with degraded acoustic signals.

The numerous symptoms presented by individuals with CAPD range from unisensory (Auditory alone) to multi-sensory issues. They find it quite difficult to understand information given orally, probably due to the impaired attention and memory skills. However, they can do better with augmenting visual cues. Similarly they find it really hard to break the multiple commands owing to their slow processing speed and impaired listening skills. Other related arenas where they face serious issues due to impaired auditory processing includes scholastic performance, inappropriate behaviour, language development, reading, comprehension, spelling, and vocabulary (NIDCD). However, there is no one to one connection or cause-effect relation between CAPD and the possible arenas affected as listed above. It results from impaired neural function and is characterized by poor recognition, discrimination, separation, grouping, localization, or ordering of speech sounds (UK Medical Professionals Committee).

CAPD is a diverse topic, with numerous controversies holding strong pillars in assessment as well as rehabilitation. Since the number of auditory and non-auditory processes affected in any given individuals with CAPD can vary in terms of its nature, stability and appearance, there comes the need for test battery approach to tackle auditory processes affected along with its depth, nature and co morbidity. Both behavioural and electrophysiological tests are developed in quite abundance to choose from different languages. Dichotic listening tests are primarily behavioural tests to assess selective auditory attention as well as hemispheric lateralization of speech sound perception (Ingram, 2007).

There are several number of tests incorporated under the headline dichotic listening tests owing to the strength of these tests to assess different aspects of auditory processing. In general the test materials are presented simultaneously to both ears, however making sure that different stimuli are delivered and performance is evaluated based on the task devised. The different tasks involve binaural integration, binaural separation etc. Binaural integration task require the individual to repeat everything that is heard in both ears. Binaural separation task requires the individual to ignore what is heard in one ear and repeat what is heard in the target ear. Another way of looking into the diversity of dichotic test is through task difficulty parameters. An example of such a diversion is dichotic rhyme test, where the task is made difficult by keeping the purpose in par with many other tests (Bellis, 2002).

For the first time in history Wexler & Halwes (1983) introduced Dichotic rhyme test (DRT) and later on Musiek et al (1989) modified the same for further clinical utility. They devised a new procedure where CVCs used with different initial consonant, but the later VC remained the same. This resulted in a perceptual chaos leading to the response as only one stimuli heard instead of two in majority of the participants (Zatorre & Robert, 1989). Later on researchers found that such a fusion of acoustic information happening at lower central auditory system is owing to the similar spectral shape of two stimuli. This led the investigators to an alternate name for this test as Fused Dichotic word test (Repp in 1976). They found a surprising inter-ear difference in response as right ear scores taking a lead than left ear in right handed participants (Musiek, 1989).

Since the purpose of taking a diversion from conventional dichotic test was to improve on the task difficulty, DRT used only speech materials as target stimuli. In addition the vast chance of manipulating numerous parameters of speech provided another hike in preference of speech stimuli. To increase the bar of clinical task difficulty among dichotic tests, DRT tried linguistically and temporally similar stimuli leading to the possibility of finding out the subtle auditory processing deficits (Speaks, 1974). By using DRT with their participants, investigators unanimously reported that itis highly sensitive for assessing the integrity of inter-hemispheric function of the auditory information (Zattore, 1989; Musiek et al., 1989; Wexler & Halwes, 1985).

Need for the study

Dichotic rhyme test is shown to be sensitive in identifying inter-hemispheric transfer dysfunction (Musiek et. al., 1989, Bamiou, et, al, 2007). It is ideal to perform Dichotic rhyme test in individual's first language as the individual's perception of speech is influenced by his/her first language/mother tongue (Singh 1966, Singh and Black., 1966). Despite its clinical usefulness Dichotic rhyme test is available only in few Indian languages. Dichotic rhyme test is developed in three south Indian languages and it is not available in Hindi language, which is the national language and widely used in Northern India. . Hence, there is a need to develop Dichotic rhyme test in Hindi language.

Aim of the study

1. To develop the Dichotic Rhyme Test using commonly spoken words in Hindi.
2. To establish normative data for the developed Dichotic Rhyme Test on Hindi speaking adults.

CHAPTER 2- REVIEW OF LITERATURE

"Central auditory processing disorder defined as a deficit in the perceptual processing of auditory stimuli in the central nervous system (CNS) and the neurobiological activity underlying that processing" (ASHA, 2005).

Dichotic listening refers to auditory stimuli that are presented to both ears simultaneously, with the stimulus presented to each ear being different. When two different words or messages are presented simultaneously to a listener, one to each ear, most people perceive most of the right ear message accurately. This finding is commonly called as Right Ear Advantage (REA). The magnitude of the right ear advantage is dependent primarily on the instruction given to the subject and linguistic content of the dichotic stimuli (Hugdahl, 1988). There have been five major theory proposed by different authors.

1. Morphologic and Functional Asymmetry of the Brain and Right Ear Advantage

This theory explains the REA in terms of the structural & functional features of the brain.

This theory was proposed by Geschwind and Levitsky (1968) who did post-mortem study on 100 human's brain. He concluded that the normal listener have left brain for speech and language function based on his observation. He found that area behind the Heschl'sgyrus was larger on the left side of the brain in 65% whereas, only 11% were having larger right side brain. The planum temporale was also one third longer in left side compared to right brain. The Wernicke's area which is classically called as auditory association area plays a major role in language function. This area makes a larger part in temporal speech cortex. Hence it is confirmed based on anatomic asymmetries that left hemisphere play a major role for speech and language function.

2. Selective Attention and Dichotic Right Ear Advantage

This theory explains the right ear advantage in terms of selective attention / listening.

Broadbent (1954) explained based on response bias that normal listener elicit first right ear response when information fed to the *right ear*.Many other studies, which have studied the effect of selective listening and strategies on dichotic REA's, asking their subjects to listen selectively to one channel, found altered both the size and direction of REA(Cherry 1953), Moray (1959), Triesman (1960). *Berlin and McNeil (1976)* added "This apparent supremacy of the right ear in dichotic listening cannot be ascribed solely to superior selective attention to one channel over another; we need additional information on why one channel seem to be able *"*to attend more closely" to speech information while the other channel seems "to attend more naturally" to non-speech acoustic information*"*.

3. A memory or storage model and Dichotic right ear advantage

This theory explains the REA in terms of memory.

Kimura (1961) and Milner (1962) have reported poorer verbal recall in individuals with left temporal lesion and poorer musical pattern recall in individuals with right temporal lobe lesion. They found that increments in REA when the dichotic message was lengthened. Bakker (1970) have reported superior right ear advantage in monaural listening task when recall task was made either long or complex. YeniKomshian Cordon and Sherman (1973) examined the effect of the memory load on the right ear advantage in dichotic listening. The time interval between stimulus presentation and response was varied.

The results from both experiment show an overall right ear superiority, which was most pronounced in the longest delay condition. With increasing delay times the number of correct responses for the left ear stimuli continued to decrease, while the number of correct responses for the right ear stimuli either levelled off or showed an increase. They also found an increase in the accuracy of the left ear scores while the right ear scores remained the same by reducing memory load.

4) Vocal tract gesture coding and Dichotic right ear advantage:

Study of evolution of the vocal tract in relation the physiological requirements producing the sounds of speech suggests that the man has also evolved matching mechanism for speech perception (Liberman 1968, Watt and Wilson 1969). There is in fact, much evidence that speech perception entails peculiar processes, distinct from those of non speech auditory perception (Studdert, Kennedy and Shankweiler, 1969). Sussman (1971), in a tone tracking task using target tones in the right or left ears (with cursors in the opposite ear) using either the tongue or right hand as controllers, found that the tongue was able to coordinate its movement better when the right ear processed the acoustic results of those tongue movements than left ear processed the acoustic results of the tongue movements. Though there was no dichotic stimulation of speech, the tongue functioned better in working with right ear than the left ear. Such asymmetry was not revealed when the right hand was used. Sussman, McNeilage and Lumbley (1973) reported the similar effects as reported by Sussman (1971) using the Jaw as a tracker.

However, Berlin, Lowe Bell, Cullen, Thompson and Loovis (1973) try to explain the asymmetry found by Sussman (1971) on the basis of proximity between the left hemisphere auditory area and the control centre's for the movement of vocal tract. They add that proximity of the tongue and larynx area in the left hemisphere to both Broca's area and primary and secondary areas of the temporal lobe, might improve the efficiency of interaction of the right ear with any movement of vocal tract.

5) The perceived source of auditory space and dichotic right ear advantage:

Fodor and Bever (1965) found that individual perceives clicks stimuli in left ear earlier than right ear when the individuals were asked to locate the position of the click with respect to an on-going sentence which was later supported by Berlin and McNeil (1976) based on that more efficient left ear to right hemisphere route processing non-verbal signals. However, the relative accuracy of the click placement was the same for either right click or left click condition to generate the perception of location earlier in the sentence than the right clicks, which led Bertelson and Tisseyre (1972) to an unusual but important set of experiments on the nature of this asymmetry. The first experiment in their four experiments replicated the findings of Fodor and Bever (1965) closely, but not exactly (Berlin and Mc Neil 1976).

Bertelson and Tisseyre (1972) attributed the effects to the place of origin of click or speech which led them to design an second experiment where the speech or clicks were given to the midline binaurally at equal sensation levels, while the other stimulus was in either the left, the right, or in the midline, revealing that the click seems to come from a position to the left of the speech(i.e.;earlier click perception than speech) which tended an earlier location, not meaning more accurately in the subjects when the speech was presented to the right ear and click to the midline.

The above findings, again led Bertelson and Tisseyre (1972) to a third experiment where in full head and half head separation listening conditions were created, in which speech was clearly in one ear while the click in the other and speech and click in the midline while the other stimulus was in one ear alone, respectively. A larger asymmetry was revealed due to the perception of clicks to the left of the speech under full head separations then in the half head separation.

This finding led them to fourth experiment with double monotic condition, where in both speech and clicks were presented in the midline revealing again the earlier perception clicks coming from the left of the speech generating a more early perceptions than when the click was either to the right or seemed to come from same source as the speech (Berlin and McNeil 1976).

6) Temporal sequencing and dichotic right ear advantage:

Papcun, Krasher and Terbeck (1972) noted that Morse code operator have large right ear advantage for Dichotically presented Morse code which was later attributed to superiority of the left temporal lobe in handling temporal sequence (Berlin and McNeil, 1976). Efron (1963) believed an active role of temporal lobe in processing all temporal sequences.

Based on the study, by Papcun, Krasher (1972), it is possible to assume a mediation of left hemisphere for sequentially patterned nonverbal sounds. The tasks involving sequential analysis of stimuli seem to be controlled by the left hemisphere. This assumption has the evidence derived from both clinical and experimental studies showing that lesions of the left hemisphere selectively impair the perception of sequential visual and audio-visual stimuli (Corman and Nachson, 1971), and the judgments of simultaneity of visual and tactual stimuli by normal subjects in similarly mediated by the left hemisphere (Efron 1963).

FACTORS AFFECTING DICHOTIC LISTENING:

There are certain factors that influence the performance on DRT. These factors can be majorly divided into

i. Stimulus related factors
ii. Subject related factors
iii. Procedural factors

STIMULUS RELATED FACTORS:

I. Stimulus parameter affecting dichotic listening are :
    - Intensity
    - Frequency
    - Temporal / Lag effects
    - Phonetic effect/Stimulus dominance
    - Effect of masking/ SNR
    - Bandwidth

- Stimulus Material used
- Stimulus familiarity
- Music & non-verbal material
- Reliability

Intensity. Hugdahl et al. (2008) investigated the effect of differences in the right or left ear stimulus intensity on the ear advantage. For this purpose, interaural intensity difference were gradually varied in steps of 3 dB from -21 dB in favour of the left ear to +21 dB in favour of the right ear, also including a no difference baseline condition. 33 right-handed adult participants with normal hearing acuity were tested. The dichotic listening paradigm was based on consonant-vowel stimuli pairs. The result shows (a) A significant right ear advantage (REA) for interaural intensity differences from 21 to -3 dB.(b) No ear advantage (NEA) for the -6 dB difference, and (c) A significant left ear advantage (LEA) for differences from -9 to -21 dB.

They concluded that right ear advantage in dichotic listening to CV syllables withstands an interaural intensity difference of -9 dB before yielding to a significant left ear advantage .The same can hold good for DRT.

Frequency. Studies have reported perceptual asymmetries occur when two different auditory stimuli are presented simultaneously. A right ear advantage is seen for speech stimuli whereas left ear advantage is seen for non speech stimuli. It is thus reasonable to assume that the ear dominance is a result of the material being used.

Kimura (1967) reported a significantly greater number of accurate identification from the left ear than right in an identification task of dichotically presented melodies in 20 normal subjects. Ei.Senson (1969) also supported the findings.

Temporal effects/ Lag effect. When two different auditory signals are presented simultaneously one to each ear, one of them is perceived better than the other. This is known as 'ear advantage'. Apart from this When one signal lags another signal in an ear then lagging signal will be perceived better. The trailing behind/lagging behind of a stimulus in terms of time in perception is called as "Lag Effect".

Lowe (1970) "The concept of the lag effect is mainly based on the onset time." The sound having a larger onset time seems to be preserved better than the sound having the earlier onset. Lag effect may be related to an interruption of the analysis of one syllable by the second syllable.

Phonetic Effects. The better perception of one CV syllable compared with the other regardless of the ear to which it is presented is called the **"**Phonetic effect or Stimulus dominance (SD)**"**. Some consonants seem to elicit a better REA compared to other components. Some vowels are more accurately identified than the others irrespective of the ears which receive them. This is vocalic effect**.** Stimulus dominance is more interesting phenomena in dichotic listening than is the ear advantage.It has been discussed under three categories.

i) Effect of VOT

ii) Place of articulation and manner

Effect of VOT. Porter et al (1976) reported that regardless of ear of presentation, the voiceless syllable was reported correctly compared to the voiced syllable. Speaks et al (1981) reported the dominance of voiceless stops over voiced in dichotic task. Berlin et al., (1973) reported that the scores for voiceless stops |pa|, |ta|, |ka| > voiced stops |ba|, |da|, |ga| in pairs of natural syllables contrasting in voicing in dichotic task. The voiceless stops_are said to be 'dominant' than the voiced stops. In general it can be noted that the syllable arrived later i.e. having later onset times by 30 to 60 msec were better perceived than the syllable which arrived earlier. This may be because of the interruption of the later syllable when the earlier being processed.

The findings were supported by Roser, John and Price (1972); Wiceum, Risburn and Speaks (1981). When left ear received voiceless CV and right ear received voiced CV then REA had been overcome.

Place of articulation and manner. Porter ,Troendle and Berlin (1976) used 6 CV /pa, ta , ka, ba, da, ga/ and paired randomly in dichotic presentation. The result concluded that velars are correctly more than alvelars, which in turn are repeated more correctly than labials (i.e., velars>alveolars> labials).

Speaks et al., (1988) used 8 pairs in which velar competed with non velar (bilabials and alveolar). Results revealed that for 6 of these pairs velars dominated the non velar in dichotic task. Rajgopal et al. (1996) found similar results in her study where velars were best perceived, followed by alveolars and labials in dichotic task.

Speaks, Carney, Niccum, & Johnson, (1981) presented dichotically CVs /pa, ta, ka, ba, da, ga/ at 70 dB SPL in 24 right handed listeners. They found that /pa/> /ba/ due to stimulus dominance of voiceless over voiced. They also found velars> non velars as /ga/> /pa/, /ba/, /da/ (due to stimulus dominance) The conclusion made was in dichotic presentation of CV stimuli- velar place dominates both bilabial and alveolar in terms of place of articulation and voiceless stops dominate voiced stops.

But they also found that /pa/ and /ta/ significantly dominated /ba/ and /da/; /ka/ dominated /ta/, /ba/, /da/, /ga/; both /ba/ and /da/ failed to dominate any syllable,/ta/ did not dominate over /ga/, /ga/ dominated /pa/ (voiced over voiceless). Stimulus dominance did occur for 4/6 pairs where velar place was not represented /pa/>/ba/, /pa/>/da/, /ta/>/ba/, /ta/>/da/. So, stimulus dominance cannot be described completely as a dominance of voiceless over the voiced stops and velar over other place of articulation.

Manner of articulation Speaks (1981) reported that voiceless stops tend to dominate over voiced stops. Speak's finding do not generalize to fricatives. Voye (2011) studied natural fricatives post alveolar /ʃ/, /ʒ/,labiodental /f/ ,/v/ and lingualvelar /s/, /z/ in CV pair. They found that stimulus dominance of post alveolar fricatives over other place of articulation and / ʃ / voiceless dominated over voiced fricative/ʒ/ also dominance of /v/ voiced over /f/ voiceless.

So, pattern of dominance in fricatives might be more complex than that reported in stops. They reported a clear tendency of less frequently used fricatives to dominate over more frequently used fricatives and thus results require replication.

SNR/ masking. Masking has an effect on the performance of Dichotic listening (DL) tasks (Samson, 1973; Cullen & Berlin et al 1976). Samson (1973) reported significant differences on DL tasks when masking noise was introduced monaurally/binaurally. A band limited noise was introduced to one ear during dichotic task, there was a linear suppression of the masked ear and a linear increase in performance in the unmasked ear. Subjects were 24 right handed adult females. The presence of binaural masking showed a linear decrease in performance from 18 SNR to 0 SNR. The right ear performed consistently better in the binaural masking condition. Cullen et al. (1974) that signal was presented at 60 dB SPL and band limiting noise was introduced, with SNR varying from 0 to 30 dB in both channels simultaneously. They found performance decreased with low SNR. Right ear advantage was maintained as long as SNR was varied between two channels with 12 dB SNR difference between channels.

Hugdahl (2008) studied background noise effects on the REA, CV-syllables were presented either in three condition: silence (Baseline), traffic background noise (BNT) and babble background noise (BNC). Both 'babble' and traffic noise resulted in a smaller REA compared to the silent condition. The traffic noise, moreover, had a significantly greater negative effect on the REA than the 'babble', caused both by a decreased right ear response as well as an increased left ear response.

Bandwidth. Thompsen et al., 1974 studied the effect of the bandwidth, when cut-off frequency at 4 kHz right ear was performed better than left ear compare. When cut-off frequency was kept 3 kHz the right ear scores was equal to left ear score. Below 3 kHz cut-off frequency left ear scores was better than right ear score.

Stimulus Material Used. Several test procedures have been developed to measure dichotic listening. All the dichotic speech tests are aimed at reducing both external and internal redundancy. So that it becomes difficult for the subject to respond. Most of the studies reviewed so far used either natural or synthetic stimulus. House et al. (1970) investigated the difference in result due to synthetic Vs natural CVs. They presented same CVs (both natural and synthesized) to some listeners. Their results showed essentially no difference in REA for both synthetic & natural CV.

Stimulus Familiarity. Nachshon & Carmon, (1975) studied the effect of stimulus familiarity on CV syllables, they took 6 consonant (3 familiar) and 4 vowels (2 familiar) The test was done in familiar to non-contexts to left ear and right ear respectively. They found that non familiar showed stronger right ear superiority .This shows Strong effect of stimulus familiarity.

Music and non-verbal material

Kimura (1967) and Cook reported a significantly greater accurate identification from the left ear than right in an identification task of dichotically presented melodies in 20 normal subjects. The result revealed more no. of musical phrases correctly recognized when presented to the left ear than presented to right ear.

Reliability. Practice effects and list effects should be accounted for when using the dichotic tests. A study by Janke (1994) suggests that verbal tasks performed prior to the dichotic listening experiment primes the hemisphere for verbal stimuli resulting in superior dichotic listening performances.

Subject related factors includes

i. Age
ii. Gender
iii. Ear effect

Age. The variations of age in dichotic listening can be referred to as "developmental dichotic listening". The area indicates the age at which the dichotic listening tasks show a hemispheric dominance for speech and language and how the changes occur in dichotic listening with the developmental changes with age and differences between the age groups. Over a decade, a considerable amount of research has been carried out on the effects of aging on right ear advantage (REA) in dichotic listening condition.

Gender. *Bryden* (1988) analyzed the results of a dichotic listening tasks across gender and found that right-ear advantage was seen in 74% of the males & only 50% in the women. Jerger et al. (1994) studied the Dichotic Sentence Identifications (DSI) in ages 50-91 years and found out that older women had poor performance for the right ear when compared with older men. The results suggested that gender difference exist in the effect of age on the left ear deficits.

Bellis & Wilber (2001) studied DDT in 120 healthy adults of different age group Results of this study shows that men begin showing difficulty for dichotic listening tasks between the ages of 35-40, while for women it is postponed until age 55-60. According to Voyer (2011) "Dichotic listening tasks produced homogenous effect. The results showed small and homogeneous sex differences in laterality in favour of men than women."

Ear effect. When the speech is presented dichotically to normal listeners, higher scores are obtained from the material presented to the right ear than to the left ear. Asbornsen(1994) reported that about 90% of the normal right handed population and 60% of left handed population show a right ear advantage.Wilson and Leigh (1996) tested 24 right-handed subjects and 24 left-handed subjects on DCVT. They found that right handed individuals had significant REA.

Procedural factors :

I. PRACTICE EFFECT
II. RESPONSE MODE
III. ATTENTION

Practice effect. Porter et al., (1976) used 6 normally produced CV non sense syllables |ba|, |da|, |ga|, |pa|, |ta| and |ka|. All the eight subjects were asked to identify both stimuli in each trial. Results revealed a slight increase in double correct responses (28% to 38%) and a slight drop in both single correct scores (65%-58%) and neither correct scores (7%

to 4%) over days. The absolute advantage of right ear over left ear did not change significantly over days. Also the absolute magnitude of the voiceless advantage did not change significantly with practice. Velar were most often reported correctly than alveolar which in turn were reported more correctly than labials even after practice. Minetts and McCantry (1979) studied the effect of training on SSW test. He found an increase in the overall correct response as a result of practice.

Response mode. There are evidences that suggest that in humans, the two cerebral hemispheres differ on the degree to which they are involved in processing different kinds of information. Auditory, symbolic, sequential material is best recalled when presented in the right ear and processed in the left cerebral hemisphere (Lackner and Teuber , 1973).

There are two sets of responses

1) Open Set :
2) Closed Set

Olsen and Matkin (1979) reported that the closed set response could be used with disordered population. They suggested that closed set responses provided good estimates of word recognition performance. The review suggests that the closed set response provided higher scores than open set response.

Janke (1973) administered dichotic test of monosyllabic CV in 38 male right handed and 50 male left handed under different response modes - CV verbal, written and pointing conditions. They found that ear advantage scores were not influenced by response mode. Krishna and Yathiraj (2001) studied 10-11 years children on dichotic CV test using two response mode (verbal and written). They found that REA was not influenced by response mode. In summary, it can be said that response mode has a minor role to play in the dichotic listening task.

Attention

Obrzut, Boliek and Obrzut (1986) investigated the effect of directed attention on dichotic listening performance with children. A sample of 12 (5 male, 7 female) were administered four types of dichotic stimuli (words, digits, CV syllables, and melodies) in three experimental conditions (free recall, directed left, and directed right). Results of the study showed REA for words and CV syllables and the expected LEA for melodies were found under free recall, the directed conditions produced varied results depending on the nature of the stimuli.

Directed condition had no effect on recall of CV syllables but had a dramatic effect on recall of digits. Keith et al (1988) examined 28 subjects aged 20-36 years to dichotic listening task, using dichotic CV identification test using 30 pairs of CV non syllables as stimuli. Three directed word listening task was used 1) right directed 2) left directed 3) recall In the directed right ear listening task, there was a right ear advantage with magnitude of 36% whereas for directed left ear listening task it was 21%. In free recall paradigm a small REA of 6.2% was found.

Several studies carried out on children indicate that normal right handed children of various age show a right ear advantage for dichotic verbal stimuli even when instructed to attend to left ear. However, most of studies on directed attention indicate that perceptual asymmetries can be influenced by the effect of attention strategy employed.

Asbjornsen and Bryden (1996) examined the effect of biased attention on the fused dichotic words test (FDWT) and the CV syllables dichotic listening test (CVT). 8 males and 8 females were given both tests with two different instructions: to direct attention to the left ear (DL) or to the right ear (DR) .They found that FDWT is not completely unaffected by attention manipulations, it is far less influenced by such effects than the CVT. This indicates that subject-initiated shifts of attention are much less likely to affect performance on the FDWT than on other dichotic tests and makes it a more valuable task to assess cerebral speech lateralization.

CHAPTER 3- METHOD

The study will be carried out in two phases,

1. Development of test material
2. Establishing normative data for the developed test material.

1. Procedure for developing test material:

Construction of test material:

N pairs (2n members) of bisyllabic Hindi rhyming words were taken from a standard Hindi dictionary. Members of each pair will differed from each other only in the initial syllable.

Familiarity of test stimuli:

These words were given to 10 adult native speakers of Hindi (5males & 5females) to rate on a 5 point rating scale, with the following rates:

0 – Very unfamiliar

1 – Unfamiliar

2 – Quite familiar

3 – Familiar

4 – Very familiar

The rating score of 2 or more was set as the criteria for inclusion of the test material.

Recording of test stimuli:

An adult Hindi native speaker was asked to produce each of this words 3 times in a continuous manner and these words were be recorded using Adobe audition software with a sampling frequency of 44100 Hz and digitization of 16 bits.

Construction of stimulus:

The final portions of each pair was made same using cross-splicing where in the initial distinctive portion of one member of each pair was cross-spiced on to the final, non-distinctive portion of the other member, making the final portion of the members of each pair identical. E.g., in /XXZZ/ -/YYZZ/ the portion of /ZZ/ in either /XXZZ/ or /YYZZ/ will be selected and positioned in both the words, thus the portion /ZZ/ same for both words.

After cross-splicing, the total duration of the rhyming word was made equal by reducing the voicing bars or by reducing the steady state portion of the vowel, of the initial CV portion of the word. Cross-splicing is done to reduce the intrinsic variability among the final syllable in a rhyming pair.

Using Adobe audition 3.0 software, the two members of each rhyming pair was recorded on stereo tracks with 0 milliseconds delay between each member of the pair. Each member of the pair is 10 seconds apart on the stereo track.

Stimuli were placed on a stereo track such that one member of the pair was routed to one ear and the other member of the pair was routed to the other ear. These n rhyming pairs(randomly) along with initial calibration tones was counter balanced (i.e.), in the first n pair if /XXZZ/ was presented to the right ear , and /YYZZ/ was presented to the left ear, then in the second n pair, the channel designation will be reversed, thus a total of 2n pair of stimuli was there. The clarity of the recorded material was checked.

2. Procedure for establishing normative data:

Subjects:30 adult native speakers of Hindi (15 males & 15 females) were considered for the establishment of the normative data.

Subject selection criteria:

The criteria for subject selection for the collection of normative data were as follows:

1. No history of hearing loss & no otologic/neurologic problems
2. No illness on the day of testing
3. Bilateral hearing sensitivity with in normal range (0-15HL) at frequencies 250Hz to 8000Hz.
4. Speech recognition threshold should be +/-12dB
5. Speech identification score of >90% at 40dBSL
6. Bilateral type-A tympanograms according to Jerger's classification (Jerger, 1970); and normal acoustic reflexes (ipsi & contra) in both ears.
7. No deficit in speech and language skills.
8. Good SPIN scores (a reduction not > 60% at 0dBSNR with respect to performance in quiet).
9. Familiarity for all the words will be ensured. All the words will be shown to the subjects.

Testing environment

All the testing was carried out in a sound treated room situation and noise levels will be maintainedas per ANSI,1991.

Instrumentation:

1. A calibrated diagnostic audiometer was used to estimate the pure tone threshold, speech recognition thresholds, speech identification scores and UCL for speech.
2. Calibrated middle ear analyzer GSI-Tympstar was used for tympanometry and reflexometry.
3. The dichotic words was presented through P-IV(or higher) computer connected to an Orbitter 922 version 2 Audiometer equipped with TDH-39 headphones.

Test procedure:

1. Pure tone thresholds were obtained at octave intervals between 250Hz to 8000Hz for air conduction and between 250 Hz and 4000 Hz for bone conduction.
2. Immittance audiometry will be carried out with a probe-tone frequency of 226Hz. Ipsilateral and contralateral reflex thresholds will be measured for 500 Hz, 1000Hz, and 2000Hzand4000Hz.

Dichotic rhyme test was administered on those subjects who pass the subject selection criteria with the test material developed.

The normalization of the words will be to the RMS value of the speech.

The XXpairs of dichotic stimuli was presented at an intensity level of 6OdBHL. Subjects were instructed to respond on an open-set answer sheet.

The task involves writing down the rhyming words heard after each presentation. All subjects were encouraged to guess when unsure of word(s).

Scoring:

The subject responses were scored in terms of:

Single correct scores: Total number ofcorrect responses for the right ear or the total number of correct responses for the left ear.

Double correct scores: scores obtained when subject correctly responds to both the stimuli presented to the two ears.

Ear correct scores: Two get the total ear correct scores, the double correct scores will be added to single correct scores of respective ear, and will be used for analysis.

Test-retest reliability

To measure test-retest reliability, 10 subjects will be subjected to the test again and scores will be analysed.

STATISTICAL ANALYSIS

Appropriate statistical analysis was done to find out the mean and standard deviation value for right ear, left ear and total score.Appropriate statistical analysis will be done to find out the mean and standard deviation value for right ear, left ear and total score.

CHAPTER 4- RESULT

The aim of the present study was to develop normative for dichotic rhyme test in Hindi. Data collection for the normative was done for 30 subjects (15 males &15 female) in the age range of 18 -40 years. The data was analyzed using the software program statistical package for the social sciences (SPSS) version 20.0.

The results are analyzed by calculating the mean, standard deviation and range. Analysis was done to obtain information on,

i. Single correct scores: Total number of correct responses for the right ear or left ear.
ii. Double correct score: scores obtained when subject correctly responded to both the stimulus presented to both ears in correct order.
iii. Ear correct scores: To get total ear correct scores, the double correct score was added to the single correct score of respective ear and were used for analysis.

Following statistics were done

- Mixed ANOVA was done to compare the results across the ear for males and females.
- Repeated measure ANOVA was done for comparison of scores of the ears.
- MANOVA was done for comparison of score across the males and females.

I. Comparison of single correct scores across ear and gender

A mixed ANOVA test was run to compare the performance of ears and gender, and their interactions. Within subject effects showed that ear was significant factor while considering single correct scores [$F(2,56)=100.289, p=.000$)]. Between subjects showed that gender were significantly different from each other with respect to single correct scores of right and left ears[$F(1,28)=5.336, p=.028$]. However, the ear versus gender interaction was found to be not significant [$f(2,56)=.199, p=.820$].

Table 4.1:

Ear correct scores within each gender

Gender	Ear	Mean	SD	Significance level
Male	Right	24.67	1.496	<0.05
	Left	20.53	1.506	<0.05
Female	Right	21.47	4.190	<0.05
	Left	17.73	5.063	<0.05

In order to find out the significance of differences within group, multiple pairwise comparisons were performed. This pairwise comparison of ears showed that right ear scores were significantly better than left ear scores (p=.000), as well as Double correct scores (p=.000). Comparison between left ear scores and double correct scores showed that left ear scores were significantly better than double correct scores (p=.000)

II. Between ear comparisons of single and double correct scores of gender

Repeated measure ANOVA was done to compare single and double correct scores between ears of males. Within subject effects showed that right ear scores , left ear scores and double correct scores were significantly different among them [f(2,28)=358.647,p=.000]. Further, pairwise comparison showed that right ear score were significantly different than left ear scores (p=.000), as well as double correct scores (p=.000). Comparison also revealed that left ear scores were significantly better than double correct scores (p=.000).

Table 4.2:

Ear correct scores across gender

Ear	Gender	Mean	SD	Significance level
Right	Male	24.67	1.496	P<0.05
	Female	21.47	4.190	P<0.05
Left	Male	20.53	1.506	P<0.05
	Female	17.73	5.063	P<0.05

Repeated measure ANOVA was done to compare between single and double correct scores of females. Within subject effects showed that right ear scores , left ear scores and double correct scores were significantly different among them [$f(2,28)=24.788, p=.000$]. Further, pairwise comparison showed that right ear score were significantly different than left ear scores ($p=.000$), as well as double correct scores ($p=.000$). Comparison also revealed that left ear scores were significantly better than double correct scores ($p=.010$).

III. **Comparison of single and double correct scores gender.**

MANOVA was done to compare between genders on right ear single correct scores, left ear single correct scores & double correct scores. Results showed that dichotic right ear scores were significantly different in males and females.

Table 4.3:

Ear correct scores across gender

Measure	Different/same	F (1,28)	Significance level
Dichotic right	Different (Male>Female)	7.761	.009
Dichotic left	Different (Male>female)	4.214	.040
Double correct score	same	2.565	.120

It was found that right ear single correct scores for males were better than that of females [$f(1,28)=7.761, p<0.05$]. However such a significant difference was not observed on double correct scores between males and females, leading to the similar performance by both genders on double correct scores.

CHAPTER 5 DISCUSSION

Ear correct scores within gender:

The present study revealed a statistically significant difference between the ear correct scores within the gender (i.e, both males and females). The right ear scores were better for both the genders suggesting an overall right ear advantage for both genders. The right ear advantage was more evident for males compare to females.

Many studies support the right ear advantage in normal hearing individuals which is attributed to fundamental property of the contralateral pathway from the right ear to language dominant left hemisphere (Kimura,1967). The electrophysiological studies have also supported ear opposite to dominant hemisphere has high score which was attributed to being crossed auditory pathway stronger than uncrossed auditory pathway (Rosenweing,1951;Tuntusi,1946). Thus both ears have ipsilateral as well as contralateral pathways are more dominant than ipsilateral pathway(Kimura,1967;Caleoaro,Cassinari,&Migliavacca,1995). The information from weaker ipsilateral pathway are getting suppressed by stronger contralateral pathway(Yasin ,2007)resulting in the right ear advantage . The right ear advantage might be also due to the morphologic and functional asymmetry of the brain (Geschwind &Levitsky,1968).Geschwind and Levitsky (1968) reported in post-mortem study that the area behind the Heschl gyrus was larger on the left side in 65% of the brain ,and larger on the right side in only 11% of right handed individuals whereas, the planum temporal was one third longer on the left side than on the right side .The auditory association area (wernicke's area) in the temporal convolution is known to be major importance in the language function. This area makes up a larger part of the temporal speech cortex. Thus they have confirmed anatomical asymmetries which correlate with the dominance of the right ear advantage which supports the findings of the present study.

The result of Dichotic rhyme test shows that normative values of right ear is 30-70% and left ear is 27-60%in normal hearing individuals.(Musiek, Kurdzielschwan, Kibbe et al,1989).The present finding can be compared to various dichotic listening studies (Bingea &Raffin,1986;Olsen,1983;Roeser et al,1976;Berlin et al,1973,Studdert-kennady et al .,1970)where right ear advantage exists. Similar results were also fund in few Indian dichotic studies (Moumitha,2003;Krishana,2001;Prachi,2000,Rajgopal1996,Kishore,2009,Sangmesh,2009;Bhartidasan,2013) .

Ear correct scores across gender:

The results of the present study revealed a significant difference between the single correct right scores across genders. Females were having a lesser scores compared to males. However, a lack of significance in left ear scores were noticed across gender. Overall these results suggest that males have higher right ear advantage than females.

The gender difference noticed in current study is incongruent with the findings reported by wexler and lipman(1988).They reported that gender differences on the right ear advantage using fused dichotic word test of 120 trials. Results revealed that males showed higher right ear advantage on the first 60 trials, relative to female subjects. These results suggest that males respond to the novelty of a new task with relative left hemisphere activation while females respond with relative right hemisphere activation.

Shaywitz eat al (1995)studied the hemispheric activation during phonological task(Rhyme) using functional magnetic resonance imaging (fMRI).Inferior frontal gyrus showed more activation in females. The similar results on gender difference were also noticed by Ikezawa et al (2008), observed gender difference using MMN. MMN s generated by pure tone and phonetic stimuli were compared, using EEG amplitude and scalp current density (SCD) measures. The results revealed that, males exhibit left lateralized activation with phonemic MMNs,whereas females exhibited more bilateral activity.

As right ear advantage in dichotic listening is a reflection of the left hemisphere's dominance for speech perception and related functions (Studdert-Kennedy & Shankweiler,1970; Kimura,1967),it could be concluded that males have more lateralized dominance ability for speech perception . These result support finding by Clements et al.,(2006),where functional magnetic resonance imaging (fMRI) was studied. Gender differences were observed during the phonological task, whereas females showed greater bilateral activity .Jerger et al (1994) studied the effect of gender in the dichotic listening test. Dichotic sentence identification (DSI) was administered. They concluded that scores of males are better than females. Similar results were obtained by Lemos et al (2008).

Double correct scores across gender

The results of the present study indicate that there is no significance difference between the double correct scores across genders (i.e., males and females).Double correct scores are poorer than single correct scores of the each ear. This was due to the difficulty in processing temporally equated rhyme pairs simultaneously and also may be due to the precise alignment of the stimuli. Similar kind of results found in Wexler and Halwes,(1983)and Musiek .et. al(1987)study.

CHAPTER 6- SUMMARY & CONCLUSION

The purpose of the study was to develop Dichotic rhyme test in Hindi and also develop the normative data for the developed test material .The test involved identification of bisyllabic words that are dichotically presented.

For obtaining normative values, data collected on 30 native Hindi speakers (15 Male and 15 Female) in the age range of 18to 40 years. The data was subjected to statistical analysis using the software program SPSS version 20.0.

The result of the study reveals that,

a. In both genders, single correct scores of right ear were better than the single correct scores of left ear, which indicates right ear advantage. But the ear advantage is more seen in males than females.
b. Left ear scores were better than double correct scores. There was a difference in the performance of left ear in males and females, leading to the better performance by males.
c. However there was no difference in double correct scores across gender, owing to the similar performance by both genders.

CLINICAL IMPLICATIONS:

A. The test can be used in assessment of binaural auditory processing in Hindi speaking adults.

B. It can be used to identify cortical lesions, and so can be incorporated as a part of central auditory nervous system evaluation battery, for testing Hindi speaking adults.

Future implication:

a. The sensitivity of this test should be evaluated before using it in routine clinical evaluations for central auditory processing disorders.

b. As the research using Dichotic rhyme test has been limited in some clinical population such as learning disability, individuals with pure word deafness etc leaving a broader opportunity for further research.

c. Since this test is developed as per adult norms, there is a need to develop and standardize similar test for various age groups.

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APPENDIX – A

The Compact disc contains the dichotic rhyme test material were given in the list below,

S.No	Right ear		Left ear	
1	टालना	/talna/	पालना	/Palna/
2	गटक	/gətək/	पटक	/pətək/
3	बहन	/bəhən/	पहन	/pəhən/
4	कहर	/kəhər/	पहर	/pəhər/
5	बटाव	/bətav/	कटाव	/kətav/
6	बलम	/bələm/	कलम	/kələm/
7	करना	/kərna/	डरना	/dərna/
8	गरीब	/gərib/	करीब	/kərib/
9	गरम	/gərəm/	करम	/kərəm/
10	बसना	/bəsna/	कसना	/kəsəna/
11	गलिंया	/gəlIjã/	डलियां	/dəlIjã/
12	गलिंया	/gəlIjã/	कलियां	/kəlIjã/
13	बिकाऊ	/bikau/	टिकाऊ	/tIkau/
14	डांटना	/dãtəna/	बांटना	/Bãtna/
15	गहना	/gəhna/	बहना	/bəhna/
16	गहरा	/gəhra/	बहरा	/bəhəra/
17	डसना	/dəsna/	बसना	/bəsna/
18	गमला	/gəmla/	कमला	/kəmla/

S.No	Right ear		Left ear	
1	पहन	/pəhən/	बहन	/bəhən/
2	पालना	/Palna/	टालना	/talna/
3	डरना	/dərna/	करना	/kərna/
4	पहर	/pəhər/	कहर	/kəhər/
5	कटाव	/kətav/	बटाव	/bətav/
6	कलम	/kələm/	बलम	/bələm/
7	करम	/kərəm/	गरम	/gərəm/
8	करीब	/kərib/	गरीब	/gərib/
9	डलियां	/dəlIjã/	गलिंया	/gəlIjã/
10	कसना	/kəsəna/	बसना	/bəsna/
11	बांटना	/Bãtna/	डांटना	/dãtəna/
12	कलियां	/kəlIjã/	गलिंया	/gəlIjã/
13	टिकाऊ	/tIkau/	बिकाऊ	/bikau/
14	बहरा	/bəhəra/	गहरा	/gəhra/
15	बहना	/bəhna/	गहना	/gəhna/
16	कमला	/kəmla/	गमला	/gəmla/
17	बसना	/bəsna/	डसना	/dəsna/
18	पटक	/pətək/	गटक	/gəmla/

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