PERCEPTION OF LINGUISTIC STRESS IN BRAIN DAMAGED

Reg No. M 9819

Master's Dissertation as a part fulfilment ofM.Sc. (Speech and Hearing), submitted to the University of Mysore

ALL INDIA INSTITUTE OF SPEECH AND HEARING
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May - 2000

Dedicated

to

Tom

"The wind beneath my wings "

CERTIFICATE

This is to certify that this dissertation entitled *"PERCEPTION OF LINGUISTIC STRESS IN BRAIN DAMAGED"* is a bonafide work in part fulfilment for the degree of Master of Science, (Speech and Hearing) of the student with *Register No.* **M 9819.**

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CERTIFICATE

This is to certify that this dissertation entitled *"PERCEPTION OF LINGUISTIC STRESS IN BRAIN DAMAGED"* has been prepared under my supervision and guidance.

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DECLARATION

This dissertation entitled *"PERCEPTION OF LINGUISTIC STRESS IN BRAIN DAMAGED"* is the result of my own study under the guidance of **Dr. SAVITHRI, S.R.,** Reader, Department of Speech Sciences, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier at any Umversity for any other Diploma or Degree.

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when our hands were
held together"

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Every thing great that has ever happened to humanity, since the Beginning has begun as a single thought on someone's mind. And it is such thought that roots every research'

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CHAPTER- I

INTRODUCTION

Prosody, or suprasegmental features of speech, include intonation, stress, rhythm and quantity which are superimposed upon the smaller speech sound segments combined in words, phrases and sentences. The melody of speech is conveyed through the prosodic features. Both intonation and stress contribute to the intelligibility of contextual speech . Intonation (variations in Vocal pitch) is used to mark the ending of a phrase, to differentiate a question and sometimes to change meaning. Stress is created by subtle changes in pitch, duration and intensity of a syllable or a word (Price - ostendorf Shaltuck, Humagel and Fong(1991). The investigation of neural substrates of speech prosody has gained a great deal of attention in the recent years, because prosody can signal both linguistic and affective or emotional components of speech. The analysis of perception of speech prosody can present interesting explanatory challenge to historical views of left hemisphere (LH) dominance for the linguistic processing and right hemisphere (RH) dominance for emotional processing (Hughlings, Jackson, 1915)

Perception is one of the higher mental functions. Thus speech perception, a branch of the overall science of perception is widely studied in most population. The various topics like basic unit of speech perception, cross language perceptual skills, cues for speech perception were and are still under study. Many temporal and spectral cues are found to be useful in the perception of speech in normal subjects. The different changes in these parameters give rise to change in percept of the speech stimulus given.

There have been several theories proposed concerning the neuro-anatomical regions active in prosodic processing. One hypothesis posits that all aspects of prosody are processed in the right hemisphere (RH) and integrated across corpus callosum with linguistic representations (Klouda, Rodin, Graff-Radford and Cooper, 1988). Another theory put forward by 'Van Lancker,(1980) elaborates on the "functional lateralization hypothesis". He claims that linguistic prosody is processed in the left hemisphere whereas emotional prosody is controlled by the right hemisphere. A third important hypothesis called 'differential lateralisation hypothesis' has recently gained a lot of experimental momentum. And it contends that individual acoustic cues to prosody are lateralised to different hemispheres, with fundamental frequency(Fo) parameters processed by the right hemisphere and temporal parameters by the left hemisphere (Van Lancker and sidtis, 1992). This 'Differential cue lateralization hypothesis' has been studied both in production and perception and is supported by the reports of impairment in the control of duration in left hemisphere damaged (LHD) whereas this was not observed in the right hemisphere damaged (RHD).The right hemisphere damaged (RHD) showed deficits in Fo processing .

Linguistic stress is one aspect of prosody which refers to both lexical and phonemic stress and emphatic stress, conveyed by changes in Fo, amplitude and duration. However these cues differ in languages. While in languages like English Fry, (1958), Lieberman, (1960) Bolinger, (1972), pitch prominence is the primary cue for stress. In languages like Swedish and Kannada (Fant, 1958, Savithri, 1987; Raju pratap, 1991, Savithri, 1999), syllable lengthening is the primary cue for stress. This may be because the durational difference between short and long vowels is marked in language like Swedish and Kannada, while it is not in English. With this, the differentiation of stress and unstressed word, using temporal parameters should be more distinct in a language like Kannada. Hence the impairment in processing temporal cues would be more evident in Kannada speaking patients with LHD.

In this context, the present study was planned. It aims at verifying the differential cue lateralization hypothesis. That is, to investigate the processing of different cues for words stress in Kannada. Specifically the perceptual abilities of emphatic stress in Kannada speaking patients with LHD and RHD is compared to their age-matched non brain damaged (NBD) Kannada speaking subjects. It was hypothesized that individuals with left hemisphere damage process the stimuli differently on stress identification task as compared to normal subjects. To approve or reject the speculation independent manipulation of the cues available in the stimuli would help us determine if two groups use different acoustic parameters in judging word stress.

CHAPTER-II

REVIEW OF LITERATURE

The review was compiled under the following headings.

1. **Stress and its acoustic cues in various languages.**
2. **Speech and language functions of cerebral hemisphere.**
3. **Perception of stress in normal subjects.**
4. **Perception of stress in patients with LHD and RHD.**

1. Stress and its Acoustic Cues in Various Languages:

Stress is the extra energy or effort used to emphasize a syllable or a word. Stress is viewed from the speaker's as well as listener's point of view. It is considered as the comparative force with which the separate syllables of the sound group are pronounced Sweet (1878), Speakers and listeners symbolically benefit from the use and interpretation of stress. Speakers emphasize salient aspects of a message to enhance the probability of listener comprehension. Listeners attend to the salient stressed segments **of** an auditory message, which in turn facilitates listener's comprehension of the entire stress bearing utterance.

1.1 Definition of Stress:

There are two major views depending on whether one emphasizes the productive or receptive aspects of loudness: the psychophysological and the psychological. Only occassionally does one get the required blend of two views in the work of an individual scholar. A physiological definition of stress is the most common. Sweet (1878) says " stress is the comparative force with which the separate syllables of a sound group are pronounced". According to Abercrombie (1923) "stress is a force of breath impulse" and according to Heffner (1949) "it is referable to kinaesthetic sensation of muscle and pressure changes". Jones (1956b) defines stress as "the degree of force with which a sound or syllable is uttered".

Bolinger (1958) says "stress is perceived prominence imposed within utterances". Stress may function linguistically at syllable, word or sentence level. Stress is a feature perceived by the listener which involves complex interactions of suprasegmental elements. Bolinger (1972) stated that the distribution of stressed elements in speech functions for, semantic and emotional highlighting by drawing listeners attention to them. Gatenby (1975) defined stress as the property that endows sequential syllables with differentiating grades of acoustic prominence.

1.2. Types of Stress:

It is a tradition in phonetics to divide stress into dynamic or expiratory stress and musical or melodic stress (Lehiste 1970). This assumption seems to have been based on a belief that stress and pitch are independent of each other. There are different types of linguistic stress and they are described in the table given below:

Type of Stress	Description
A. Word stress	Domain of stress is a word.
(i). Bound stress	In this, the position of stress identifies the word as a phonological unit.
(ii).Phonemic / Free stress.	Here, the stress occupies an independent position within the phonology of the language.
(iii). Morphological stress	This is an intermediate type between phonemic and bound stress. Position of the word is fixed with regard to a given morpheme but not with regard to word boundaries.
B. Sentence level stress	The domain of stress is a sentence.
(i). Primary stress	The speaker while wanting the listener to pay attention uses this.
(ii). Contrasrive stress	This is used to distinguish one particular morpheme from the other morpheme that may occur in the same position.
(iii). Emphatic stress	This is used to distinguish a sentence from its negation.

Table 1: Types of stress.

1.3. Acoustic Cues for the Perception of Stress:

Stress is cued by different parameters like increased fundamental frequency, increased intensity, prolonged duration or change in the quantity. The importance of these parameters in indicating stress is language dependent. Various investigations have been done in different languages to find out the acoustic parameters cueing stress. Table 2 given below gives details on the prominent cue for stress in various language.

Author	Language	Subjects	Cues
Stetson (1951)	English	-	Vowel quantity
Fry (1955)	English	100	Duration, intensity
Fant(1958)	Swedish	-	Duration
Bolinger(1958)	English	-	1. Pitch prominence 2. Duration
Jassem(1959)	Polish	-	Frequency
Rigault (1962)	French	-	1. Frequency 2. Duration
Lehiste (1968a)	Estonian	-	3. Duration
Bertinetto (1980)	Italian		4. Duration
Balasubramanian (1981)	Tamil	-	--> Prolongation of vowel that is phonologicaly long. --> Prolongation of consonant and alottal onset. --> Addition of one of the two emphatic particles /e:/ and /t 2:n/.
Ratna etal(1981)	* Kannada	-	1. Increase in intensity 2. Steepness of intensity rise. 3. Pause before the word 4. Duration.
Savithri(1987)	* Kannada	4	Duration
Rajupratap (1991)	* Kannada	10	Duration
Savithri(1999)	*Kannada		Duration

Table 2: Cues for stress in different languages.

As reported in languages like English, Polish, French pitch prominence is the primary cue for stress. While in languages like Swedish, Kannada syllable lengthening is the primary cue for stress. This may be because of the marked durational differences between long and short vowels in these languages. It can be assumed that the differentiation of temporal parameters should be more distinct in a language like Kannada. Though different opinion exist among investigators regarding the prominent cues of stress all of them do agree that increase in FO, intensity duration and alteration in the vowel quality are primary cues for stress.

2. Speech and Language Functions of Cerebral Hemispheres:

There are several issues of interest in the investigation of the neural substrates for the processing and control of prosody.

1. Is the function (linguistic Vs emotions) lateratised or are the acoustic cues (pitch Vs timing) lateralised?

2. Given that the linguistic prosodic system is part of several grammatical components (phonological, lexical, syntactic), to what extent does a particular breakdown in the prosodic system affect these components ?.

3. Are the comprehension and production of prosodic cues similarly affected by brain damage and under the same hemisphere control ?.

2.1 Lateralization:

The issue of cerebral lateralisation for the processing of prosody, stress specifically stress can be viewed along side data suggesting cerebral laterality for other linquistic components. The left hemisphere has long been assumed to be specailised for linguistic processing (Kimura, 1964) and the right hemisphere has been established to have a special role in processing emotional information (Milner 1962, Curry 1967). If the function served by a stimulus (i.e., emotional or linguistic) determines the laterality of processing, one would predict left hemisphere involvement for linguistic prosody and right hemisphere in emotional prosody. An alternative possibility is that the acoustic cue itself determines the lateralisation of prosodic processing. Thus if the right hemisphere processes musical or non linguistic pitch, (Kimura 1964) it may also be involved in the processing of linguistic information conveyed by pitch. The third possibility is a differential lateralisation of acoustic cues for the processing of acoustic cues, with Fo to the right and temporal cue to the left hemisphere. This assumption has gained a lot of experimental evidence in the recent past.

In an investigation of normal subjects' processing prosody, Zurif and Mendelsohn (1972) used strings of dichotically presented nonsense words, upon which they imposed the acoustic correlates of syntactic structures, i.e., intonation contours. The researchers found that only the so - called structured material yielded significant right ear advantages (REAS) as compared to monotonous readings of lists of the same nonsense words, which yielded no ear asymmetry. A left hemisphere preference resulted when the prosodic component was tied more closely to a linguistic structure, here a sentential intonation contour. Without this structure, i.e. in the monotonous reading in which the contours were not meaningful linguistically, the left hemisphere was not favoured. In contrast there was a right prefrontal activation during pitch judgements of the same CVC syllables. This suggests that FO processing is associated with right hemisphere mechanism.

Zatorre, Evans, Meyer and Gjedde (1992) in an attempt to understand processing of prosody, conducted positron emission tomography with non brain damaged individuals. They compared activation patterns in tasks requiring phonetic and pitch judgements. The results indicated increasing activity in Broca's area, during phonetic judgements of CVC syllables.

VanLancker and Sidtis (1992), studied the neuro anatomical mechanisms subserving speech prosody. They concluded that the mechanisms subserving the comprehension of prosody are bilaterally distributed with right hemisphere more specialised for processing F0 and left hemisphere more specialised for processing temporal acoustic parameters. And they called it as differential lateralisation of acoustic cues in the hemispheres.

Blumstein and Cooper (1974) used filtered speech to derive the intonation contours of four sentence types corresponding to interrogative declarative, conditional and imperative. Separate from the phonetic medium. Whether subjects were asked to identify contour pattern or sentence type, a dichotic presentation of these stimuli yielded a left ear advantage (LEA), although the results in the latter tasks were non significant. More importantly, when non filtered nonsense syllable were presented dichotically with four different intonation contours, significant LEAs were still obtained.

The difference between the stimuli used by Zurif and Mendelson (1972) and these used by Blumstin and Cooper (1974) is that the former researchers made use of grammatical ordering of English function words and bound morphemes. Blumstein and Cooper's stimuli were not enhanced with this grammatical characteristic. This could explain why Blumstein and Cooper obtained LEA results, the prosody was still in a phonetic medium but unable to aid in any constituent chunking. Without this, linguistic function to perform, prosody may have engaged the right hemisphere, which analysed the intonation contour as non verbal, melodic elements.

There is a considerable confusion as to what extent the right hemisphere is involved in the processing of non-emotional linguistic prosody. There are several levels within the linguistic system at which prosody operates. The right hemisphere does not appear to be primary in the processing of pitch used to contrast linguistic tone at a phonological level. VanLancker and Fromkin (1973) found a right ear advantage for Thai tones for Thai speakers but not for English speakers.

3. Perception of Stress in Normal Subjects:

The literature documenting the perception of stress in normal subjects remain rare and few. But with the available data, it can be noticed that the acoustic cues like Fo. amplitude and intensity play a very significant role in the perception of stress. There are a number of factors that influence the judgement of stress. The listener relies on differences in

--> the length of syllables;

--> the loudness of syllables;

--> the pitch of syllables;

--> the sound qualities occurring in the syllables.

--> the kinesthetic memories associated with his own production of the syllables he is receiving.

These factors form a complex in which, no one is independent of the others. Thus a stress judgement may be influenced by the length of the syllable and particularly by the length of the vowel that it contains but not independent of the vowel quality. In the English word /mo:bid/, the first syllable is perceived as stress partly because the first vowel is long. This vowel is however long in opposition to the first vowel of /mo:biditi/ and not in contrast with the second /i/, for in the latter word, the first vowel is still long in contrast with the second although the stress is now perceived to be on the second syllable.

Certain quality differences in English have particular significance in stress judgements. The substitution of the neutral vowel /a/, for some other vowel, the reduction of a dipthong to a pure vowel, or the centralisation of a vowel are all powerful cues in the judgement of stress. Some features of consonant quality, such as the strength of friction or aspiration and the sharpness of onset of the consonant sound may act in a similar way.

Fry (1958) explored three physical dimensions such as duration, intensity and Fo in determining stress judgement in English. He found duration ratio to be an important cue in perception of stress. Intensity ratio showed similar effects in a less marked way. However cues of fundamental frequency proved to out weigh both duration and intensity.

Vowel amplitude and phoneme stress was evaluated in American English by Lehiste (1970). She found that the perception of linguistic stress was based on speech power, fundamental voice frequency, vowel quality and duration. The laryngeal quality was found to make a very secondary contribution.

Fry (1965) attempted to explore, the part played by vowel quality in stress judgements obtained from English listeners versions, of the word pairs 'object' and 'contract', 'subject' and 'digest'. These were synthesized in which there was systematic variations of the frequency of the first and second formants in the first syllable of 'object' and 'subject'. Variation in vowel duration ratio was introduced in the same stimuli in order to provide a means of estimating the weight to be assigned to the changes in the formant structure. The fundamental frequency of the periodic sounds was kept constant at 120Hz throughout. The overall intensity of syllable was regulated so that the maximum intensity in the two syllable of a test word was equal and a constant difference of 6dB between formant 1 and formant 2 was maintained throughout.

The stimuli were made into a listening test in which each stimulus occurred once. Stress judgements were obtain^ from 100 subjects who were all young speakers of southern English. The results suggested that formant structure cue for stress may be less effective than the intensity cue.

Though the primary cues of stress perception remains to be Fo, amptitude and intensity. The prominent feature that cues stress varies from language to language. While in languages like English, where the durational difference between short and long vowels is not clear, increment in fundamental frequency signal stress (Boliger, 1958). But in languages like Kannada, where durational differences are predominant, lengthened vowels, signal stress. (Rajupratap, 1987; Savithri, 1987; 1999).

Savithri (1987) studied some acoustical and perceptual correlates of stress in Kannada. She chose 11 three word meaningful Kannada sentences. In each sentences the stressed word was varied to make four types of sentences as-

1. əvn təmma dəppəkkindəne/ non stressed
2. əvn təmma dəppəkkindəne/ stress on 1st word
3. əvn təmma dəppəkkindəne/ stress on 2nd word
4. əvn təmma dəppəkkindəne/ stress on 3rd word

In total 39 sentences were prepared. Four Kannada speaking adults (2 males+ 2 females) spoke these sentences. The spoken sentences were recorded and were made to listened by 30 subjects to indicate the word stressed and the perceptual cues of the same. Only those words which were identified as stressed by 80% or more subjects were subjected to acoustic analysis. Fo, intensity, duration Fl and F2 of the stressed words were compard with those of the unstressed utterances. Acoustic analysis revealed duration as the main cue and perceptual analysis revealed duration and intensity increments as major cues for stress.

Savithri (1999) aimed to evaluate the importance of vowel duration as a cue for word stress in Kannada. Five two word phrases as uttered without stress by a native Kannada female speaker aged 25 yars were recorded and synthetic tokens were made out of this. This was given for perceptual evaluation to ten Kannada speaking normal subjects. The responses were tabulated and the percent responses were found. Vowel duration was found to be the most prominent cue in Kannada.

Savithri (1999) investigated the relative importance of Fo, intensity and duration in signaling word stress. Two word phrases, uttered by a 25 year old native female Kannada speaker with and without emphasis on the first word were recorded. The Fo intensity and duration of the stressed and the unstressed words were measured. Six experiments were done in which the Fo intensity and duration of the stressed and the unstressed word were edited to correspond to the stressed word.

Expt 1: Fo of unstressed word in all the phrases were increased to correspond to the Fo of the stressed word.

Expt 2: The source intensity of the unstressed word in all five phrases was increased. Increment amounted to lOdB and was done in steps of 10msec.

Expt 3: Vowel duration of the unstressed word in two of the phrases was increased to correspond to the vowel duration of the stressed word. Increment was around 9 and 67 msec respectively.

Expt 4: Fo and source intensity was increased.

Expt 5: Fo and vowel duration of the unstressed word was increased.

Expt 6: Fo, source intensity and vowel duration of unstressed word were increased.

A Total of 63 tokens along with the original phrases with unstressed word were audio recorded which formed the material. Ten female subjects were audio presented with the material and were instructed to indicate when they perceived stress, on the first word of each token. Results indicated that the increments in duration were a major cue for stress in Kannada followed by increments in Fo and intensity.

To summarize, the perception of stress by normal subjects depends on the primary acoustic features, like Fo, amplitude and intensity. But the prominent cue varies from language to language on which the listeners depend.

4. Studies on Perception of Stress in Patients with LHD and RHD:

4.1 Perception of stress in patients with LHD:

Monrad Frohn (1963) described three classes of prosodic abnormality of importance to clinical neurology. Hyper prosody is an excessive or exaggerated prosody. Dysprosody is a distorted prosody and aprosody refers to an attenuation or lack of normal prosody. This particular section is intended to focus mainly on the perception of prosody and specifically of stress in the LHD and RHD patients.

Blunsteiri and Goodglass (1972) paired compound nouns (red cap) and adjective / noun phrases (red cap) that differed by location of primary stress. When patients were presented with one member of the pair and instructured to point to the appropriate illustration of the meaning accuracy was high. Both Wernicke's and Broca's aphasics were found capable of differentiating a meaning change caused by a shift in phonemic stress. Left hemisphere damage did not affect the ability to perceive phonemic differences signalled by stress placement. It is possible that these aphasics did not experience complete loss of language, and stress contrasts were among the spared abilities.

Data contrary to these results came from Baum et al (1982) who found that Broca's patients performed significantly worse than normal controls in comprehending sentences that were disambiguated by stress change. Similar to Blumstein and Goodglass picture pointing task "Baum et als study had patients, identify stress that best fit sentences such as "she is home sick" and'she is home sick". The authors concluded that Broca's aphasics have a deficit in processing and perceiving variations in the acoustic information that signals stress.

In addition Gandour (1983) found that Thai aphasics were impaired on a tone identification task, but a right hemisphere damaged Thai speaker was not impaired.

Ambiguity regarding the benefit of stress for aphasic listeners led Kimelman and Me Neil (1981) to replicate an investigation by Poshek and Brookshire (1982). Poshek and Brookshire used 12 expository paragraphs?* that had been equated for length, lexical and syntactic complexity and reading level. Three paragraphs were recorded with normal stress and three different paragraphs were recorded with exaggerated stress on selected target words. Aphasic subjects then listened to the paragraphs in both conditions and answered Yes / No questions about the paragraphs. Comprehension was better in the exaggerated stress condition.

Kimelman and Mc Neil (1987) randomly selected and re-recorded four of the paragraphs developed by Poshek and Brookshire. Each paragraph was recorded once using normal stress and again using emphatic stress. After listening to each paragraph, the aphasics were tested with Yes / No questions. This study confirmed that their comprehension of spoken paragraph length narratives was significantly better when target words were emphatically stressed than when they were normally stressed.

An issue of interest concerns the acoustic components of the prosodic system. Both linguistic and emotional prosodic cues are conveyed by the same three acoustic parameters, FO amplitude and duration. If the prosodic system is impaired, one question of interest is, whether all parameters are affected equally or whether one (or more) can be impaired or retained independently of the other. There is some evidence that the production of pitch and duration cues can be separately affected. Danly and Shapiro (1982) found that Broca's aphasics exhibited utterance final pitch fall, as well as declination in short sentences but not in longer more syntatically complex sentences. However, sentence final lengthening was absent. It appears then that some Broca's aphasics have control of pitch (at least over short sentences), but their use of duration of signal boundaries may be impaired.

Emmorey (1987) tested the ability to comprehend and produce the stress contrast between noun compound and noun phrases (eg. Green house Vs Green house) on 8-nonfiuent aphasics, 7-fluent aphasics, 7-right hemsphere damaged patients and 22-normal controls. The aphasics performed worse than normal controls on the comprehension task and the RHD group performed as well as normal subjects. The ability to produce stress contrasts was tested with a sentence reading task; acoustic measurements revealed that no non fluent aphasic used pitch to distinguish noun compounds from phrases, but two used duration. All but one of the RHD patients and all but one of the normal subjects produced pitch and or duraiton cues. These results suggest that linguistic prosody is processed by the left hemisphere and that with brain damage the ability to produce pitch and duration cues may be dissociated at the lexical level.

Enmorey et al (1987) in a study on aphasics and right hemisphere damaged patients concluded that left hemisphere may be involved with sentential intonation. They explain this by saying that intonation contours may be treated as holistic units rather than as separate sequences of contours and might thus engage the right hemisphere. But lexical stress is a local phenomenon between successive words or syllable and thus might engage the left hemisphere.

Kimelman (1991) in another investigation determined the influence of stressed word prosody on auditory comprehension by listeners with aphasia. Paragraph length narratives were computer edited to yield two conditons. In one condition, both the target words and the surrounding context were periodically neutral in the second conditon, target words were stressed and the surrounding contexts were prosodically neutral. The paragraph length stimuli were presented to 10 aphasic listeners and their comprehension was tested. Analysis revealed that prosodic informaiton carried only by stressed target words within paragraph length stimuli did not provide significant comprehension benefits to aphasic listeners. The comprehension involvement typically observed when paragraph length narratives are stressed is, therefore most likely due to prosodic cues that precede stress bearing target words.

4.2 Perception of Stress in Patients with RHD:

The intonation and stress studies mentioned so far that suggest hemisphere activity in stress processing have combined prosody with syntactic structuring, grammatical morphemes and phonemic distinctiveness. When prosody was divorced form meaningful phonetic informaiton (Blumstein and Cooper 1974) it resulted in what could be interpreted as right hemisphere involvement. Loss of prosody (aprosody) from hemisphere damage has been reported by Ross and Mesulam (1979). Other reports indicate that even the perception of prosodically conveyed emotions is impaired in the right hemisphere patient (Heilman, Scholes et al., 1975, Tucker et al., 1977).

Most evidence indicates that right hemisphere is involved is processing emotional or affective prosodic cues (Ross and Mesulam 1979: Ross 1981), Heilman Scholes and Waison 1975; Tucker Watson and Heilman 1977; have found that patients with right hemisphere damage are impaired in the comprehension or production of 'affective speech'. Heilman et al (1975) presented right hemisphere damaged patients with semantically neutral sentences read with what was considered to be a happy, sad, angry or indifferent tone. These patients made more errors than LHD patients in identifying the emotional tone. Tucker et al., (1977) replicated this result and also showed that the deficit was not merely a difficulty in naming the emotional tone but included in impairment in discrimination as well.

Complementing Blumstein and Goodglass (1972) and directly testing the hypothesis of a right hemisphere ability for stress perception is a study by Weintraub et al (1981) which replicated the Blumstein and Good^glass experiment for lexical stress perception, but with right hemisphere damaged patients. The lexical contrasts proved more difficult for right hemisphere damaged patients than control subjects with no brain damage. So unlike the aphasic subjects of the Blumstein and Goodglass study, and more like the Baum et al (1982) patients, right hemisphere patients of Weinstraub et al exhibited a deficit in stress perception. Even though the stress occurred in a linguistic context, ability to process stress was diminished.

At the lexical level Weintraub et al (1981) found that right hemisphere patients were worse than normal subjects at discriminating between noun compounds and phrases (Black board and black board). Blumstein and Cooper (1974) found a left ear advantage for intonation contours. Heilman et al (1984) found an impairment in right hemisphere damaged patients ability to classify interrogative and declarative intonation contours. Aphasics also showed impairment on the task, indicating that both hemispheres might be involved in the comprehension of these intonation patterns. These evidences indicate that the right hemisphere is not involved in the comprehension of linguistic prosodic cues at the phonological level, but may be involved at the lexical or sentence levels.

Another issue concerning the processing of prosody by the brain involves the distinction between comprehension and production. Three of the case studies of right hemisphere damaged patients of Ross (1981) exhibited a dissociation between their ability to identify the emotional tone of an examiner's voice without visual cues.

Behrens (1988) studied the role of right hemisphere in the production of linguistic stress. And they found a spared processing mechanism for linguistic prosody, thus mitigating against the view of a general dysprosody tied to RHD. Shapiro (1985) studied the role of the right hemisphere in the control of speech prosody in prepositional and affective contexts. Results suggested that damage to the right hemisphere alone may result in a primary disturbance of speech prosody that may be independent of the disturbances in affect often noted in RHD population.

Behrens (1988) studied the production of linguistic stress on eight male RHD patients with unilateral right hemisphere CVAs and seven male control subjects. Productions of phonemic stress tokens (eg. Red coat Vs red coat) as well as examples of contrastive stress, or sentential emphasis (eg. Samhated the movie) were elicited from the subjects. Two types of analysis were conducted on these utterances. Acoustic analysis focused on the correlates associated with word stress namely changes in amplitude, duration and fundamental frequency. The perceptual saliency of emerging cues to stress was also examined by the presentation of test tokens to phonetically trained listeners for identification of stress placement. The patients as a group produced fewer acoustic cues to stress compared to the normal subjects, but no statistical differences were found between groups for either stress at the phrase level or at the sentence level. In the perceptual analysis, stress produced by the patient group was judged to be less salient than that for normal group. Thus the data suggest a spared processing mechanism for linguistic prosody in RHD.

Studies on split brain patients suggest that the disconnected right hemisphere does not as a rule possess the capacity for speech production. Any prosodic information processed in the right hemisphere is passed through corpus callosum speech centers during speech production. Klouda et al (1988) studied the role of collosal connections in speech prosody, (in a 39 year old right handed women who suffered an aneurismal hemorrhage damaging anterior four fifths of corpus callosum)

The results showed that speech prosody is impaired following callosal damage. And they concluded by saving that the right hemisphere generally contributes to the processing of FO information which is then integrated with the information processed in the left hemisphere speech centers via the corpus callosum. They also found that durational measures were relatively intact in this patient, suggesting that duration may be processed primarily in the left hemisphere. This finding is in consonance with the differential lateralisation hypothesis (mentioned earlier) proposed by (VanLancker and Sidtis 1992) which is the most recent area of investigation. The deficits of prosody in the brain damaged population can throw more light to the same area.

4.3 Perception and stress in patients with LHD and RHD.

Support for differential lateralisation hypothesis (VanLancker and Sidtis 1992) comes from studies of both production and perception. Oulette and Baum (1993) reported impairments in the control of duration in the production of lexical and emphatic stress by individuals with left hemisphere damage (LHD). Individuals with right hemisphere damage (RHD) did not exhibit such deficits. (Enmorey 1987).

VanLancker and Sidtis (1992) compared the performance of participants with LHD, RHD and non brain damaged (NBD) individuals on an emotional prosody identification task. They found that both groups of patients with brain damage were impaired relative to NBD participants, but that the performance of the clinical groups did not differ in terms of accuracy. However a discriminant analysis permitted the authors to determine which acoustic cues in the stimuli predicted the comprehension errors made by the individuals in each group. Results of this analysis showed that the patients with LHD and RHD were using the acoustic cues to prosody differently in judging emotions conveyed. In particular patients with LHD seemed to be rehing on FO variations, whereas patients with RHD, seemed to be basing their judgements on durational cues. Thus VanLancker and Sidtis (1992) concluded that the mechanisms subscreening the comprehension of prosody are bilaterally distributed, with RH more specialised for processing FO and LH for temporal acoustic parameters.

In an effort to replicate the findings of VanLancker and Sidtis (1992) Pell and Baum (1997) conducted a similar analysis exploring the identification of both linguistic and affective prosody. The results of discriminant analysis failed to indicate that the patients with LHD and RHD were relying on different acoustic cues in making prosodic judgements. Thus according to them the hypothesis that individual acoustic cues to prosody are independently lateralised remains speculative.

Baum (1998) investigated phoneme and emphatic stress contrasts in RHD LHD and NBD adults. The results demonstrated that the LHD subjects performed poorly on phonemic stress contrasts as compared to the RHD group. RHD performed poorer than normal subjects. All groups performed better on the emphatic stress subjects with the scores of LHD patients at chance level for the FO neutralised stimuli. These findings are in relation to VanLancker's hypothesis.

Sarah, Prakash and Savithri (2000) investigated the 'lateralization hypothesis' in the perception of emphatic stress in three Kannada speaking adults with left hemisphere damaged and their age matched normal subjects. The acoustic parameters studied were FO, Intensity, duration and their multiple combinations on three-syllabic Kannada utterances. The result indicated that patients with the left hemisphere damaged perceived emphatic stress poorly compared to normal subjects. The authors also noted that duration was a prominent cue in the perception of emphatic stress in Kannada. Since the patients with LHD perform poorer on temporal parameters the difference in the performance between LHD and normal subjects can be explained.

Studies in languages like Kannada where duration is a major cue for stress, would be interesting in that the role of hemispheres in responding to temporal cues would be highlighted more compared to the language English. In this context the present study, aimed at investigating the perception of emphatic stress in Kannada in patients with LHD, RHD and NBD. It was hypothesized that patients with RHD would perform poorly *on* experiments dealing with change in FO using emphatic stress.

CHAPTER - III

METHODOLOGY

Subjects:

A total of six Kannada speaking brain damaged adults having suffered a single unilateral CVA supported by the CT scan and diagnosed by neurologists served as the experimental group. Out of this , 5 patients had left hemisphere damage and one had right hemisphere damage. Their age ranged from 21 to 56 years. All the subjects were inpatients in the Department of Neurology. NTMHANS. The control group consisted of six normal age matched kannada speaking adults. Table 3: shows the subject details.

Sl. No	Age	**Sex**	**Pathology**	**Aphasia**
1.	21	M	MCA infarction	Anomia
2.	24	M	Left MCA infarction	?Broca's
3.	25	M	Left MCA infarction	Anomia
4.	30	M	Left Cerebral infact	Anomia
5.	56	M	Left Cerebral infact	Broca's
6.	30	M	Right PCA infact	No language defect

Table 3: Subject Details

Material:

Five two-word meaningful kannada phrases (bisyllabic adjective-noun) formed the material .Table 4- shows the material. Word underlined is stressed .

Sl.No	**Phrase**
1.	bili butti
2.	Kappu shu
3.	nili bassu
4.	Udda pennu
5.	Chikka angi

Table 4: Material used for the Study (Word Underlined is Stressed)

The phrases were written one each on a card and a 41 year old native female kannada speaker uttered them with and without stress on the underlined word into the microphone attached to the 12 bit A/D converter. All the phrases were recorded into the computer memory using a 16 KHZ sampling frequency. Using the 'ANALYSIS' program of the SSL, (VSS, Bangalore) the fundamental frequency and intensity of the phrasers were extracted at every 10 msecs. Using the 'DISPLAY' program of the SSL, the duration of the individual phonemes in the stressed and unstressed words were calculated from the waveform. Using 'PATPLAY' Fo, Io, Do, and their multiple combinations of **the** unstressed words were charged to that of the corresponding stressed word . Seven experiments were conducted in which various parameters were charged. The details of these experiments are in Table 5

Experiment	Parameter Charged	Details	Total No. of Tokens
1.	Fundamental frequency (F)	Fo of unstressed word in each phrase was changed to Fo of the counter-part stressd word ever 10 m.secs	5
2.	Intensity **(I)**	Io of unstressed word in each phrase was changed to Io of the counter-part stresstAvord even' 10 m.secs	5
3.	Duration (D)	D^n of the individual phoneme in the unstressed word was changed to that of the stressed word.	5
4.	Frequency and Intensity (FI)	Fo and Io of the unstressed word in each phrase was changed to Fo and Io of the counter part stressed word every 10 m.secs	5
5.	Intensity and Duration (ID)	Io and Do of the unstressed word in each phrase was changed to the counterpart stressed word	5
6.	Frequency and duration (FD)	Fo and Do of the unstressed word was changed in each phrase to the counter.part stressed word.	5
7.	Intensity frequency and duration (IFD)	All three parameters of the unstressed word in each phrase was changed to the counter-part stressed word.	5
		Total tokes 35 only.	

Table 5: Details of Experiments for Creating the Synthetic Phrases.

Thus a total of 35 synthetic phrases were generated. These 35 synthetic phrases were paired with their corresponding unstressed original phrase forming a total of 40 synthetic phrases. They were randomized, iterated thrice and audio recorded. Thus a total of 120 pairs of synthetic phrases formed the material. The details are shown in the Table given below:

S - Synthetic P - Phrase U - Unstressed

Pair Sl.No	Details of The phrase pair	Parameter altered
1. 2. 3 4. 5.	UPl - UPl UP2 - UP2 UP3 - UP3 UP4 - UP4 UP5 - UP5	Original Phrase pair no changes made
1. 2. 3 4. 5.	SPl - UPl SP2 - UP2 SP3 - UP3 SP4 - UP4 SP5 - UP5	Fo change only
1. 2. 3. 4. 5.	SPl - UPl SP2 - UP2 SP3 - UP3 SP4 - UP4 SP5 - UP5	Io change only
1. 2. 3. 4. 5.	SPl - UPl SP2 - UP2 SP3 - UP3 SP4 - UP4 SP5 - UP5	Duration change only
1. 2. 3. 4. 5.	SPl - UPl SP2 - UP2 SP3 - UP3 SP4 - UP4 SP5 - UP5	Frequency & Intensity change only
1. 2. 3. 4. 5.	SPl - UPl SP2 - UP2 SP3 - UP3 SP4 - UP4 SP5 - UP5	Intensity and duration change only

1. 2. 3 4. 5.	SP1 - UP1 SP2 - UP2 SP3 - UP3 SP4 - UP4 SP5 - UP5	Frequency and duration change only.
1. 2. 3. 4. 5.	SP1 - UP1 SP2 - UP2 SP3 - UP3 SP4 - UP4 SP5 - UP5	Intensity, frequency and duration change.

Table 6: Details of the synthetic phrases

Method:

Patients were individually treated in a noise free room of the department of Neurology, NIMHANS, Bangalore. The normal subjects were tested in their homes. The synthetic phrase pairs were presented to the subjects through headphones of the tape recorder (AIWA HS-GSI 22) They were instructed to listen to the material carefully and to mark in the response sheet as to whether the pair of phrases was same or different. The subjects with brain damage were permitted to do the same through any means (pointing gesture, sign, icon)

Analysis:

The total number of same/different responses for the five phrases were tabulated and the percent same/different response for each phrase was plotted on a graph. Combined scores of all phrases were then plotted to find the trend of the response. The responses of the normal subjects were compared with those of the brain damaged.

CHAPTER - IV

RESULTS AND DISCUSSION

Results:

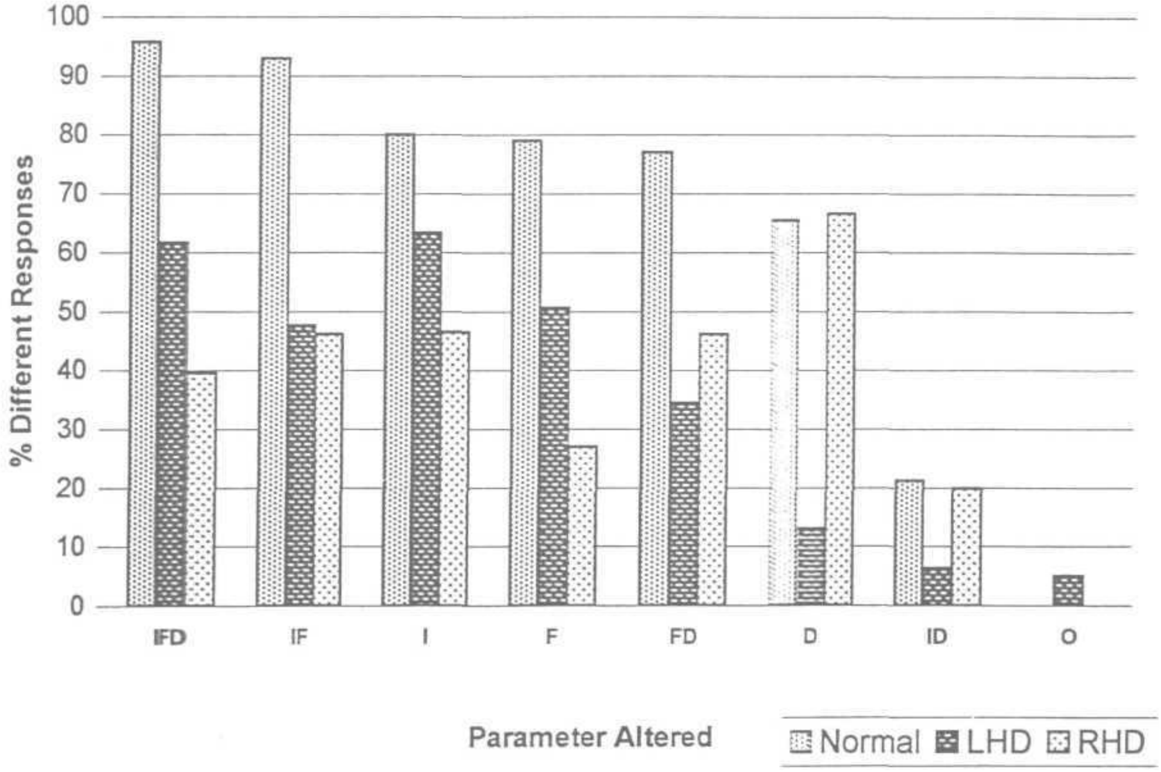
In general it was found that the normal subjects showed better perception of word stress for all the altered parameters, and the brain damaged population showed poorer performance with differences from phrase to phrase. Table 7 shows the combined scores of phrases 1-5 of the category 'different' response for all three groups (NBD, LHD, RHD) Graph 1 shows the combined score showing the trend of the response.

Altered Parameter	Normal	LHD	RHD
EFD	95.8	61.6	39.6
IF	93	47.6	46.2
I	80	63.3	46.4
F	79	50.6	27
FD	77	34.4	46.2
D	65.4	13	66.6
ID	21.2	6.4	19.8
0	0	5	

Table 7: Shows the Combined Scores of Phrases 1-5

Normal subjects could differentiate the stressed word from the unstressed, when all three parameters (frequency, intensity and duration) were altered. They perceived the stress minimally when the phrases were altered only on intensity and duration. The LHD patients could differentiate the stressed word from the unstressed when intensity, was altered, followed by the phrases with the alteration of all the three parameters. Duration

Figure 1:
Combined Scores (Phrases 1-5)



IFD	Intensity, Frequency and Duration
IF	Intensity and Frequency
I	Intensity
F	Frequency
FD	Frequency and Duration
D	Duration
ID	Intensity and Duration
O	Original

and intensity alterations brought out minimal scores. The phrases with temporal alterations could not be well differentiated for stress by LHD patients. The RHD patients could differentiate stressed word from unstressed, when duration was altered least differentiation was observed when intensity and duration was altered .

Analysing each of the phrases across the three groups it was noticed that the performance varied. However the general trend was maintained across all the phrases in each of the group. Table 8 and Graph 2 show the % different response of normal subjects and LHD and Table 9 and Graph 3 show the % different response for normal subjects and the RHD patients for phrase I.

Altered Parameter	Normal	LHD
EFD	100	86.6
IF	93.3	73.3
F	80	66.6
I	66.6	53.3
ID	20	6.6
D	13.3	6.6
FD	13.3	6.6
0	0	6.6

Table 8: Indicates percent Different Response for Phrase 1 for Normal subjects and LHD

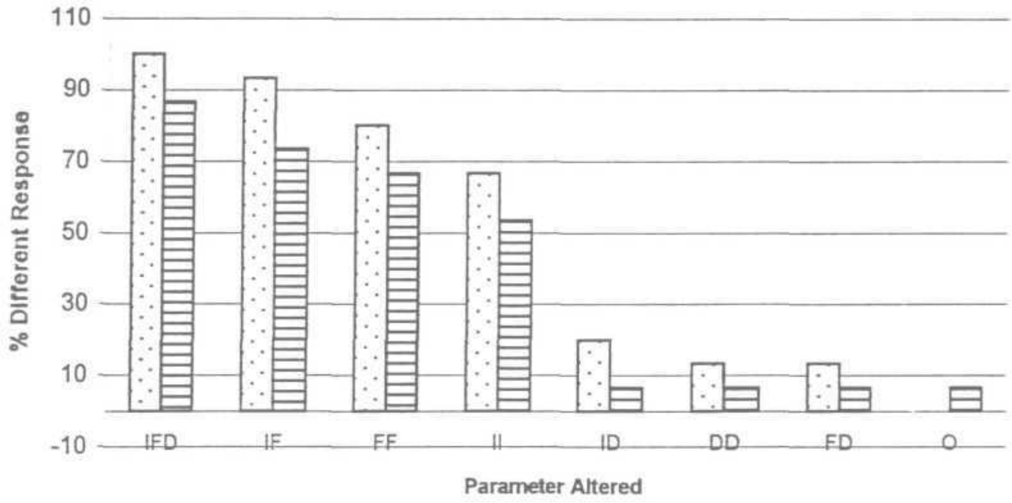
The normal subjects and LHD patients showed maximum percent different response for the phrase with all three parameters varied. [(Intensity I), Frequency (F) and Duration (D)]. The normal subjects could not differentiate stressed word from unstressed when frequency duration were altered and LHD patients could differentiate stressed word from unstressed when duration was altered with other parameters (Except EFD). The RHD patients could differentiate stressed word from unstressed when intensity and duration were altered. Reduced scores were noticed consistently on all tokens with alterations of frequency.

Altered Parameter	**Normal**	RHD
F	100	0
IF	100	33.3
EFD	100	33.3
I	**0**	0
D	0	0
FD	0	0
ID	0	66.6
0	0	0

Table 9: Indicates percent Different Response for Phrase 1 for Normal subjects and RHD

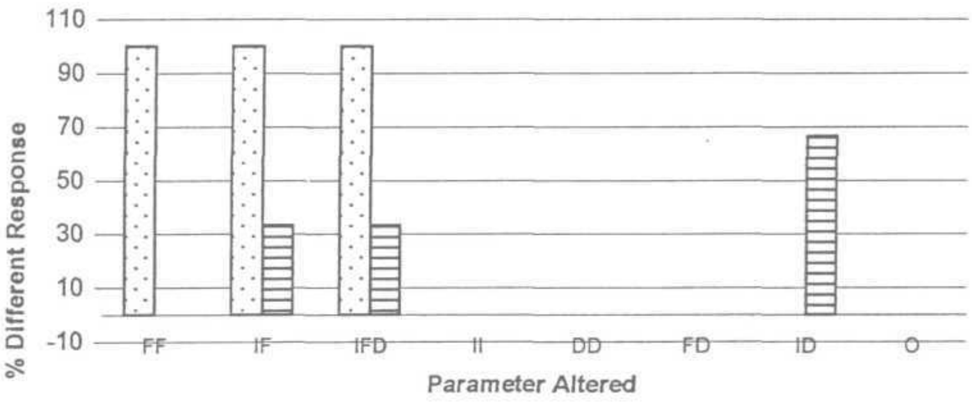
Table 10 and Graph 4 show the % different response for normal subjects and LHD patients and Table 11 and Graph 5 show the same for normal subjects RHD patients for phrase 2. For phrase 2, both normal subjects and LHD patients could differentiate stressed word. From unstressed word when frequency alterationswere made. The normal subjects subjects poorly differentiated stressed word from unstressed with intensity alterations and intensity and duration alterations. The LHD patients poorly differentiated the stressed word from the unstressed, when temporal alterations were made. The RHD patients differentiate stressed word from unstressed word when duration was altered. Poor differentiation was observed for alterations in frequency. Poorest differentiation was shown for the phrase with ID and EFD change.

Figure 2:
Indicates Percentage Different for Phrase I change



□ Normal ⊟ LHD Patients

Figure 3:
Indicates Percentage Different for Phrase I change



□ Normal ⊟ RHD Patients

Altered Parameter	**Normal**	LHD
F	100	80
FD	100	26.6
IFD	100	46.6
D	86.6	20
IF	86.6	20
ID	80	20
I	80	66.6
0	0	6.6

Table 10: Indicates percent Different Response for Phrase II for Normal subjects and LHD.

Altered Parameter	Normal	RHD
F	100	33.3
D	100	100
FD	100	33.3
IFD	100	0
I	66.6	66.6
IF	66.6	66.6
ID	0	0
O	0	0

Table 11: Indicates percent Different Response for Phrase II for Normal subjects and RHD.

Figure 4:
Indicates Percentage Different for Phrase II change

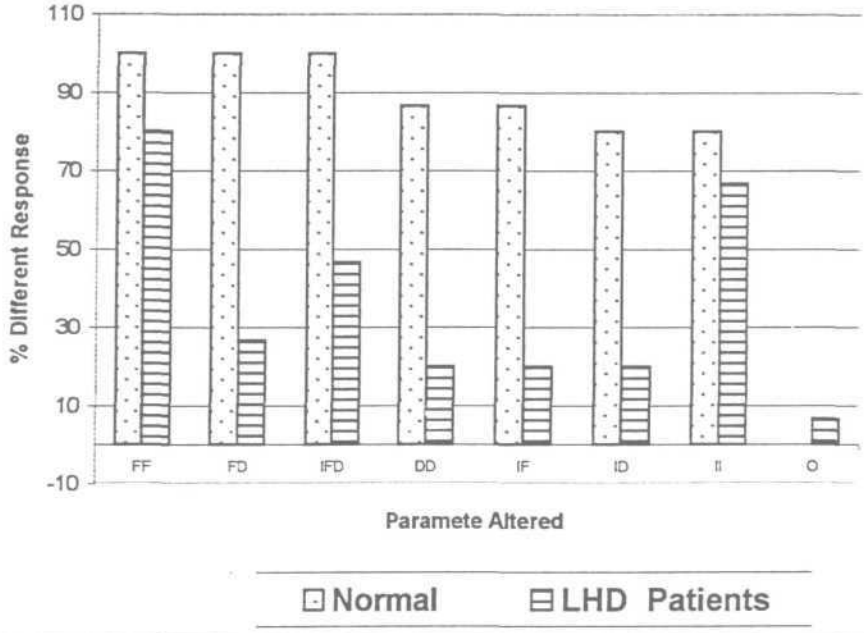


Figure 5:
Indicates Percentage Different for Phrase II change

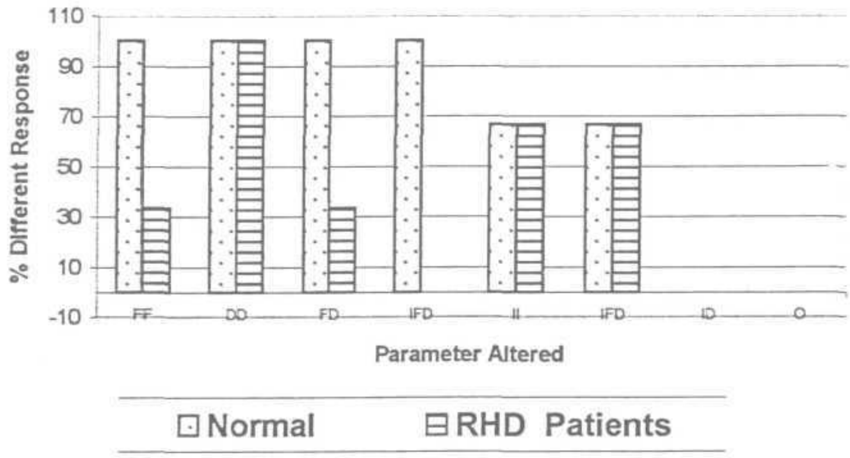


Table 12 and Graph 6 show the percentage different response for Phrase 3 in normal subjects and LHD patients. Table 13 and Graph 7 show the same for normal subjects and RHD patients.

Normal subjects showed maximum % different response when IFD alterations were done whereas LHD patients showed maximum % different response for I and IFD alterations. Normal subjects showed minimum different scores for ID alterations and LHD showed p o c % different scores for all alterations with temporal parameter combination, except IFD. The RHD patients had maximum % different scores on the duration alteration and the minimum on frequency alteration. Both normal and the RHD patients performed poorly on ID changed phrase.

Altered Parameter	Normal	LHD
IF	100	53
IFD	100	66.6
FD	80	6.6
F	80	40
I	66.6	66.6
D	66.6	6.6
ID	6	0
0	0	13.3

Table 12: Indicates percent Different Response for Phrase HI for Normal subjects and LHD.

Altered Parameter	**Normal**	**RHD**
F	100	33.3
IF	100	33.3
FD	100	66.6
IFD	100	66.6
I	66.6	33.3
D	33.3	100
ID	0	0
O	0	0

Table 13: Indicates percent Different Response for Phrase IE for Normal subjects and RHD

Figure 6:
Indicates Percentage Different for Phrase IIII change

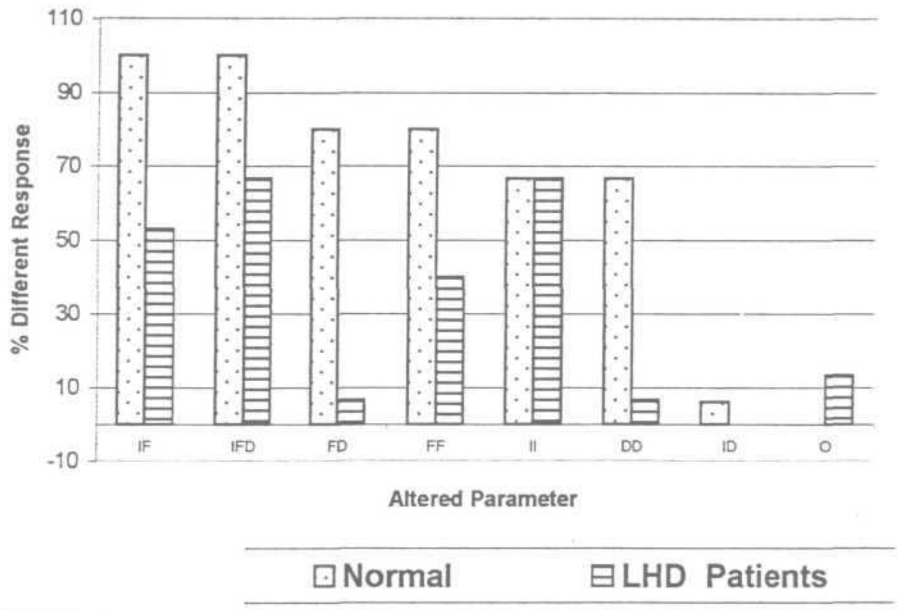


Figure 7:
Indicates Percentage Different for Phrase III change

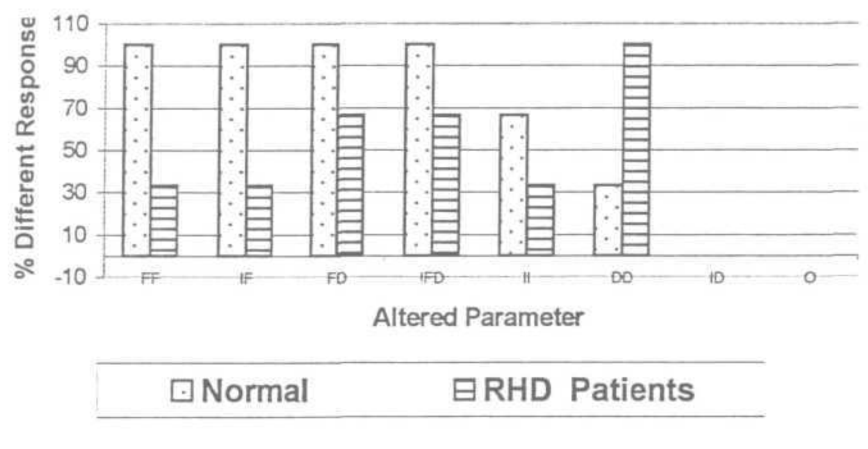


Table 14 and Graph 8 show the percentage different response for phrase 4 normal subject and LHD patients. Table 15 and Graph 9 show the same for normal subjects RHD patients. For this phrase the normal subjects and the LHD patients showed the maximum different response for EF alterations alone. Both the groups showed minimum different response for the phrase with ID alterations and F alterations. However the LHD group showed poor, different scores for all the phrases with temporal parameter alteration. The RHD patients showed maximum different response for IFD alterations and the minimum for frequency alterations.

Altered Parameter	Normal	LHD
IF	100	86.6
I	93.3	66.6
FD	93.3	60
D	86.6	20
IFD	86.6	46.6
F	13.3	13.3
ID	**0**	6.6
0	0	0

Table 14: Indicates percent Different Response for Phrase IV for Normal subjects and LHD.

Altered Parameter	**Normal**	RHD
F	100	33.3
I	100	33.3
D	100	33.3
IF	100	66.6
FD	100	66.6
IFD	100	66.6
ID	0	33.3
0	0	0

Table 15: Indicates percent Different Response for Phrase IV for Normal subjects and RHD

Figure 8:
Indicates Percentage Different for Phrase IV change

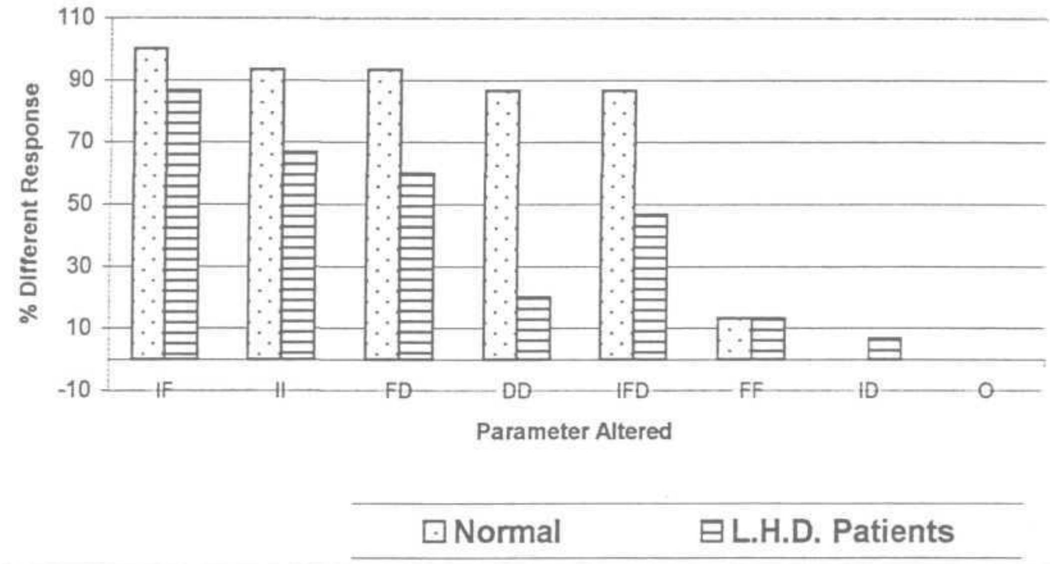


Figure 9:
Indicates Percentage Different for Phrase IV change

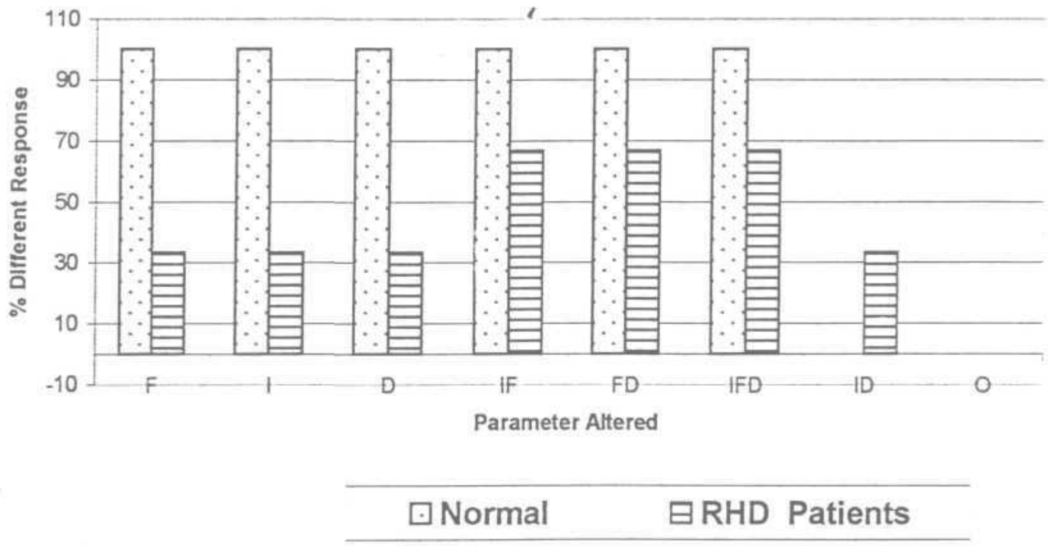


Table 16 and Graph 10 show the % different response for phrase 5 for normal subject and LHD patients. Table 17 and Graph 11 show the same for normal subjects and RHD patients.

Altered Parameter	**Normal**	**LHD**
F	100	53.34
FD	100	73.34
IFD	93.3	60
I	93.33	66.66
IF	73.34	13.33
D	73.34	13.33
ID	0	0
0	0	0

Table 16: Indicates percent Different Response for Phrase V for Normal subjeas and LHD.

Altered Parameter	**Normal**	**RHD**
F	100	
I	100	100
D	100	100
IF	100	66.6
FD	100	66.6
IFD	100	33.3
ID	0	0
O	0	0

Table 17: Indicates percent Different Response for Phrase V for Normal subjects and RHD.

The normal subjects LHD patients obtained maximum different scores/ When alterations in frequency and durations were performed and minimum differences when duration parameters were altered.

Figure 10:
Indicates Percentage Different for Phrase V change

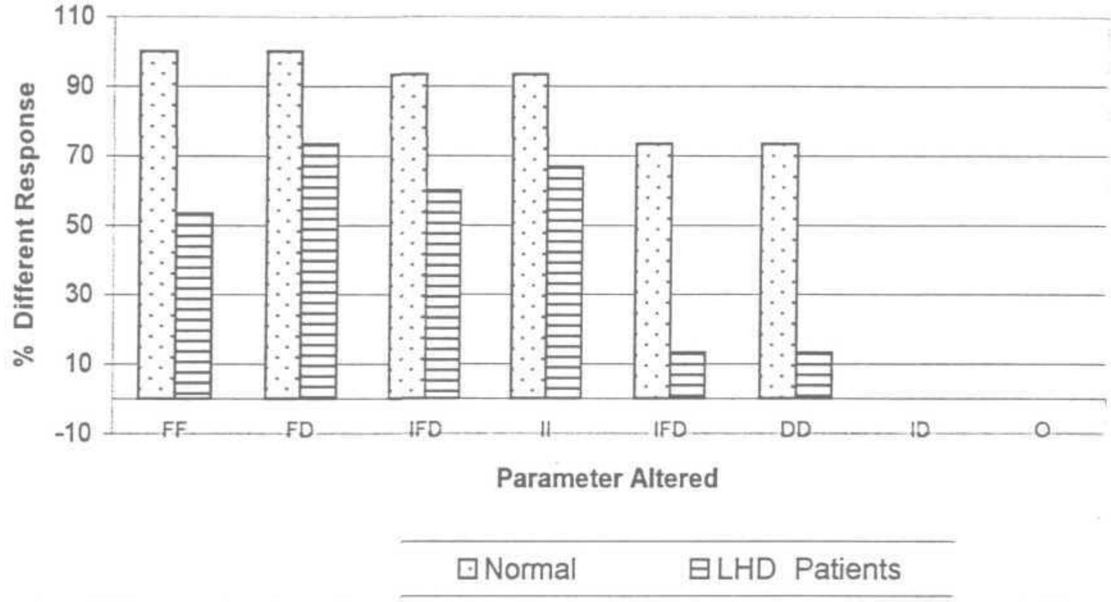


Figure 11:
Indicates Percentage Different for Phrase V change

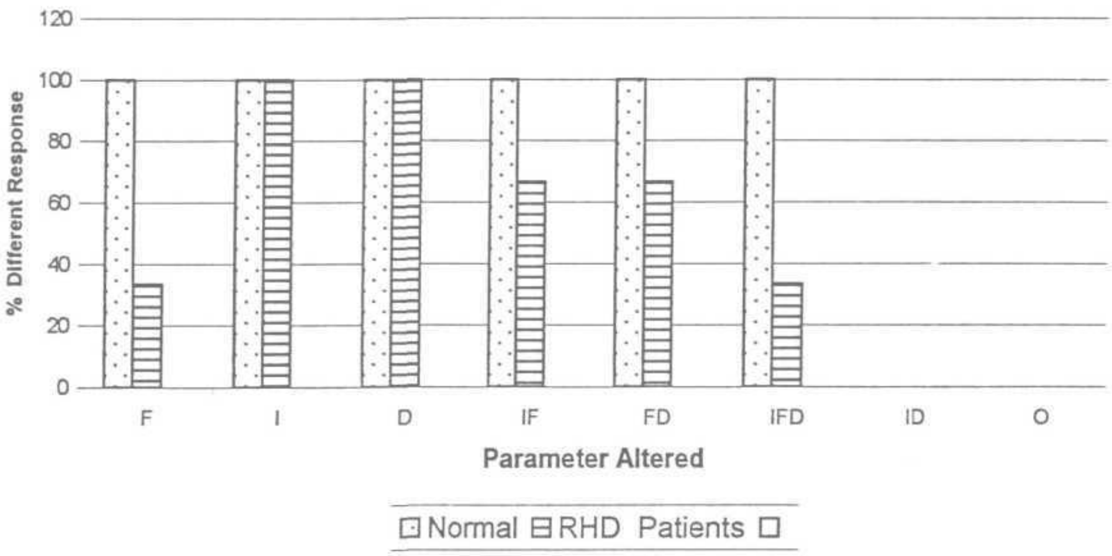


Table 18 summarises the results. The results indicate that the LHD and RHD patients performed poorly in differentiating stressed word from unstressed word. The LHD patients performed similar to normal subjects and performed better when alterations in the parameter frequency was made. The RHD patients performed better when alterations in the temporal parameter (duration) was made. In contrast LHD performed poorly when alterations in temporal parameters were made. Graph 12 a, b show the % different response by normal subjects, LHD and RHD patients. It was observed that RHD patients performed better than normal subjects for phrases 2 and 3.

PHRASE	N	**LHD**	**RHD**
PI	IFD FD	IFD FD, ID	ID F
P2	F LID	F D	FD IFD
P3	IF. IFD ID	I, IFD, FD, ID, D	D F
P4	IF ID.F	IF, ID,FD.D	IFD F
P5	F,FD D.ID	FD, D, ID	D, I, F, IFD
AVG.	IFD ID	IFD ID	D ID

Line 1: Maximum Scores
Line 2: Minimum Scores

TABLE: 18 Summary of the Results

The results of the present study support the notion that prosody is controlled by both the hemisphere; the frequency aspect by the right hemisphere and the temporal aspects by the left hemisphere. However the relative importance of the hemispheres in prosodic processing needs further probing. Also, investigations in patients with damage in specific areas of the hemisphere and subcortical areas may prove useful in understanding prosodic processing.

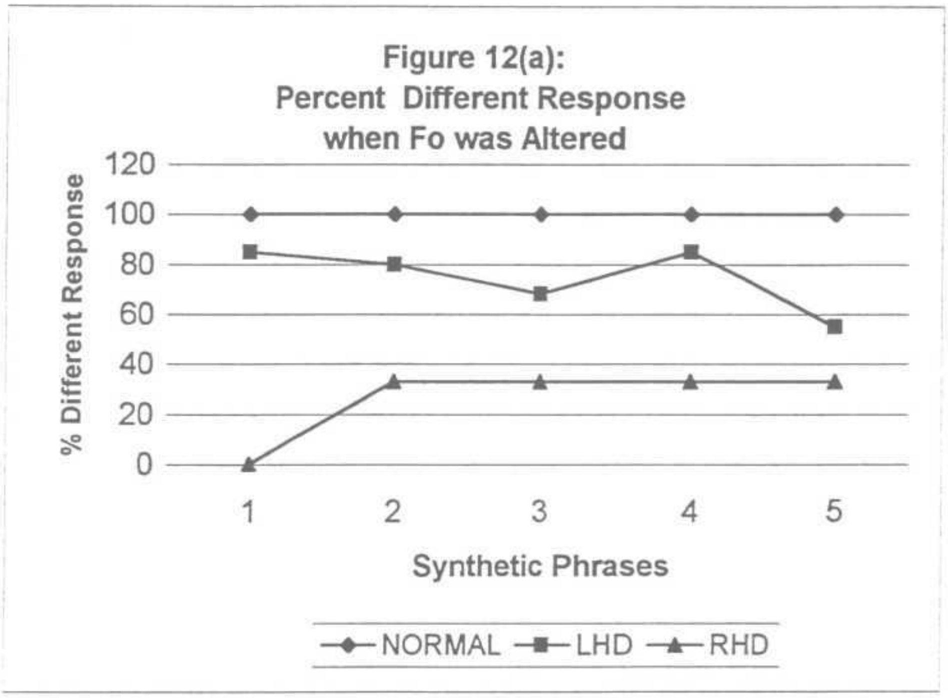


Figure 12(a):
Percent Different Response
when Fo was Altered
% Different Response
120
100
80
60
40
20
0
1
2
3
4
5
Synthetic Phrases
NORMAL
LHD
RHD

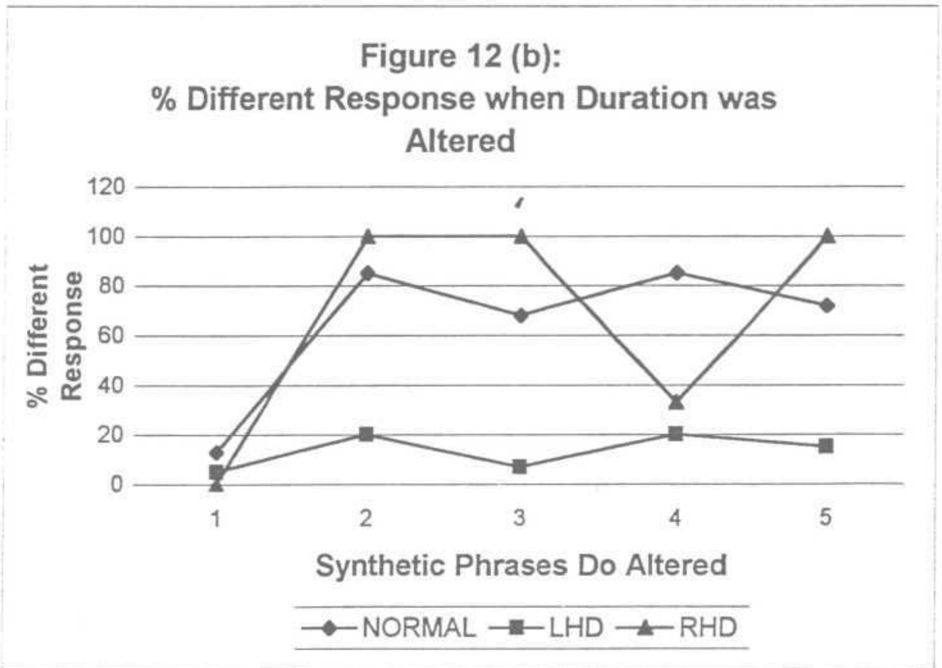


Figure 12 (b):
% Different Response when Duration was
Altered
% Different Response
120
100
80
60
40
20
0
1
2
3
4
5
Synthetic Phrases Do Altered
NORMAL
LHD
RHD

DISCUSSION:

The results indicate that LHD patients perform better when frequency parameters are altered and RHD patients perform better when temporal alterations are made. This supports the 'Differential lateralization hypothesis. (Van Lancker & Sidris (1992)). While the LHD patients used intensity and frequency parameters for the perception of emphatic stress, the RHD patients relied on duration and intensity to a large extent. As found by Vanhancker et al (1992. Baum. 1998, Sarah et al(2000)his study also proved that the individual acoustic cues lateralise to different hemispheres, with Fo to the right and duration to the left.

From the results obtained and the hypothesis posed, it is clear that patients with LHD have deficits in processing temporal parameters. The damaged left hemisphere is unable to do the processing of durational cues and hence there is a deficit in its perception. These patients in turn make use of other cues like frequency and intensity to perceive stress.

The LHD patients showed difficulty in all phrases with temporal cue alteration except EFD. This may be because in this token, the change in I and F was sufficient enough to bring about the perception of stress.

The frequency processing was different in RHD patients. The RHD patient had the temporal processing intact. The patient showed maximum different response across phrases for the duraiton altered phrase, which the sometimes (P2 & P3) better than in normal subjects. This can be explained as, an enhancement of the temporal processing ability to compensate the deficit of the right hemisphere inturn being perception of the word stress.

Alterations of the parameter intensity as such, seemed not affected in both groups, across phrases. This indicates that the processing of intensity is not affected in these groups of patients. And hence the area responsible for the processing of intensity remains speculative. Comparing the results of this study with that of Baum et al (1998) one can understand the significance of language specify in the perception of word stress. Baum et al (1998) in English found poorer scores on Fo as compared to duration in emphatic stress perception in the LHD group. In English Fo is a major cue for stress, while in Kannada it is duration. While in Baum's study the difference in the score between LHD and normal patients for the parameter duration was 20 percent, it was found to be 52 percent in the present study. This indicates that in languages where stress is cued by duration, performance by LHD patients may be poorer. Figure 13 a,b compares the findings of Baum's (1998) study in Engliskand the present study in Kannada.

These findings support the language specificity of word stress. As emphatic stress is more dependent on the parameter duration in Kannada the LHD patients of this study performed poorer on the task compared to Baum's patients, Considering LHD are poor at processing temporal parameters. In case of RHD, their processing of the parameter duration is good due to the spared left hemisphere. Hence the difference between normal subjects, LHD and RHD group is marked.

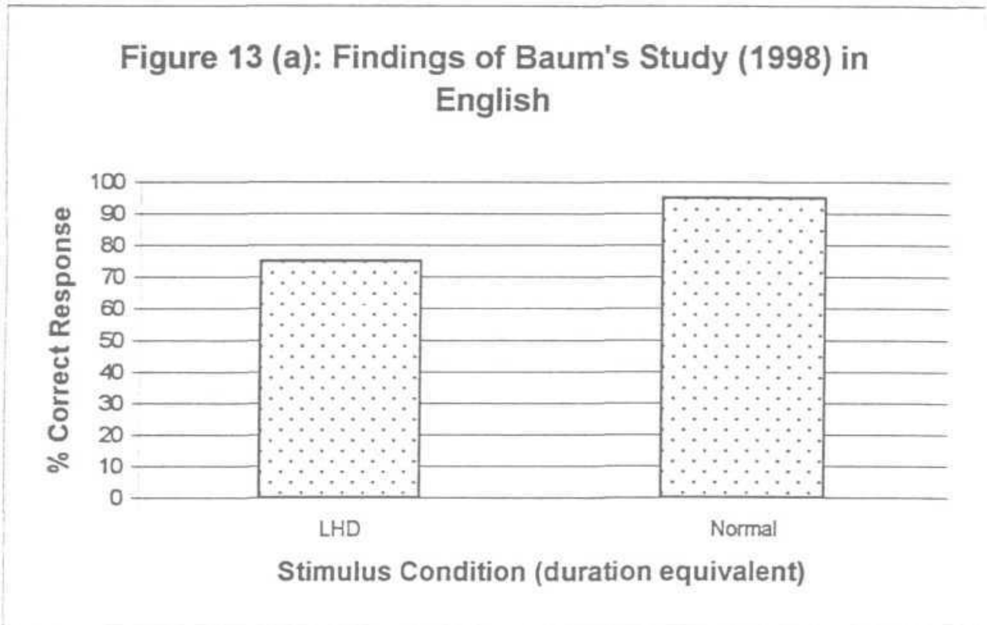


Figure 13 (a): Findings of Baum's Study (1998) in English
% Correct Response
100
90
80
70
60
50
40
30
20
10
0
LHD
Normal
Stimulus Condition (duration equivalent)

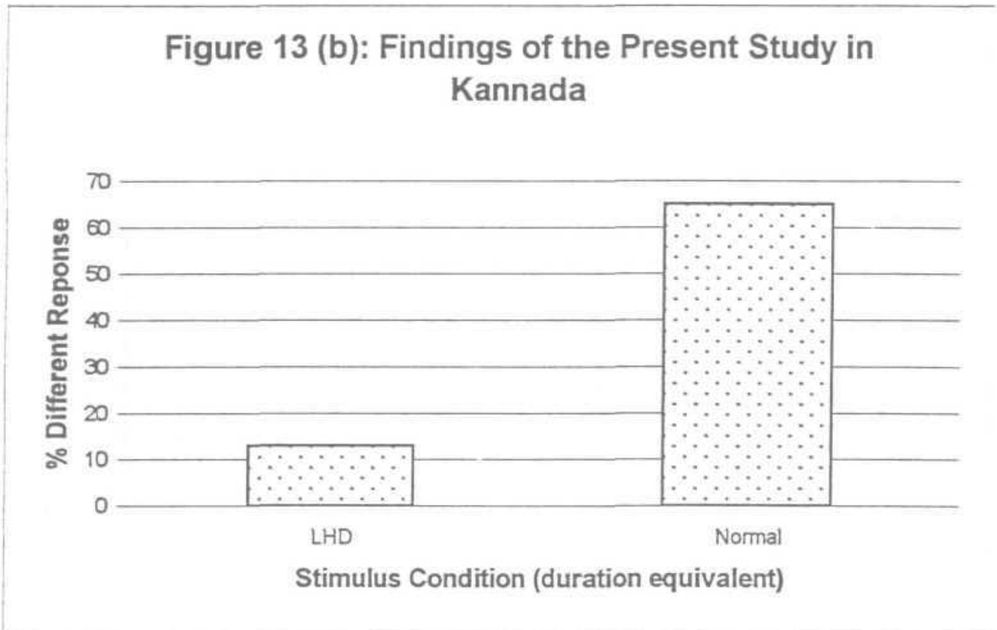


Figure 13 (b): Findings of the Present Study in Kannada
% Different Reponse
70
60
50
40
30
20
10
0
LHD
Normal
Stimulus Condition (duration equivalent)

CHAPTER V

SUMMARY AND CONCLUSIONS

The neural substrates subserving speech prosody has been investigated in the past and there have been various notions suggested delineating the anatomical area responsible for prosodic processing. The most recently investigated hypothesis is the differential lateralisation hypothesis given by VanLancker and Sidtis (1992). They claim that, the processing of acoustic cues are differentially lateralised in the two different hemispheres, with the frequency parameters in the right hemisphere and the temporal parameters in the left hemisphere.

This particular hypothesis has gained experimental evidence both in speech production and perception studies. There have been studies done on brain damaged population to confirm the same hypothesis. Studies done by VanLancker et al (1992J Baum et al(l998) Sarah et al 2000 have confirmed this particular hypothesis in LHD, RHD, and NBD patients. It is found in their studies that the LHD group shows deficits in the processing of temporal parameters, whereas the RHD shows deficits with frequency' parameters.

Stress perception has been found to be language dependent. The prominent cues for perceiving stress varies from language to language. In languages$_j$ English, (Fry, 1958; Lieberman, 1960; Bolinger, 1972) pitch prominence is the primary cue for stress. In languages like Swedish and Kannada (Fant, 1958, Savithri, 1987; Raju pratap, 1991; Savithri 1999). Syllable lengthening is the primay cue for stress. This is because of the strong durajfonal difference between short and long vowels in Kannada, which is not seen in English.

With this, the differentiation of stressed and unstressed word, using temporal parameters should be more distinct in a language like Kannada. In this context the present study was planned. It aimed at comparing the perception of emphatic word stress in Kannada speaking Left Hemisphere Damaged (LHD), Right Hemisphere Damaged (RHD), and Non Brain Damaged (NBD) age matched adults. It was hypothesized that individuals with LHD and RHD process stimuli differently on stress identification task as compared to normal subjects. To approve or reject the speculation, independent manipulation of the cues available in the stimuli was done to determine if the three groups used different acoustic parameters for perception of word stress.

Six Kannada speaking brain damaged adults, five with LHD and one with RHD of the age range 21-56 years were chosen as subjects. The control group consisted of six age matched normal subjects. The material used was, five two-word meaningful Kannada phrases. (Bisyllabic - adjective noun). These were uttered by a 41 year old native female Kannada speaker with and without stress on the first word and .recorded into the memory of the computer. The phrases were synthesized by altering frequency, intensity and duration independently and in their multiple combinations. These tokens ^paired with its corresponding original unstressed phrase. These were randomized and iterated thrice and recorded into a cassette. The material consisted of a total of 120 pairs of synthetic phrases. They were presented to the subjects in a noise free room through Headphones.

The subjects were instructed to indicate whether the pair of phrases presented were same or different. The responses were tabulated and the percent same or different responses for each phrase was plotted on a graph. The combined scores of all phrases were also plotted to find the trend of the response.

The results indicated the following;

> LHD & RHD, patients poorly when compared to normal subjects,

a. The LHD patients showed deficits in the perception of temporal cues. This is attributed to the deficits in the processing of durational cues due to the damaged LH as LH is responsible for temporal processing.

b. LHD patients showed good scores for the phrases with alteraton of intensity cue. The scores of the RHD patient also, on the same was good. However, LHD showed better performance than both normal subjects and RHD. This can be attributed as compensatory mechanism within the hemispheres.

c. The RHD patient showed deficits in the perception of frequency, parameter. This is attributed to the deficits in the processing of frequency cues due to the damaged RH as RH is responsible for the processing of frequency.

d. RHD patient showed good scores for the phrases with alteration of durational parameter. This could be attributed to a compensatory strategy by the undamaged left hemisphere to perceive word stress.

The results support the differential lateralisation hypothesis. It appears that both the hemispheres are involved in prosodic processing. While the right hemisphere process the frequency parameters, the left hemisphere processes the temporal parameters. However, the role of right hemisphere may be greater in prosodic processing as evident by the good scores in RHD patients. Investigations in patients with specific lesions, and with subcortical lesions may prove useful in understanding prosodic processing.

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