INTRA-WORD STRESSED SYLLABIC DURATION IN NON-FLUENT APHASICS AND RIGHT HEMISPHERE DAMAGED.

Shibu (Joseph)
Reg. No. M 9618

A dissertation submitted as part fulfilment of Final Year
M.Sc. (Speech and Hearing)
to the University of Mysore, Mysore.

ALL INDIA INSTITUTE OF SPEECH AND HEARING
MYSORE - 570 006
INDIA

May 1998

DEDICATED
TO
MY PARENTS

To you I owe what I am today,
words not enough to show my love for you,
for ever and ever, I will love you

C E R T I F I C A T E

This is to certify that this dissertation entitled "Intra word Stressed Syllabic Duration In Right Hemisphere Damaged and Non-Fluent Aphasics ", is the bonafide work in part fulfilment for the degree of "MASTER OF SCIENCE (SPEECH AND HEARING) " of the student with Register Number M9618.

Mysore
May 1998

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C E R T I F I C A T E

This is to certify that this dissertation entitled "Intra word Stressed Syllabic Duration In Right Hemisphere Damaged and Non-Fluent Aphasics ", has been prepared under my supervision and guidance.

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May 1998

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DECLARATION

I hereby declare that the Dissertation Entitled *"Intra word Stressed Syllabic Duration In Right Hemisphere Damaged andNon-Fluent Aphasics",* ***is the result of my own study under the guidance of Dr. N.P. NATARAJA, Professor and Head, Department of Speech Sciences, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier at any university for any other Diploma or Degree,***

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ACKNOWLEDGEMENTS

I would like to extend by heartfelt gratitude to my teacher and guide ***Dr. N.P. NATARAJA,*** for his guidance, patience and immeasurable help. Also I would like to thank him for being a constant souice of inspiration and for putting up with all my liables.

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Last but not the least, thanks to the ***Almighty*** for every bit of success and failure I have experienced in the completion of this dissertation.

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INTRODUCTION

INTRODUCTION

Communication is basic to any living being. Speech and language has been considered to be the most important and commonly used means of the basic act of communication.

Language is described as the transmission of utterances in an intelligible and meaningful fashion. These utterances are studied in units referred to as "linguistic units". The properties of linguistic units are phonology, semantics, morphology and syntacts.

Phonology is the area of language containing acoustical characteristics of speech. It is divided into segmental and suprasegmental. Phonemes are the elements common to a group of sounds. Segmental phonemes are the vowels, semi-vowels and consonants. The other portion of phonology involves the supra-segmental phonemes or the stress, intonation and juncture features of an utterance.

Suprasegmentals, also called prosodics, are properties of speech that have a domain larger than a single element. The suprasegmental information in speech can be described by physical quantities of amplitude, duration and fundamental frequency of voice. These suprasegmental features include stress, intonation, rhythm and quantity. While the term stress, refers to increased effort, intonation refers to the changes in the fundamental frequency, quantity to the time taken to other speech sounds and rhythm to the pattern of movement in speech.

Among these, stress is used to emphasize a word and to bring about difference in meaning. It can be defined from the listener's point of view or from the speaker's point of view. Bloomfield (1933) defines stress as increased loudness on a paiticular syllable. Jones (1950) defines stress as an utterence of syllable with greater effort than other neighbouring syllables in words or sentences.

Stress has been correlated with various acoustic as well as perceptual parameters by different investigators. Fant (1957) considers lengthening of the syllables as the most obvious physical correlates of stress . Fry (1958) considers duration as a more reliable correlate. For Bolinger (1958), the primary cue for stress is the pitch prominence and Lieberman (1960) attributes peak amplitude as a reliable correlate. Savithri (1987) attributed intensity prominance and duration as important correlates of stress in Kannada. Though difference of opinion exists among investigators regarding the prominent cues of stress, all of them do agree mat increments in fundamental frequency, duration, intensity and alterations in the vowel quality are the primary acoustic cues of stress.

Syllables carrying stress have been found to be greater in amplitude and duration and/or higher in fundamental frequency in compaiison with unstressed counterparts in normal speakers. (Behrens, 1988, Emmorey, 1987, Klatt, 1976, Meclean and Tiftang, 1973).

Studies by crystal and House (1990) showed that duration of a syllable is a function of both its stress condition and the number of its phones. Various studies by Fry (1957, 1958), Gaitenby (1965) and Lieberman (1960) has shown the effects on syllable stress on the duration of the syllable. Fourakis (1986) reported that with a word the initial syllable duration was affected by changes in both stress and tempo. The durational parameter has been extensively studied among the speech of the clinical population especially the brain damaged individuals. Untill recently it was thought that the left hemisphere was solely involved in the speech and language process. The contribution of the right hemisphere towards the speech production especially in their prosodic aspects has been remarkable.

Most phonetic investigations of speech timing in aphasic speakers have focused on segment-sized linguistic units. It has been found that non-fluent aphasics experience difficulty with the temporal aspects of speech (Blomstein and Baum 1987). Studies in general have revealed that the Left Hemisphere Damaged (LHD) population have more difficulty in stress production compared to Right Hemisphere Damaged (RHD) and normals and the RHD individuals do experience difficulty in the stressed production but not as much as the LHD.

Baum and Shari. (1990) in their study of acoustic analysis of intra-word syllabic timing relations in anterior aphasics, investigated syllabic shortening in multisyllabic utterances. Analysis of the acoustic data showed that overall anterior nonfluent aphasics decreased the duration of a syllable when it appeared in a multisyllabic context as compared to when it appeared alone. However, three of the four aphenics showed an increase in duration for three syllable as compared to two-syllable words. This duration pattern was in contrary to that found among normals.

Purpose of the Study :

Numerous studies have been conducted on normals and brain damaged population to explore the temporal aspects of Speech. Keeping the results obtained from normals as standard and comparing it with the results obtained from brain damaged population, revealed that the temporal aspect of speech in general was devient among the brain damaged population. Although various studies have focussed on prosodic aspects in general among the **Normals** and **Brain Damaged** very few studies have focussed on the acoustic aspects of stress on the Brain Damaged. The duration/temporal aspects wliich is the most important acoustic correlate of stress is found devient among the brain damaged. How devient is it among the brain damaged is not very clear. Moreover, the information on the hemispheric dominance for stress is scattered.

Although many studies have been carried out to find the effect of stress on the temporal aspects of speech, most of these studies have concentrated on the sentence, phrase and word level. Few studies have been concentrated on the syllabic level and among those which have focussed on the syllabic level

[Crystal and House 1990, Gaitenby (1965), Lieberman (I960)] have shown that the effect of stress and effect of word length is best seen in the syllable. Martin (1972) maintained that the syllabic stress provide a rhythmic structure of beats that are thought to be targets for organizing the articulatory program.

Kozhevnikov and Chistouich, 1965; Fujimura and Louins (1978) have opined that the CV syllables are the elementary programming unit in speech production. Not many acoustic studies on the brain damaged have really used a CV syllable combination.

Though syllables have been used in the studies of acoustic aspects of speech, not much importance given to the position of the syllable. Fourakis (1986) have reported that the effect of stress and tempo was best seen at the initial syllable of the word. There are very few studies on the initial syllabic stress and their effect on these temporal patterns of the intial syllable in a multi syllabic context. Moreover, most of the studies at initial syllabic level have been carried out in English and various other languages. There are very few such studies on Indian Languages. Language with no specific syllabic stress position would enable us to use initial syllable. In Kannada language no specific stress position noticed at the word level. To achieve the advantages of having the syllable in the initial position, and the effect of stress in non specific stress position languages like Kannada, stress should be induced.

The left hemisphere often dominates the world of Brain and thus the contribution/function of the Right Hemisphere often goes unnoticed. Though the durational patterns have been studied among the Right Hemisphere Damaged population, it has not been studied as extensively as the left hemisphere damaged population and moreover very few studies done at the syllabic level among the Right Hemisphere. Therefore, it was considered interesting and necessary to study stress at syllabic level among the brain damaged population.

The present study was aimed at comparing among aphasics (non-fluent) with right hemisphere damaged with normals in terms of the effect of stress on the temporal patterns of the initial syllable in multysyllabic words of Kannada Language.

R E V I E W

REVIEW

Every language has sound features apart from the sound segment itself. These are termed supra segmentals or prosodic features and include length, stress, rhythm and intonation. Prosody has been viewed as decoarative ornamentations, functioning to make speech more aesthetically pleasing. Prosody is intensic and critical in both perception and production of speech. Prosody functions as the foundation or structural support for the organization of speech communication (Freeman, 1983). Perceptually, intonation assists the listener in segmenting the flow of speech by coutouring words. Syntractically, prosodic features help differentiate among the different sentence types such as declaratives, questions, imperatives through different intonation patterns. Lexically prosodic features aid in differentiating grammatical categories such as verbs and nouns. In addition, prosodic features also relate to specific pragmatic functions.

The primary prosodic parameters, along which system of linguistically contrastive features can be plotted, are the psychological attributes of sound described as pitch, loudness and duration, which have a primary relationship with the physical dimensions or fundamental frequency amplitude, and time respectively.

As Pisoni and Samesals (1971) suggest "prosody may serve as the interface between low level segmental intonation and higher levels of grammatical structures in speech". Haggard (1975), elaborates on this interface role of prosody by stating that "prosody carries direct phonetic cues to certain semantic and grammatical classes; it therefore serves to restrict the search process.

The acoustic cues for prosodic features which have received the most extensive attentions are fundamental frequency, intensity and temporal spacing of acoustic events (most frequently expressed as duration and rate measurement). These may carry segmental information also. The acoustic cue that has been labelled temporal spacing of acoustic events includes a number of time based parameters that have been studied in relation to segmental and supra segmental perception and production.

Investigators of speech motor control have increasingly focussed on timing as a critical variable in understanding the organization and execution of speech production. Most current research in the time domain has focussed on duration and rate measurements. Duration measurements used in investigators have included duration of subsequent intervals (such as stop clusters time or transition time), segment duration (both for consonant and vowels), cluster duration, phrase clause and sentence duration; duration of intervals between stressed vowel onsets or between stressed syllables; and duration of silent intervals (pause duration).

Stress :

As mentioned earlier prosodic features include stress, intonation, rhythm, rate and jucture. Stress may be defined in terms of greater effort that enters into the production of a stressed syllable as compared to unstressed syllable (Lehistle, 1970), when stress is defined from a listener's stand-point the claim is often made that stressed syllables are louder than unstressed syllables (Bloomfield, 1933). Thus, stress denotes both an aspect of the articulatory or motor side of speech and also a feature of the sounds perceived by a listener.

In the common usage, suceeding parts of an utterance are said to bear stronger or weaker stress in comparison with other parts of the utterance and normally the parts so characterised are syllables. Hence, stress is a term that refers to a relation between syllables and successive variations in this utterance constitute the rhythmic pattern of an utterance.

Sweet (1878) says "stress is the comparative force with which the separate syllables of a sound group are pronounced". According to Abercombie (1923) "stress is force of breathe impulse". Clause (1936) opines that "stress is an impulse (primarily of a psychological nature) which expresses itself in the first place by an increase of pressure in the speech mechanism and approximately coincides with the point of greatest pressure".

Trager and Smith (1951) consider that stress is assumed to be manifested by loudness, each level being louder than the next lower level. However, Bolinger (1958) says that "stress is the perceived prominence imposed within utterances". Fonagy (1966) considers stress as "the function of great speaking effort".

Thus, stress involves the rendering of one element more prominent than other elements within a unit and is achieved primarily by alterations of duration, loudness and or pitch (Allen and Hawkins, 1978, 1980; Fry, 1955; Lieberman, 1967; Lieberman, Harris and Sawashima, 1970).

Types and functions of stress :

In traditional phonetics, stress has been frequently divided into dynamic or expiratory stress and musical or melodic stress. This assumption seems to have been based on the belief that stress and pitch are independent of each other. Jones (1950, 1962) listed level stress, crescendo stress, diminuendo stress and crescendo-dimineundo stress. All four have been claimed to exist in *serbo-croatian* (Fry and Kostic, 1939; Trager, 1940).

Stress may function linguistically at word level and sentence level. **Word level stress** or **phonemic stress** presupposes that the domain of stress is a word, and that the definition of a word does not depend on a criterion involving stress (Lehiste, 1970). The minimum size of the unit of stress placement is the syllable, however stiessed and unstiessed monosyllabic words can be distinguished only within a larger utterance. Thus, the minimal unit of contrastive stress placement is a sequence of two syllables. If the placement of stress on one of the syllables of the utternace is not predictable by morphological, lexical or syntactic criteria, it is said that stress occupies an independent position within the phonology of the language. This kind of linguistically significant stress is termed as **phonemic** or free stress. (Lehiste, 1970).

Languages in which stress functions to distinguish between otherwise identical words include Russian and English. In English there are very few pairs of words that are distinguished by nothing except the place of stress. Here, stress is used contrastively. For free stress shirting the stress changes the word into another word and not into a nonword.

On the otherhand, in a number of languages the place of stress on certain syllable is fixed and is detennined with reference to the word. The position of stress identifies the word as a phonological unit (Jackobson, 1931). Placing the stress on a different syllable changes the word into a nonword. In languages with such **bound stress,** there is no opposition between stressed and unstressed syllables within word-level phonology.

Bound stress may occur on the fust syllable of a word, as in Czech or Hungarian; on the last syllable as in French or Turkish, or on the penultimate syllable as in polish. The placement of bound stress may also follow more complicated rules as in Latin where stress is placed on the penultimate syllable, if long and on the third syllable from the end, if the penultimate syllable is short (Jakobson, 1931). Shifting the bound stress results in mispronounciation.

An intermediate type between phonemic stress and bound stress is **morphological stress** (Jakobson, 1931). In languages with morphological stiess, the position of stiess is fixed with regard to a given morpheme but not with regard to word boundaries. Morphological stress may differentiate between compound words but not between individual morphemes. This kind of stress distinguishes between the two German verbs ubersetzen, "to translate" and ubersetzen "to take across". Weinrich (1954) calls this type of stiess **constructive stress.** In Tamil, the placement of stiess is not fixed (Rahavendra, and Leonard, 1989).

Sentence level stress:

When stress functions at the sentence level, it does not change the meaning of any lexical item but it increases the relative prominence of one of the lexical items. There are three types of stress (Bierwisch, 1966). Primary stress (non-emphatic stress), contrastive stress and emphatic stress.

Each sentence has automatically a **primary stress.** Here, in a segment of the sentence what the speaker wants the hearer to attend to is stressed.

Contrastive stress occurs in sequences of sentences with parallel constituents that are filled with different morphemes. In other words, contrastive stress is used to distinguish a particular morpheme from other morpheme that may occur in the same position.

Emphatic stress is used to distinguish a sentence from its negation. Occasionally, it may be phonetically indistinguishable from contrastive stress; but there are instances and languages in which two are different.

Bierwisch (1966) explains that in german emphasis is accompanied by a greater degree of reduction of other stresses in the sentence than is found in the case of contrastive stress.

Functions of stress:

Prosodic features including intonation, rhythm and stress fulfill important functions in speech perception and production. **Perceptually,** prosodic information assists the listener in sequenting the flow of speech by contouring words. **Syntactically,** prosodic features help differentiate among the different sentence types through different patterns. **Lexically,** prosodic features aid in diffemtiating grammatical categories, such as verbs and nouns. In addition, prosodic features also relate to specific **pragmatic** functions. For eg. contrastive stress is used to distinguish between topic and comment (Chafe, 1970).

Linguistic stress is a feature of speech perceived by the listener which involves complex interactions of suprasegmental elements. Bolinger (1972) has stated that the distribution of stressed elements in speech functions for semantic and emotional highlighting by drawing the listener's attention to them. Bates (1976) added that it is used to distinguish new and old information in discourse. The new information is generally stressed while the old information is not.

Baltaxe (1984) explained that linguistic stress functions to set off elements which arry a heavier information load and which the speaker wishes to place into focus. Thus, stress can be used simply to give special emphasis to a word or to contrast one word with another.

Another major function of stress is to indicate the syntactic relationships between words or parts of word. There are many noun-verb oppositions in English. For eg. "an overlfow", "to overflow" - in tin's pair the noun has the stress on the first syllable, the verb has it on the last. The placement of stress indicates the syntactic function of the word. Similar oppositions occur in cases where two word phrases form compounds such as "a walk out", "to walk out", "a put-on", "to put on". In these cases, there is a stress only on the fust element of the compound for the nouns but on both elements for the verbs.

Stress also has a syntactic function in distinguishing between a compound noun such as "a hotdog" and an adjective followed by a noun as in the phrase "a hotdog". Compound nouns have a single stress on the first element, and the adjectival phrases have stresses on both elements. If a sufficiently complex set of rules are formulated, it is possible to predict the location of stress in the majority of words for instance in English.

Cues of Stress:

Amplitude modulation is manifested in language by what is most commonly termed as stress. It has, however been observed that what is interpreted by the speaker or hearer as stress has no simple correlation with loudness. It is associated with other factors also like pitch and duration. The plurality of cues has often led to the view that what is termed as "stress" is not even basically a matter of amplitude at all and alternative definitions have been given by different investigators. Trager and Smith (1951) consider **"stress as loudness".** For them loudness is the major factor in the perception of stress. According to Fant (1957) lengthening of a syllables is the most obvious physical correlate of stress. He proposes to measure the area under syllable peak combning intensity and duration in a single measure. Bolinger (1958) consideres **"stress as accent".** Thus, for Bolinger the primary cue of stress in the utterance is pitch prominence. Lieberman (1960) considers **"stress as rhythm".** According to him it is the rhythm of the sentence that is underlying the perception of stress. For Savithri (1987) intensity and duration are the important cues.

Though difference of opinions exists, all of them agree that increments in fundamental frequency, duration, intensity and alterations in the vowel quality are the primary acoustic cues of stress. Most work to date on acoustic correlates of stress has been done in languages like English (Bolinger, 1958; Fiy, 1958; Lieberman, 1960), Swedish (Schmitt, 1956); and Welsh (Williams, 1985). It appears that the important cues for stress may differ from language to language.

Fonagy (1958) says that stress is not definable in acoustic terms and that the listener simply uses various cues as a basis for judging the degree of force employed by the speakers. Cooper and Meyer (1960) say that stress is a product of a number of variables whose interaction is not precisely known. Fisher-Jorgensen (1967) comments that none of these cues are necessary and none is sufficient alone. A number of acoustic cues correspond to a simple physiological difference and to one final feature i.e. stress. The exact cue still remains unknown.

The relative importance of fundamental frequency, intensity and duration in perception of stiess have been studied expeiiinentally in several languages including English (Fry, 1955, 1958; Bolinger, 1958; Morton and Jassem, 1965), Polish (Jassem, Morton, and Steffen-Botog, 1968), French (Westin, Buddenhagen and Obrecht, 1966), Tamil (Balasubramanian, 1981); Kannada (Savithri, 1987). Table-1 presents a brief review of findings reported in these studies.

Author	Language	Subjects	Cues
Stetson (1951)	English	-	Vowel quantity
Fry(1955)	English	100	Duration Intensity
Fant(1957)	Swedish	-	Lengthening of the syllables
Bolinger(1958)	English	-	(1) Pitch prominence (2) Duration.
Fry(1958)	English	-	(1) Duration (2) Intensity, (3) Pitch prominence.
Jassem(1959)	Polish	-	Frequency
Tiffany(1959)	American	-	Vowel diagram is larger for a stressed vowel.
Liebenman (1960)	American English	16	(1) Higher F_0 92) Peak envelope amplitude (3) Longer duration.

Author	Language	Subjects	Cues
Rigault (1962)	French	-	(1) Frequency 92) Duration
Shearme and Holmes (1962)	English	-	Acoustical vowel diagram
Lehiste & Ivic (1963)	Serbocroatian	14	Duration
Lindblom(1963)	English & Swedish	-	Length of syllable.
Morton & Jassem (1964)	English	-	(1) Variation in F_o (2) Duration, (3) Intensity.
Fonagy* (1966)	Hungarian	-	Prominence produced by means of respiratory effort.
Westin Buddenhagen & Obrecht (1966)	Swedish		(1) F_o (specially of 1st syllable) (2) Quantity, intensity.
Jasswem and Morton and Steffen Botog (1968)	Polish		F_o Variations, durations
Lehiste (1968a)	Estonian	-	Duration
Berinstein* (1979)	Kechi	10	(1) Change of F_o, (2) Intensity (3) Duration.
Bertinetto* (1980)	Italian	-	Duration
Balasubramanian (1981)	Tamil	-	Prolongation of vowel that is phonologically long. Prolongation of consonant and glottal onset. Addition of one of the two emphatic particles /e:/ and /ta:n/
Rathna,* Nataraja & Subramaniyaiah(1981)	Kannada		(1) Increase in intensity, (2) Steepness of intensity rise (3) Pause before the word (4) Duration.
Savithri(1987)	Kannada	4	(1) F_o (2) Duration (3) Intensity.
Savithri* (1987)	Kannada	4	(1) Durational changes. (2) Intensity changes.

Author	Language	Subjects	Cues
Rajupratap* (1991)	Kannada	10	(1) Durational changes, (2) Loudness changes.

Table - 1: Studies on cues of stress

*Denotes perceptual studies.

Thus though majority of cues are same, there are some differences and the cues vary with languages. For English and Polish the major cues seems to be F_o, duration, intensity whereas for Swedish, Estonian and Kannada duration is the major cues.

Measurement of stress :

Many methods have been proposed in the past to locate stress.

Lieberman (1960) gives a flow chart to represent his method of locating stressed syllables in pairs of syllables, from acoustic cues alone (Figure - 1).

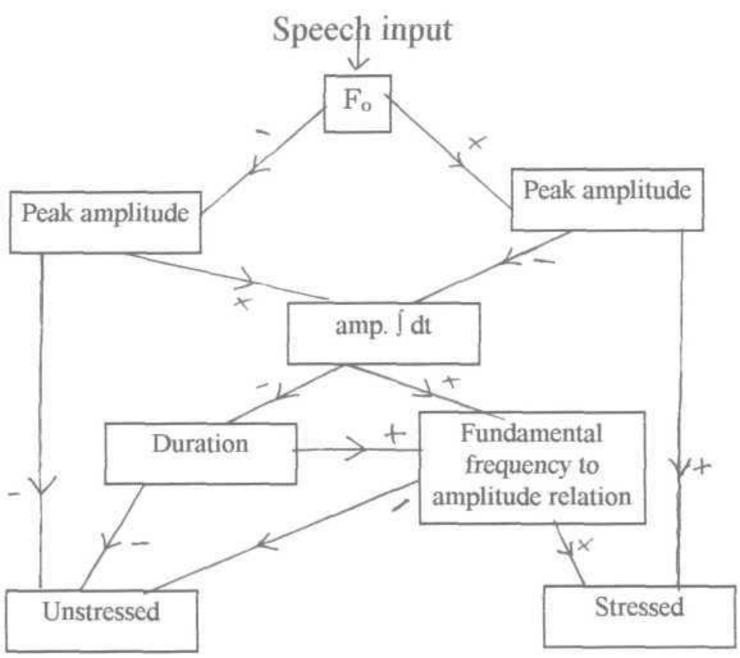


Fig. - 1: Program for mechanical recognition of stressed syllable Lieberman, (1960) The fundamental frequency criterion at the top of the flow chart corresponds to the traditional notion of "pitch-prominence". Lieberman's flow chart represents a program for mechanically recognising the stressed syllables in stress pairs.

The first step of this program is to note the syllable that has the higher fundamental frequency. This is indicated on the diagram by the positive arrow. If the amplitude of this syllable is also higher, then it is the stressed syllable. If however, the peak amplitude is lower as indicated by the negative arrow, the integral of the amplitude with respect to time over the entire syllable is noted. If this is positive and the pitch difference and amplitude ratio between the stressed and unstressed syllables fall into the permissible area, then the syllable is stressed. Many other paths can be followed that all arive at either a stressed or unstressed judgement. In Lieberman's study the judgements made on the basis of this scheme on his data were in agreement with the perceptual stress judgements 99.2% of the time.

Lea, Medress and Skinner (1975) devised a strategy for computer understanding of speech (Fig. 2). It uses prosodic features to break-up continuous speech into sentences and phrases and locates stressed syllables in those phrases. The algorithm for locating stressed syllables (from fundamental frequency contours and high energy syllabic nuclei) correctly located the nuclei of over 85% of all those syllables perceived as stressed by a panel of listeners.

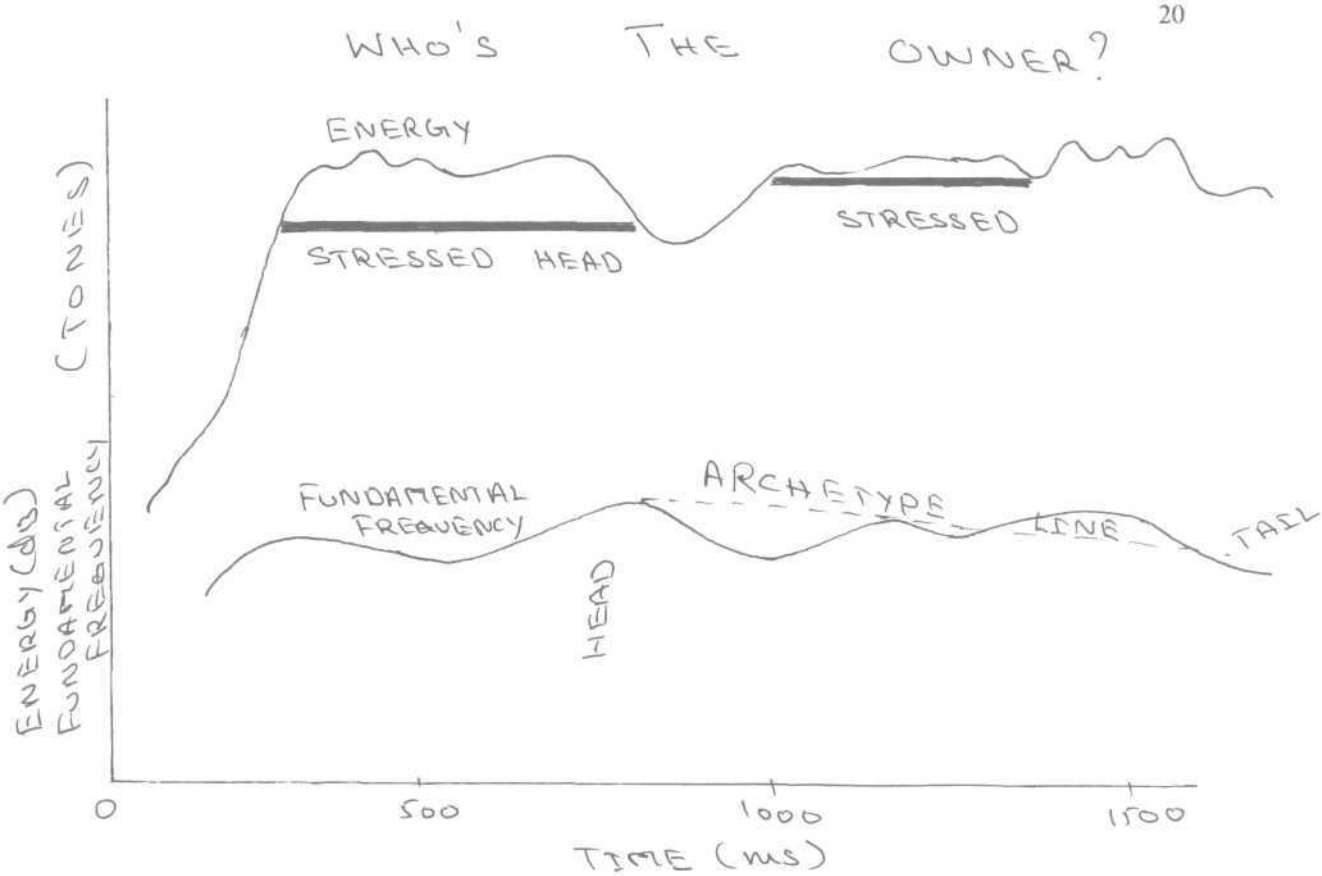


Fig.2: Archetype contour (Lea, Medress and Skinner, 1975)

Figure -2 illustrates the use of the acoustic correlaters of rising F_o and large energy integral in an algorithm for locating the stressed syllables within constituents of sentences. A stressed "HEAD" to the constituent is associated with a portion of speech which is high in energy with rising fundamental frequency and bounded by substantial (5 dB or more) dips in energy. Other stressed syllables in the constituent are expected to be accompanied by local increases in fundamental frequency ie., local rise above the gradually falling F_o contour. Thus, there are different opinions about locating stress. Some locate it by fundamental frequency prominence, some by intensity prominence and some by both F_o and intensity prominence.

Knowledge about the timing in speech helps in understanding the mechanism of speech production, speech perception in speech synthesis, automatic speech and speaker verification. Variation in segment duration are important cues of acoustic variability in the realization of linguistically identical units (Nooteboom 1973). Durational patterns reflect the speaker's mood, speaking rate and the locations of the emphasized material. The phonetic identity of different types of segment is cued by their duration (Klatt, 1976) perceptual studies of natural and synthetic speech that have been altered with regard to temporal aspects (Huggins 1972,). Indicate that listeners can perceive very small changes in segmental duration as devient. The speech sound heard is determined by the duration of a gradually changing speech event such as a formant transition (liberman et al, 1956, Suzuki, 1970). Also duration can effectively disambiguate synthatically ambiguous sentences even in the absence of cues provided by fundamental frequency and pauses (Lehiste, Olive, and Streeter, 1976).

Various factors (Klatt, 1976) affect the durational patterns. Of these, a few have been studied in Kannada (Savithri 1987) in a series of studies.

Duration of vowels : Vowel duration in Kannada, measured as the time between the onset and offset of regular- wave forms on 6 subjects revealed that the vowel duration was affected by several variables. High vowels were found to be shorter than low vowels. The voicing, aspiration and retroflexion of the post-vocalic consonants tended to lengthen the vowels and nasality and clustering of the PVC (post-vocalic consonants) shortened the vowel duration.

(1) Extra linguistic factors : Speaker's mood and physical condition, speaking rate, Age, sex (2) Discourse-level factors : Final setence lengthening, final word lengthening, final syllable lengthening. (3) Semantic factors - Emphasis-semantic novelty (4) Synthactic factors - Phrase structure lengthening, prepacial lengthening, word final lengthening (5) phonetic factors - Inherent phonological duration, effect of linguistic stress, effect of neighbouring consonants, effect of neighbouring vowels (6) Physiological factors.

Duration of consonants :

Studies on consonant duration in Kannada showed that (1) The voiceless stops were longer than their voiced counterparts. (2) Strongly aspirated stops were longer than the slightly aspirated (3) the verars were the longest among the strongly aspirated stops, (4) Geminates were longer than the non-geminates (5) Palatals were the longest among the geminates. (6) retroflexes were the shortest and palatals were the longest (7) No significant difference was noticed between the duration of consonants following vowels and (8) females exhibited longer consonant duration when compared to males.

Efficient perception and production of spoken English are dependent upon both the rhythmic structure and proper execution of syllabic stress (Martin, 1972). The complete function of stress in transmitting content in connected speech are fully described by Cruttenden (1986) and Boonsliter, Creet and Hastings (1973). "Stress is a physical signal that brings the meanings at times for which attention is mobilized in advance. It is in the temporal domain that syllabic stress may serve two additional functions required for fluent speech production; (a) to provide a rhythmic structure of beats that are though to be targets for organizing the articulatory program (Martin 1972) and (b) to facilitate coarticulations during production of the syllable's initial consonant and time. According to Wingate (1988) the processes involved in linguistic formulation create for all speakers a fault line at the juncture of syllables initial consonant and rime. The fault line is particularly cued during the production of prominent syllables when (coarticulation is more dependent upon the precise actualization of stress.

In English, segmental duration are cues for the phonetic, semantic and synthetic structure of an utterance. Klatt (1976) reviews the data regarding the perception of segmental duration and concludes that "segmental timing carries a high functional load in English". Duration was found to be primary perceptual cue in distinction such as voicing, stress and vowel intensity precisely because of the large number of factors related to segmental timing. It is very difficult to tear apart the many factors that influence segmental duration.

Prosodic categories and segmental duration stress :

A physiological source of stress, increased muscular- exertion on the part of the speaker often manifests itself in increased pitch, loudness and segmental duration. Fry (1955) studied the effects of intensity, frequency and duration variation on the perception of stress by listeners. He found that increase in stressed syllable duration resulted in for more perceptions of stress than could possibly be cued by increase in intensity.

Segmental syllabification model : The model account a discrete segmental structure for phonemes, which are taken to be the basic units that are grouped in the sequences to make syllables. The most important features of this model are, 1) every phoneme is in exactly one syllable, and 2) word boundaries are adequate syllable boundaries. Segmental syllabic boundaries can occur only before the sibilant, the stop, or the second vowel in the template under investigation.

Hierarchial syllables:

Selkirk (1982) argued that syllables have a deeply hierarchial binary branching internal structure. These liieraichical syllables are made up of two primary constituents, on onset and rhym. The rhyme is further divided into a nucleus of highly Sonorant segments followed by a coda of consonants. The nucleus branches for both dipthongs and time vowels.

In her definition of syllable, Sylkirk (1982) also advanced a theory of resyllabification according to a rule. This rule caused segments having the feature [- syllabic], typically syllabic onsets to reassociate with the previous syllabic when they are followed by an instrument syllabic. For eg: the onset [SP] of the second syllable of teaspoon will be associated with the first syllabic, rather than the second syllable. The [-stress] feature refers to lexical stress, so that resyllabification is limited to intraword contexts.

Anderson and Port (1994) maintained that using linear classification procedures, the speech timing carries a great deal of information about suprasegmentals like lexical stress and syllable structure. Porevious studies of speech timing had stress that changed in segmental and suprasegmental properties resulting in non-local changes to segmental duration (Fourakis Part; 1986, Port et al 1987: Port and Crawford, 1989).

Delattre (1966) concluded that "syllabic stress affects syllable duration for every position or type of syllable, but this conditioning is relatively strong in English, weak in Spanish and medium in German. Marios Fourakis (1986) measured the temporal characteristics of word initial stressed syllables in CVCV type words in modem Greek. It showed that the timing of the initial consonant in terms of its closure duration and VOT together comprise a voicless interval independent of place and manner of articulation.

Netsell, R (1970) conducted study to find the physiological mechanism of syllable stress. The results revealed that minimal stress contrasts are affected by the laryngeal systems and more than minimal contrasts incorporate active participation of the sub and supra laryngeal systems. The data are also supportive of Ohman's energy pulse hypothesis. In that it is speculated that the entire speech musculative is energetized for stress and that this energy is manifested differentially in the sublaryngeal, laryngeal and supralaryngeal systems as a function of the degree of stress.

According to Crystal & House (1990) - the average duration of syllables of different complexity had a quasi linear dependency on the number of phones in the syllables, where the linear factor and the vowel duration are functions of stress. The duration of stress groups had a quasilinear dependency on the number of syllables and the number of phones. Studies on duration of syllables revealed that (1) average vocalic duration is independent of the number and order of phones in a syllable, but is dependent upon stress condition(2) The duration of a syllable is a function of both its stress condition and the number of its phones. The findings of crystal and House (1990) further suggests that the average length of syllables is highly correlated with the number of segments in them. Crystal and House (1988) analyzed the syllabic stress on the duration of speech sounds. Results revealed that stress assigned to a syllable had a major effect on the duration of its components. They talked about the effect on the components seperately. Duration is affected by context, as when vowels are longer before voiced than before voiceless consonants (Chess, 1970) or when consonants are shorter in clusters with other consonants than when single (Haggard, 1973) Stress had significant effects on segmental duration. Effects of syllable stress on these durations are reported by Fry (1915, 1958), Gaitenby (1965) and Lieberman (1960) among others. Generally, in the presence of stress and at a slow rate of speech acoustic segments are longer than in any other condition, everything else being equal. Tuller et al (198lab) found that changes in stress affected syllable duration less than changes in rate.

Fourakis (1986) conducted a study to find the effect of change in stress and rate of speech on the durations of speech intervals. They examined the effects of such changes on syllable and intra syllabic segment duration in the word-initial syllables of three syllabic words in Modern Greek and found that rate and stress have equal effects.

Foorakis (1986) reported that within a word the initial syllable duration was affected by changes in both stress and tempo. The stressed syllable shortened by 25% in going from slow to fast tempo. However, it was concluded that the effects of changing tempo on the syllable duration are equaivalent to changing stress. The vowel duration is not affected by the place of articulation of the preceding consonant when stressed. The consonant durations were affected by changes in stress and temp, is exactly the same manner as the syllables.

Disimoni and Darley (1977) reported that a specification of stress would make the sound longer than when the stress is unspecified. All word initial stops have mean durations greater than all word final stops within the initial/final category, all stressed stops are longer than all unstressed stops. Disimoni and Darley (1977) examined the duration of |p| in three utterance length conditions of one, three and five words. Their results seem to suggest that while the duration of |p| decreased from the one to the three word condition, it increased from the three to five word conditions.

Several models of vowel duration been proposed in an attempt to describe and predict the effects of various factors that influence vowel duration. [Bornwell, 1971, Caisse, 1982; Crystal and House, 1988; Klatt, 1973; Lehistle, 1975; Lindblom, 1973; Lindblom and Popp, 1973; Nooteboom, 1972; Port, 1981; Van Saster and olive, 1990 and others]. Most of the current models were based on either the influence of one factor or on the interaction of two factors on vowel duration. A number of these models belong to one of the following three main categories.

(i) Incompresibility (Klatt, 1973; Nooteboom, 1972), (ii) Multiplicative [Klatt, 1973, Port 1981], (iii)Additive {Caisse, 1982, Lehiste, 1975].

The incompressibility model [Klatt, 1973] claims that the influence of various factors on vowel duration is best captured in terms of a ratio measure or proportion change in duration. It was motivated by the finding that the combined effects of two factors on vowel duration was less than the product of their independent influences because the effect of one factor was reduced in the presence of the other factor [Klatt 1973]. For eg; vowels shortened to 66 % of their inherent duration when going from a monosyllabic word to a polysylabic word, in a voiced post vocalic consonant. If both the shortening factors combined independently and multiplicatively, the vowels ought to have shortened to 44% Klatt (1973) called this resistance to compression in the presence of a second factor the incompressibility effects and proposed his incompressibility model to capture true this behaviour.

The additive model [Caisse, 1982; Lehiste, 1975] makes the claim that factors influence vowel duration in terms of a constant amount of duration rather than in terms of a ratio or proportional amount, and that two or more factors combine in an independent fashion. This model was proposed to capture the independent but additive combination of two or more factors.

The multiplicative model, although rejected by other researchers [Lindblom, 1973; Klatt, 1973] was supported by Part (1981) as he found that influence of post vocalic consonantal voicing on vowel duration was independent of the influence of vowel intensity on vowel duration. These two factors combined independently and multiplicatively. Port (1981) found this to be true for the combination of phonological factors only and not for the combination of non phonological factors which followed three production of incompressibility model.

CV syllables may be conceived as the elementary programming unit in speech production (Kozhevnikov and Chistovich, 1965, Fujimura and Lovins (1978) Intra syllabic gestures would thus be expected to be more cohesive than inter syllabic gestures. Assuming that the speech production mechanism operates on the basis of phone sized segments. It might be suggested that coarticulatory features pertaining to a later vowel are not allowed to be anticipated across an intervening consonant (Gay 1978a).

Engstrand (1988) studied articulatory activity underlying changes in stiess and speaking rate. Subjects were asked to produce VCV utterances under controlled rate stress conditions. The spectral characteristics of the vowels were not significantly influenced by changes in the speaking rate. They were however, significantly emphasized under stress. In general the study revealed that the spectral characteristics of the vowels |iau| were significantly influenced by stress but not by rate, however durational changes were nonlinear and depended on both stress and rate.

The question of the effect of stress assignment on the influence on vocalic duration of the place of articulation of the post-vocable consonant was studied by Dismoni and Darley (1977). They found that labial context (CV) produced longer vowels than the alveolar or velar contexts. Examination showed that stress caused a 2:1 increase in avereage duration for labials and alveolars and only a 1.6:1 increase for velars.

Collins et.al (1983) reported that most normal speakers in English reduce the duration of the stress word vowel as words increase in length. Theoretically, this durational reduction reflects low level linguistic knowledge.

The experimenters conducted study on the apraxic and normals. They were asked to repeat 3 sets of 3 words which progressively increased in length and they were analyzed spectrographically. Results revealed that both groups reduced vowel duration as words increased in length, words and vowel duration for apraxics of speech patients, however were often significantly longer than those for normals. Results suggested that vowel reduction is a robust phenomenon wliich resists improvement in apraxia of speech, despite often significant disturbance in motor programming.

Barnwedl's (1971) reported that the vowel necleus in a two-syllable word should be approximately 70% of its duration in a one syllable word and should approximately 50% of a multisyllabic word. Normal subjects followed this lawful order more uniformly than the apraxic subjects.

Fourakis (1991) maintained that the acoustic characteristics of vowels are affected by two processes namely phonological and phonetic vowel reduction. Phonological vowel reduction applies to unstressed vowels. Phonetic vowel reduction is supposed to apply to all vowels and caused by fast speech rates, context, as well as lack of stress. The experimenter here studied the effects of changes in stress and in rate of speech (tempo) on the acoustic characteristics of American English monophthongal non retroflex vowels in two contexts, [[*n,d] and [b,d]*], in a carrier sentence, under four conditions of tempo stress (Slow-stressed, slow-unstressed, fast-stressed, and fast-unstressed). The effect of a change in stress on vowel duration even found to be slightly larger than that of a change in tempo. Although the results indicate that tempo and stress may not have a major influence on the distance of individual vowels from the neutral point, the size of the vowel space overall was affected. The vowel space was largest for the slow stressed condition and smallest for the fast unstressed conditions.

Changes in stress and tempo can have two kinds of effects on sounds. These are effects on the temporal characteristics and effects on the spectral characteristics, while there is a general agreement that vowels tend to be shorter when they belong to a relatively unstressed syllable and also when spoken at a faster tempo there is disagreement as to whether the effects of stress and tempo are equivalent i.e., when either stress or tempo is varied, with the other held constant, which variable has a greater effect on vowel durations. Tuller et al (1982), reported syllable duration in English under different conditions of stress and tempo. Both of tlieir speakers showed gieater effects of tempo than of stress.

With respect to the effect of tempo and stress on the spectral characteristics of vowels, there are also conflicting reports on the nature of these effects and their relationship to the temporal reduction brought about by these two factors. Lindblom (1963) examined eight Swedish vowels, stressed and unstiessed, with slow and fast rate of speech. He found that fast tempo and lack of stress resulted in a shortening of these vowels and that this shortening was strongly correlated with formant undershoot, defined as failure to reach target formant frequency. Lindblom (1963) stated that "as the syllable decreased in duration, the vowel became reduced or more schwa-like in character (Miller 1981). Concerning the temporal shortening effects, it was found that a change in stress had a sliglitly gieater effect on vowel duiations than a change in tempo. This difference although small was statistically significant.

Klatt (1976) maintained that the pattern of duration of individual phonetic segments and pauses convey ifhromation about the lingusitic content of an utternace. Acoustic measures of segmental timing have been used by many investigators to determine the variables that influence the durational structure of a sentence. It was concluded that in English, duration often serves as a primary perceptual cue in the distinction between (1) inherently long Vs short vowels. (2) Voiced Vs voiceless fricatives. (3) Phrase-final Vs non-final syllables. (4) Voiced Vs voiceless post vocalic consonants, as indicated by change to the duration of the preceeding vowel in phrasal final position. (5) Stressed Vs unstressed or reduced vowels and (6) The presence or absence of emphasis.

Berinstein (1978) conducted study to determine the hierarchy of acoustic correlates of stress in K'eckchi language and to determine the relative importance of these acoustic parameters in signalling the distinction between stressed and unstressed syllables in the language. Four acoustic parameters used by speakers in producing the stress/nonstress distinction were measured. F_o ratio, peak F_o, peak vowel intensity and duration. Differences in duration within words are due to the phoneme length distinction, not to stress. Thus durationis poorly correlated with stress, rather it is dependent on phonemic length and word type.

Thus so far it was seen that in K'eckchi certain acoustic pararnters like F_o ratio, peak F_o, and peak intensity-are correlated well with stress, whereas duration is not. Also, in the perception experiment it was found mat duration was not a good cue for stress. One reason for this is that because it is used to signal a phoneme length contrast in the language. However, this effect is not true (i.e., duration not important) for all languages In conclusion, the imporance of acoustic correlates of stress in K'eckchi is indicated primarily by a change of F_o, secondarily by intensity and finally by duration. Further, thefindings regarding this language supports the hypothesis that:

1. Duration has little or no cue value to the stress/no stress distinction in a language in which there are long and short vowels distinguished solely by length.
2. In languages with no phonemic contrasts in tone or length, the "unmarked hierarchy" for cues relevant to the perception of stress will be primarily indicated by a change of F_o, next by duration in and lastly by intensity. In language with such contrasts, the subjective cue correlating to that contrast will be superceded by the other cues of the hierarchy.

The duration acts as a poorer cue for either production or perception in K'ekchi language. This may be due to the final stress in this language. In order to explore if this final stress is the cause for poorer duiational cue Beinstein compared K'eckchi with another language cakchiquel, a related Mayan language with final stress. It was found that a language with a fixed location of stress does not necessarily have a position bias which coincides with the stress role. This is because, it is not always the case that this position will be cued. It has been seen that in K'eikali that the position is not cued by duration while in cakcdiquel (to some extent) it is. This, cue is argued because duration is used to signal a vowel length contrast in a K'eckchi and it is not used in this way, in cakchiquel, therefore, it is stated that whether or not a position will be cued for stress in languages with a fixed stress role is dependent upon the phonemic cue of length (or pitch) in that langauge. The way in which a listener uses this information depends upon his/her expectation of stress properties which may vary from language to language.

Oiler (1973) studied the duration of speech segments as a function of position in utterances (initial, medial, final). They used nonsense syllables as the stimuli. Results showed that final syllables were found to be longer than nonfinal syllables. Final-syllable consonant increments were less than vowel increments, for instance, absolute final consonant increments were about 20 msec. Also word initial consonants were found to be lengthened by 20 - 30 msec over medial consonants. It was found that in English non-sense syllables (1) final syllable and initial-consonant lengthening occur in utterances with various intonational pattern (imperative, declarative, interrogative). Final-syllabic and initial consonant lengthening occur in various kinds of syllables, including syllables with dipthongs, with fricative consonants, with voiceless stops with consonant clusters and with no final consonants i.e., CV syllables.

Studies on the physical correlates of stress should take position-in-utterance effects into consideration. Data from the present study as well as from others indicate that final unstressed syllables may be longer than non final stressed syllables. Comparison between final unstressed syllables and non final stressed syllables could suggest that duration is not a correlate of stress at all. Obviously, studies of the physical correlates of stress should compare the duration of final syllables only with that of other final syllables.

Some aspects of the articulatory control process causes durational increments in certain position in utterances. Boundary-eue-fluency was found to be a good aid for final explanation of this effect. This not only explain final syllable lengthening but also word initial consonant lengthening. Explanations for final lengthening are : Due to final-syllable intensity drops. General relaxation of speech gestures towards the end of differences according to Ohman's model of vowel and sentence intonation. It should be noted that total speech energy remains constant on syllables of the same degree of stress. These studies show how the suprasegmentals specifically the stress and its acoustic correlates influence the comprehension and production of speech. Speech on the other had has a very intricate relationship with language.

It is a well known fact that language is represented in brain and it is species-specific behaviour. This is made possible because of an innovative and complex CNS and bodily structures that make this high form of communication possible. This CNS is designed to process sequentially complex aspects of language. A schematic representation of the respective roles of the right and left cerebral hemispheres of the Brain in cognitive processing as portrayed in the literature, calls to mind a socio economic map of the world. The left hemisphere is the industrialized, economically developed sector. It dominates the world of brain taking control not only in situations in which it is in fact better equipped to do so, but also in situation inwhich the right hemisphere might have performed quite adequately albeit by different perhaps less sophisticated methods. The right hemisphere in this analogy, is the underdeveloped, third world sector, of the brain defined by more or less diffuse organizational principles and possessing crude but nonetheless valuable resource which often go untapped and underutilized.

The right hemisphere was until recently an uncharted territory. Only in the last 20 years have investigators began to identify various roles of the right hemisphere. Most of the evidence that has been presented does not support the clinical view point that verbal communication is under the exlusive control of the left hemisphere. Studies indicate that the integrity of the right hemisphere is necessary for those cognetive processes that allow for many of the components of verbal communication which are not necessarily covered by linguistic processes per se.

The left hemisphere on the other hand has been the one that has been most extensively studied. Although some of the earliest medical records refer to languge disorder after brain damage, it was not until the second half of the

19th century that aphasic (the left hemisphere damaged population) was explored more systematically.

The relationship between hemispheric processing and linguistic prosody remains unclear. Specifically research studies undertaken to examine the expressive aspects of linguistic prosody have reported deficient functioning in Left Hemisphere Damaged (LHD) adult patients and for normal production in Right Hemisphere Damaged (RHD) patients (Behrens, 1988, 1989, Cooper, Soarer, Nicols, Michelow and Goloskie, 1984,. However other research studies have reported deficits in the expressive aspects of linguistic prosody in RHD patients (Shapiro and Danley 1985, Weintraub, Mesulan and Krammer 1981). Further research studies examining the receptive aspects of linguistic prosody have reported deficient functioning in LHD patients (Baum, Daniloff, Daniloff and Lewis 1982). Heilman et.al (1984) reported that LHD patients and RHD patients differed equally as compaied with normal controls in tlieir inability to comprehend linguistic prosody.

Aphasia is a many faceted problem,and has been studied using different frameworks. The realization that the problem is complex has persuaded investigators, of the need for communication across discipline. According to Eisenson (1973) Aphasia is an impairment of language functioning of persons who have incurred localized cerebral damage that results in a reduced likelyhood that an individual involved in a communicative situation will understand or produce appropriate verbal formulations.

It is clear that aphasic persons experience difficulty in understanding and/or producing appropriate verbal formulation. Thus there exists a communication gap, or a barrier between them and their common patterns.

Various workers in the field of aphasiology over the years have classified various aphasic syndromes. In general, in individual aphasics researchers have tendered to develop their own tenninology to differentiate the various types of aphasia based on their idea of the nature of aphasia.

Many authors make use of simple dichotomies to classify aphasia. The two most widely used dischotomies are the expressive receptive division proposed by weisenberg and McBride (1935) and the motor-sensory division originally introduced by Wernicke (1874). Two additional dichotomies also frequently used in the literature include the fluent. Non-fluent (Benson, 1967) and anterior Posterior (Goodglas and Kaplan, 1972) dichotomies (Murdoch 1990).

Recent years have seen renewed interest in the speech production deficits exliibited by aphasics. Most recent acoustic/phonetic reseaich has demonstrated that anterior aphasics generally display articulatory implementation deficits, whereas posterior aphasics exhibit deficits in phonological planning (Alaiovanine, ombredone and Durand 1939; Blumstein et al, 1977; Blumstein et al 1980; Tuller, 1984).

Most phonetic investigations of speech timing in aphasic speakers have focussed on segment-sized linguistic units ie., consonants and vowels. It has been found that non-fluent aphasics experience difficulty with temporal control of voicing in stop consonants and usually in nasal consonants (Blumstein and Baum 1987). Their timing deficit is usually attributed to an impairment in a phonetic motoric component. Fewer studies have focussed on timing relations that go beyond individual speech segment.

In particular, acoustic analysis have shown that Broca's patients have problems with the temporal control of articulatory gestures, especially those requiring the coordination of two independent articulators eg: the larynx and the tongue or lips in the production of voicing in stop consonants and the velum and the tongue or lips in the production of nasal consonants. (Blumstein et al 1977; Blumstein et al; 1980).

The speech out put of a Brocas aphasic has traditionally been described as dysprosodic (Goodglas and Kalpan, 1983). The clinical use of the term has generally cannoted a deficit in all aspects of prosody with perhaps a primary deficit in the programming of fundamental frequency. However, recent finding from acoustical analysis of Broca's speech have indicated that not all aspects of prosody are equally impaired, others are clearly intact. In particular speech timing appears to be relatively more disturbed than fundamental frequency (Danly and Shapiro, 1982).

The initial motiviation for investigation of Right Hemisphere processing of prosody is based on clinical impression of RHD patients whose speech is characteriszed as general intact, but with a disruption of overall prosodic contours and emotional tone (Heilman, Scholes and Watson, 1975; Searleman, 1977). This disruption is called in Manrod-krohn's (1947, 1963) terms, dysprosody. Monrad-Krohn's (1947) recognised that prosody function at various levels in the communication act which also includes linguistic prosody. Although prosody may serve various functions, its acoustic manifestations involve a number of acoustic parameters, including amplitude, duration and F_o (Fry, 1955, Lieberman, 1960, Morton and Jassens 1965) research has implicated Right Hemisphere control for linguistic prosody (Shapira and Danly, 1985; Weintraub, Mesulam, and Kramer, 1981). However, investigations into the production of linguistic prosody by this population are mixed.

Acoustic investigation has been carried out by Emmorey(1987) Copper, Scares, Nicol, Michelow, and Goloskie (1984) and by Shapiro and Dandy (1985), on the prosodic component of speech produced by RHD population. Emmoreys (1987) examined the use of duration and F_o to distinguish compound nouns from noun phrases in the speech of left and right hemisphere damage. He concluded that RHD was associated with an intact ability to produce stress contrasts.

With reference to stress, the paitients (LHD and RHD) cannot be described as aprosodic, ie., failing to produce the acoustic correlates of stress, nor can they be considered dysprosodic, i.e., using the correlates in an abnormal manner.

Code (1987) stated that it is generally accepted that the right hemisphere is involved in the processing of prosody. The evidence cited for this comes from investigation of prosody after RHD and from dichotic studies with normal subjects. However, the nature of the right hemisphere's role in the processing of prosody is not so clearly specified but many claims have been made with regard to this processing (Ryalls and Behrens 1988). Bryan (1989) conducted study on group of RHD, LHD and normals on a series of tests designed to examine discrimination and production of different aspects of linguistic prosody. These included lexical stress, emphatic stress, lexical stress in sentence contexts and intonation. The RHD were significantly impaired on all of the tests as compared to the control group. Furthermore, they were impaired as compared to the LHD on some of the tests. This support the notion that right hemisphere has an important role in the processing of linguistic prosody.

Blonder et al (1995) maintained that RHD showed more restricted fundamental frequency (F_o) Contour, no changes in the timing of peak F_o, an increased rate of speech, less variability in pause duration and no change in breath-group duration. In a spectrographic study of lexical stress in compound words and noun phrases, Ernmorey (1987) found that RHD patients' utterances were intact. Like wise, Behreins (1988) studied contrastive stress production using acoustic quantities and found that RHD patients were able to produce stress contrasts.

Number of studies have suggested a semi superiority for emotional prosody, both in comprehension (Heihnan et al, 1975; Weschler 1973) and in production (Rors, 1981, Tocker, Watson and Heihnan, 1977). Further research has implicated right hemispehere control for linguistic prosody as well (Shapiro and Danly 1985; Weintraub, Mesulam, and Kramer, 1981). Results of comprehension tasks with non emotional stimuli alternately attribute preserved (eg: Heihnan, Bowers, speedie, coslett 1984) and diminished processing abilities in RHD groups for perception of intonation types, contrastive stress and the like.

Acoustic investigation has been carried out by Emmovey (1987) Copper, Soares, Nicol, Michelou and Goloskie (1984) and by Shapiro and Danly (1985), on the prosodic component of speech produced by RHD population. It was found that RHD speakers approximate normal production to a greater extent than did non-fluent aphasic patients. Thus, concluded that RHD was associated with an intact ability to produce stress contrasts.

Behrens, (1988) reported of a general prosodic disturbance associated with right hemisphere damage (RHD). Production of phonemic stress token (eg: Re'dcoat Vs red coa't) as well as examples of contrastive stress, or sentential emphasis (eg: sam hated the movie) were elicited from 8 male RHD's and 7 controls. The patients as a group produced fewer acoustic cues to stress compared to the normal subjects but no statistical difference 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 that that for the normal group although a high degree of variability was evident in both population. Thus suggesting a spared processing mechanism for linguistic processing in RHD speakers, thus mitigating against the view of a general dysprosody tied to RHD.

Behrens (1989), proposed that the integrity of acoustic patterns in the speech of neuiological patients may be dependent on the size of the linguistic domain involved (syllable/word Vs sentence). For phonemic stress, prosody is manifested at a syllabic level, with potential programming spanning only one lexical unit or a short noun pluase. Contiastive stress is conveyed at a lexical level, yet must involve planning over a sentence length unit (Cutter and Isard 1980). Baum et al (1990) reported that the presumably greater programming demand of contiastive stress has little effect upon the integrity of acoustic correlates to that stress, consistent with the hypothesis of an articulatory implementation deficit in these patients.

In her study of inter syllabic timing relationships in the speech of nonfluent and fluent aphasic patient, Baum (1990, 1992) measured syllable duration in triplets of words increased in length and from 1 to 3 syllables. Both groups of aphasic patients exhibited the expected shortening of the root syllable in two syllabic words. Unlike normals, however, no further decrease in root syllable duration in 3 syllable words. Ratio measures indicated that non-fluent aphasics did not decrease syllabic duration as much as either fluent aphasics or normal.

Boongirdo et.al (1993) examined temporal characteristics of mono syllabic, bisyllabic and tri syllabic words in Thai to evaluate timing at the word level in brain damaged patients. Subjects included young and old normal adults, right hemisphere damaged patients and left hemisphere non-fluent and fluent patients. Utterances were produced at a conversational speaking rate. Results indicated that as an absolute or relative measurement scale, magnitude of the shortening effects on non final-syllables in poly-syllabic words was significantly smaller in left non fluent aphasics than in other groups. In trisyllabic words duration of the penultimate syllable for left fluent aphasics was also significantly longer and mat for normal. Left non fluent and fluent aphasics are significantly more variable than other speakers in their production of bisyllables and trisyllablic words. These findings, however, are congruent.with those of simoni and Darley (1977). They attributed the temporal disturbances in longer utterances to a slower rate of articulation.

Acoustic phonetic investigation of consonants and vowels produced by aphasic or apraxic speakers have shown that they experience difficulty with articulatory implementation of temporal parameters of speech (Kent and Rosenbek 1982, 1983; Ryalls 1981: Ziegler and Von cramon 1986). However, not all temporal parameters are equally susceptible to disturbance (Baum, Blumstein, Naeser and Palumbo, 1990, Blumstein and Baum, 1987). Ryalls

(1987) concluded that the degree of disturbance in vowel operation varies depending on the size of the linguistic unit within which vowels are produced. Posterior and anterior aphasics have been reported to exhibit greater variability in vowel durations than normals (Ryalls 1986). Gondour and Dardarananda (1984) found that despite increased variability, the relative contrast between short and long vowels remained relatively intact in the speech of anterior aphasics.

Gandour et.al (1992) explored the extent of timing deficits in vowels produced by brain damaged speakers of a language with a phonological cantrast in vowel length. Short and long vowels in Thai were produced in isolated monosyllabic words by 20 normal adults and 14 right hemisphere patients and 17 left hemisphere apahasics. Vowel duration was measured spectrographically. Although the phonological contrast was relatively preserved, as indicated by average duration, a subtle timing deficits in vowels produced by non-fluent aphasics was indicated by a compressed duration continuum and increased variability in vowel production. Thus the timing deficit in anterior aphasics is not only seen in increased linguistic units but also in monosyllables. Despite increased vaiiability, Duffy and Gawle (1984) and Ryalls (1986) similarly found that relative difficulty in vowel duration were preserved in monosyllabic utterances produced by English speaking apraxics and anterior aphasics, respectively. Timing control of vowel duration at the monosyllabic level is eventually intact in right hemisphere patients and fluent aphasics. The performance of the right hemisphere non-aphasics rules out the possibility that a general brain damage may be responsible for the timing deficit.

Rather than a uniform prolongation of both short and long vowels, nonfluent aphasics differentially lengthened and shortened short and long vowels, respectively, resulting in a compression of the duration continuum. Thus any disintegration of timing control is not simple and consequence of a slowed rate of articulation. Ryalls (1987) concluded that vowel lengthening in non-fluent aphasics appears to be significant in polysyllabic utterances only. Baum et.al (1990), found that vowel produced by anterior aphasics in isolated monosyllables was longer than those produced by posterior. Thus the linguistic size cannot be solely attributed to increase lengthening of vowel although anterior aphasics seem to be particularly vulnerable to those phonetic parameters requiring the temporal integration of the movement of two independent aiticulators (Blumstein and Baum 1987). This finding emphasizes that disruption of timing control may still be found in phonetic parameters that do not require such temporal integration of articulators. Tin's is seen in vowel length in Thai.

Keller (1975) conducted a spectrographic study of aphasic speakers' vowel production which demonstrated divergences of both a phonemic and a phonetic nature from normal speakers. Ryalls (1981) conducted a spectrographic study of vowel production in French monolingual motor aphasics and compared them to normal speakers. In general, there was more variability in vowel productions on the part of the aphasic speakers as a group and this greater variability reached a statistical significance in several instances. There were also a few cases where the aphasic speakers demonstrated differences in average formant means, which was taken as an evidence of "phonetic disintegration of internal phonemic targets". Vowel durations for the aphasic speakers were significantly longer than were those for normal speakers.

Ryalls (1986) conducted a comparative study of vowel production in anterior and posterior aphasics using ninee nondiphthong vowels of American English and compared to a group of normal. F_o, vowel duration and first two formants of the vowel were meausred. Although there were no significant difference in the formant frequency mean across groups, there were significantly longer standard deviations for the aphasic groups compared to normal. Standard deviations of duration were significantly greater for the anterior aphasics compared to normals.

The study has discussed some of the ways in which vowel production might be acoustically compared across groups of speakers. The role of stimulus length should also be taken into consideration, as Kent and Rosenbek (1983) have pointed out. These researchers found that vowel lengthening for their subjects increased as the syllabic length of the utterance increased. The stimuli in Ryalls (1981), where a significant difference was found between anterior aphasics and normal speakers for vowel duration, were polysyllabic.

It could also be the case that brain damage in general, results in some form of impairment of phonetic output, even if this damage occurs outside the cortical language areas. Aphasic patients maintain good control of acoustic features that relate to supra-laryngeal control, although they are more variable in this control. Increased variability is a general feature of aphasics no matter what the linguiistic level.

Analysis of vowel durations indicated that the anterior aphasics produced overall longer vowels than did either anterior posterior or posterior aphasics. The findings that overall vowel duration is larger for anterior aphasics compared to normally has been reported by various researchers (Cf. Ryalls, 1987). There are at least two explanations for these findings. One is that the subjects overall production of sound segments is slower resulting in longer vowel duration. Another is that these patients are having difficulty producing the final consonant at the CVC utterances and as a result, there is a consequent lengthening of the preceeding vowel.

Baum et.al (1990) conducted a study to determine whether both anterior and posterior aphasics exhibit deficits in temporal coordination, and if so, whether these deficits are the result of the same or different underlying mechanism. This study explored a number of temporal (durational) parameters of consonants and vowel production. Detailed analysis of CT scan lesion data were also conducted to explore whether more specific neuroanatomical correlation could be made with speech production deficits. A series of acoustic analysis were conducted including voice-onset time, intrinsic and contrastive vowel duration as produced by Broca's aphasics with anterior lesion (A patient), non-fluent aphasic with antereior and posterior lesion (AP patients), and fluent aphasics with posterior lesions (P Patients). The constellation of impairments for the anterior aphasics including both the 'A' and 'AP' patients suggests that their disorder primarily reflects an inability to implement particular types of articulatory gestures or articulatory parameters rather than an inability to implement particular phonetic features. They display impairments in the implementation of laiyngeal gestures for both consonant and vowel production. These patterns seems to relate to particular anatomical sites involving Broca's area, the anterior limb of the internal capsule and the lowest motor cortex areas for larynx and tongue.

The constellation of impairments for the anterior aphasics including both the 'A' and 'AP' patients suggests that their disorder primarily reflects an inability to implement particular types of articulatory gestures or articulatory parameters rather than an inability to implement particular phonetic features. Difficulties with laiyngeal control have also emerged for anterior aphasics, not only in the production of voiced fricatives but also in earlier research analyzing the spectral patterns for the production of place of articulation in stop consonants (Shinn and Blumstein 1983). Thus, anterior aphasics seem to have impairments in the implementation of laiyngeal gestures affecting not only voicing in consonant production, but also those spectial parameters that reley on the interaction of the laryngeal system and the supra-laryngeal vocal tract system.

Analysis of vowel durations indicated that the anterior apliasics produced overall longer vowels than did either AP or P Apliasics. The findings that overall vowel duration is longer for anterior apliasics compared to normals had been reported by various researchers (Ryalls. 1987).

Mc. Neil, et al (1990) studied the speech timing characteristics of apraxic and conduction aphasic speakers. Acoustic analysis was used to obtain absolute utterance durations, segment duration and vowel formant trajectories from utterances produced under control, fast and slow rate conditions. Segment-to-whole ratios and slope values were calculated. Results support the hypothesis presented by Kent and MC Neil (1987) that there is a phonetic motoric component contributing to the speech patterns of both the aproxic and conduction aphasic speakers sample. The compensatory slowing hypothesis suggested by several investigators (eg: Darley, Aronson and Brown 1975) proposes that aproxic speakers might purposefully decrease their speaking rate to enhance speech production. In oilier words, the slow performance is the compensatory result of the speech motor control deficit. Another hypothesis is that the decreased rate of speech might also be explained by an impaired comparator system which requires more time to validate the production relative to some internal target representation. Monred-Krohn's (1963) reported that dysprosody in Broca is solely the result of articulatory difficulties and not a manifestation of underlying linguistic deficits.

Examination of the physiological control of speech, the relationship between breathing patterns and speech prosody, for eg, may also be a useful means of understanding neurolinguistic issues. In a study of spontaneous speech production and respiration. Sehonle (1979) has documented two types of breathing patterns one associated with a silent resting state and the other accompanying speech. Broca's aphasia may exhibit exaggerated patterns of swift inspiration and slow exhalation during utterances they are attempting to integrate. Reflecting a basic level of organization, records of breathing patterns may provide independent evidence for the segmentation of utterances which span several breath groups.

Acoustic analysis of the global attributes of speech production in anterior patients has suggested that tliese patients have difficulty in the lining of articulatory movements as well as in laryngeal control. (Alaiovanine et al 1939; Lehiste, 1968; Shawkweriler) or and Harris, 1966). It has been suggested that this difficulty reflects a speech mechanism characterised by articulatory weakness and articulatory movements which are often spastic and excessive in force and duration. Anterior aphasics evidence a deficit in the timing or integration of movements of the articulatory system.

Shin and Bloustein have concluded that on the one hand static aspects of speech productions seem to be relatively preserved in Broca's aphasics on the other hand, the dynamic aspects of speech production seem to be impaired. According to Kant (1976), timing may be the most critical factor in skilled motor performance. Smith (1980) recorded the speech of severe patients receiving cortical stimulation during epilepsy surgery were acoustically analyzed and duration measurements of the sound |s| under stimulation and nonstimulation conditions were compared. It was found that in the dominant hemisphere, stimulation tended to significantly increase the duration of |s|; but not all stimulation sites were comparably affected. Stimulation of frontal lobe locations was also observed to more frequently result in durational increase than when temporal or parietal sites were stimulated. However, for sites affected, the actual magnitude of durational increase was comparable among the three lobes.

Thus it does seem that stimulation of the language dominant hemisphere most commonly lengthens speech segment durations. However, there do appeal to be differential effects among various sites, some locations seem to be affected substantially more than others. It also appeals that stimulation of the non-dominant hemisphere location does not appreciably affect speech-segment duration. Thus, as has been observed for so many other language-related performance speech tuning control may also be associated with dominant hemisphere function. Based on these data, it was therefore concluded that stimulation of the dominant hemisphere, frontal lobe locations tends to be associated with segment dmation increase more frequently than are temporal and parietal lobe stimulation.The anterior motor speech area is in some way involved in speech timing contiol and that coitical stimulation disrupts that function. The fact that other sites at some distance from anterior motor speech areas also exhibit similar effects, however, might be the result of transcortical and/or subcoriical connections between anterior, speech motor areas and the more posterior location involved.

Guellette and Baum (1993) explored the ability of LHD and RHD and normal speakers to produce acoustic correlates of linguistic prosody. Results indicated thai LHD aphasic demonstrated patterns of durational alterations thai were statistically different from those obtained for the contiol and RHD groups. The data are indicative of a basic impairment in speech timing subsequent to LHD. Thus showing the superiority of LHD is the processing of prosody (stress specifically).

The findings of impaired durational manipulations in the encoding of prosody is consistent with past acoustic evaluations of the speech of non-fluent LHD speakers (Danly and Shapiro 1982, Gandour et.al 1989). Together, these findings lend support to the hypothesis of differential laieralisaiion for the processing of different acoustic parameters (Behrens 1989, Cooper et al 1984, Danly and Shapiro 1982, Gandour et al 1989, Ryalls 1982). In addition, it is of interest to note that impaired control of temporal parameters of speech of the segmental level has been implicated in LHD patients with frontal lesions (eg: Baum 1990, 1992, Baum et.al 1990, Blumstein et al 1977, 1980, Duffy and

Gawle 1984, Tuller 1984, Ryalls 1986). It is possible, then, that deficits in the processing of linguistic prosody attributed to LHD speakers may reflect a more basic impairments ot speech timing in these patients, defective prosodic processing may be only symptomatic of this more pervasive impairment.

Dardarananda et.al (1989) conducted a detailed acoustic analysis of timing, intensity and F_o of a Broca's aphasic who was a native speaker of Thai. Timing was measured with respect to syllables, phrases and sentences in connected speech. F_o variation associated with the five Thai tone was measured in both isolated words and connected speech. Results indicated that timing was differentially impaired depending upon complexity of articulatory gesture and size of the linguistic structure. Timing, as well as intensity, was aberrant at the sentence level. In contrast F_o contours of the five tones were spared at all levels of linguistic structure. Findings were interpreted to support the view that dysprosody in Broca's aphasia was more applicable to speech timing than to F_o.

Ouellette and Baum (1993) explored the ability of LHD non-fluent aphasics, RHD patients and normal speakers to produce acoustic correlates of linguistic prosody; production of phonemic stress contrasts (eg: **Black'** board Vs black **board)** and contrastive stress token (eg: the man took the **bus)** were elicited and subjected to acoustic analysis. Results indicated that RHD and LHD groups resembled normal speakers in the use of fundamental frequency (F_o) and amplitude to encode stress, indicating preserved abilities in both neurological population. However, the LHD aaphasic subjects demonstrated patterns of durational alterations that were statistically different from those obtained for the control and RHD groups. The data are indicative of a basic impairment in speech tuning subsequent to LHD. This study did not necessarily lend support to the notion of a left hemispheric dominance over linguistic prosody (Baum et al. 1982, Behrens 1985, 1986, 1988, cooper et al 1984, Emmorey 1987) nor are they wholly consistent with a functional load theory of prosodic lateralization (Behrens 1985, 1986, 1988). Rather, the relatively present prosodic abilities evidenced within both neurological patient groups may argue against past models of lateralizations for specialized prosodic processing. The isolated impairment in the use of duration as a cue to prosody reported for the LHD group indicated that these patients suffered a primary deficit in the control of speech timing which was not necessarily restricted to a prosodic domain.

In all studies where production impairments have been revealed in both anterior and posterior aphasics, temporal parameters of speech have been implicated. Consideration of temporal parameters provides a means of exploring the nature of the production deficits in aphasic patients. There are a number of durational parameters that may serve either a phonological or phonetic function in English. For eg: duration serves a phonetic role in fricative consonants. Each fricative has its own characteristic duration with [f, θ] in English being shorter in duration than $\left[S, \check{s}\right]$ Because this duration parameter characterizes an intrinsic property of these fricatives, it is not used in the language system to distinguish among the class of fricatives, duration in this case is a phonetic feature. There are number of temporal parameters which function contrastively (Phonological) in English. These include VOT, vowel duration, noise-onset time. These temporal parameters which have an intrinsic but no contrastive parameters in English include difficulty in intrinsic vowel length (eg: tense vowel such as |i| are longer than lax vowels such as [I]) and intrinsic fricative noise duration (eg: [f] and [θ] are inherently shorter than [S] and $\begin{bmatrix} v \\ s \end{bmatrix}$. In Wernickes' only those durational cues that signal phonological contrasts should be compromised and those durational parameters that reflect intrinsic phonetic characteristic should be spared. In contrast, in Broca's, all durational attributes should be compromised regardless of their phonological (contrastive) or phonetic (intrimic) status.

The VOT studies by Blumstem et al (1977), Iron et al, 1982: Shewan, Leeper and Booth, 1984; Toller, 1984) concluded that anterior aphasics have a deficit in the coordination of articulators required for the acoustic production of voicing contrasts. Studies on fricatives point to a potential temporal coordination impairment for anterior aphasics.

Tuller (1984), vowel durations for the aphasics subjects were longer, overall, than those for normals. Ryalls (1986) found no significant differences between anterior, posterior and normal subjects' vowel durations but found that standard deviations of the duration measures were significantly larger in the anterior aphasics group than in normal. Further concluded a phonetic deficit in both anterior and posterior aphasic speakers. There is also the notion that dysprosody in Broca's is not solely a manifestation of articulatory or phonatory deficits, but instead a manifestation of timing disturbances over larger-sized linguistic units.

Thus it is evident from literature that the durational aspects has been the focus among the Brain Damaged individuals. However, the results of these researchers on the durational aspects are scattered.

METHODOLOGY

METHODOLOGY

Studies have been carried out to find the effect of stress on the temporal aspects of speech, most of these studies have concentrated on the sentence, phrase and word levels. Very few studies have concentrated on the initial stress syllable in a multisyllabic context. Moreover, most of the studies at initial syllabic level have been carried out in English and various other languages. There are no studies on Indian languages. Further, though the durational patterns have been studied among the right hemisphere damaged population, it has not been studied as extensively with the left hemisphere damaged population and moreover very few studies ahve been done at the syllabic level among the right hemisphere.

The present study tlierefore aimed at comparing Aphasics (non-fluent) with Right Hemisphere Damaged with normals in terms of the effect of stress on the temporal patterns of the initial syllable in multisyllabic words of Kannada language.

It was therefore, decided to consider the following measures to compare among the normals, Right Hemisphere Damaged and Left Hemisphere Damaged.

Acoustic Parameters.

Frequency		**Unit**
Mean Fundamental frequency	:	H_z
Mean First formant frequency	:	H_z
Mean second formant frequency	:	H_z

Temporal Measures

Mean initial stressed syllable duration	:	msec
Mean vowel duration of the initial stressed syllable	:	msec
Mean consonant duration of the initial stressed syllable	:	msec
Mean whole word duration	:	msec

SUBJECTS :

Eighteen subjects participated in the experiment. Four had unilateral left Hemisphere Damage and four had unilateral Right Hemisphere damage and ten were non-neurological controls. The controls were without a history or evidence of speech, language, cognetive or neurologic deficits as measured by a neurologic examination conducted by a board Certified neurologist and by a large battery of standardized speech, language and cognetive tests administered by a certified speech language pathologist. The subjects were native Kannada speaking right handed adults who could read and write Kannada.

Medical criteria for inclusion of the brain-damaged subjects were :

- Vascular etiology.
- Single insult.
- Six to thirty months post-onset of cerebro-vascular accident (CVA) and individuals who suffered from trauma or rumours were excluded.

The extent and localization of lesion deficits for subjects through C.T. Scans provided when available. All the Left Hemisphere Damaged Patients had been diagnosed by a speech-language patliologist as suffering from non-fluent aphasia, while none of the Right Hemisphere Damaged Patients demonstrated aphasic signs. Additional patient information is provided in Table - 2.

TABLE - 2

Code	Sex	Chronological age (in years)	Time post onset (in months)	Lesion in formation	Diagnosis
Right Hemisphere Damaged Patients.					
R_1	**M**	45(2)	13	Right MCA teritory thrombotic stroke.	
R_2	**M**	40(9)	16	Right MCA teritory thrombotic stroke.	
R_3	**M**	33	10	Right CVA$^+$	
R_4	**M**	38(2)	**12**	Right CVA$^+$	
Left Hemisphere Damaged Patients.					
L_1	**M**	55(1)	7 mths.	Stroke involving left MCA	Moderate non-fluent aphasia.
L_2	**F**	23	12mths	Stroke involving left MCA	Moderate non-fluent aphasia.
L_3	**M**	30(4)	10mts	Stroke involving left MCA	Moderate non-fluent aphasia.
L_4	M	46(2)	15mts	(-)	Moderate non-fluent aphasia.

(-) - No information available.
\+ - No C.T. or radiology specifics available.
CVA - Cerebro vascular accident.
MCA - Middle cerebral artery.

Table - 2: Table showing details of the Patient.

The behaviroural criteria included were -

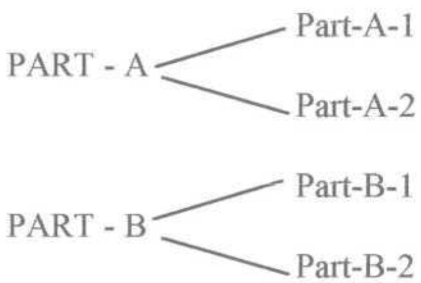
Premorbid right handedness with no known familial history of left handedness, adequate hearing to perform experimental tasks and adequate visual-reading ability. Formal and informal arrangement were done to test the handedness, hearing and visual-reading ability.

STIMULI:

The stimuli used in the current study consisted of words ranging from bisyllable to Penta syllable words. Six sets of words were used. Each set consisted of four words, stalling from bisyllables to pentasyllabic words. The words in each set started with the same CV syllable. The first syllable (CV) of the words in each set started with different consonants (|p|, |t|, |k|, |b|, |d|, |g|) however, the vowel |a| remained constant for all the first CV syllables of the words in all the sets. Each word was written in bold letters on a card (5 x 3 inches) for presentation to the subjects. The first syllable of each vowel in all the sets were underlined in blue colour.

PROCEDURE:

For the purpose of convenience the study was conducted in two main parts.



PART-A-1

Tins part aimed at preparing the materials to be used in the study. Initially list of 100 words containing 25 words each for bisyllable to penta syllable words were prepared which were given to fifteen judges (ten graduate students with a mean age at 20 years and whose mother tongue was Kannada and five Kannada Lecturers from leading education Institutes and with a mean age of 35 years) who were asked to judge the words for familiarity and ease of production on a tluee point rating scale. The judges were seated in a quiet room and each one was provided with two response sheets with the following instructions written above, "you have been provided with a list of words and numbers - 0,1 and 2 besides each word. Please read these words and give your judgement as to the familiarity of these words.

Circle ' 0 ' if the word is very familiar.

Circle ' 1 ' if the word is familiar'.

Circle ' 2 ' if the word is not familiar.

After this take the next sheet with words and numbers written on it and please give your judgement as to how easy are these words to say.

Circle ' 0 ' if the word is very easy.

Circle ' 1 ' if the word is easy.

Circle ' 2 ' if the word is difficult."

Based on these responses of the judges (i.e., the familiar and easy words were taken), six sets of words were prepared. Each set consisted of four words starting from bisyllable to penta syllable words. The word lists and the rating scale of one of the judges is provided in Appendix.

PART-A-2

This part of the experiment was carried out to collect speech samples from normals, right hemisphere damaged and non-fluent aphasic patients. The experiment began with the following instructions. "You will be shown a card with a word written on it. Please say the word by stressing the first syllable of the word which is underlined with blue ink and later say the same word without any stress". Before eliciting the responses from the subjects, the subjects were given demonstration as to how to say the target words. Each word was uttered by each subject three times in a random order as and when the cards were presented. One card at a time was presented. (Sample of the card showing how to stress the initial syllable is shown in the Appendix).

The responses were recorded on a cassette tape in a quiet room using digital sony tape recorder and H legent D-80 directional microphone placed approximately 10 cm from the subject's mouth. Using this procedure the speech samples were elicited and recorded for each subject of all the three groups under study. In the case of words that were unstressed when they were supposed to be stressed, these words were recorded again from the respective subjects. Thus a total of 384 words (stressed and unstressed) were recorded for the expemnental subjects and a total of 480 words for subjects of the contiol group.

PART-B-1

The initial syllable stressed and unstressed words thus produced by the subjects were further fed to the computer and using the "Frequency and intensity programme" of the VAGHMI SOFTWARE (VSS, Bangalore), the following major acoustic correlates of stiess were obtained.

Fundamental frequency

Intensity

Duration.

To obtain the fundamental frequency and intensity of the initial syllable of each word, the cursor was placed on the initial syllable of the words(stressed and unstressed words) and using the "statistics" the mean fundamental frequency and intensity of the initial syllable was obtained. Duration of the initial syllable was obtained by moving the cursor from the onset of the initial syllable till the end of that syllable.

The fundamental frequency (F_o), intensity and duration of the same initial syllable stressed and unstressed words produced by the subjects of both experimental and control groups were compared. A word (initial syllable of the word) was considered stressed only if the F_o, intensity and duration was higher compaied to F_o, intensity and duration of the same word produced unstressed by the same subject.. Syllables carrying stiess have been found to be greater in amplitude and duration and or higher in F_o in comparison with unstressed counterparts in normal speakers (Behrens, 1988, Emmorey, 1987, Klatt, 1976, Meclean and Tiftang 1973 and Savithri 1987) Since the unstressed words recorded from the subjects were just for the sake of comparison, these unstressed words were eliminated and only the stressed words were retained thus making a total of 192 words produced by the experimental group and 240 words produced by the control group. Thus the measurements of stress, in terms of F_o , intensity and duration were obtained for all the utterances of subjects of all the three groups.

PART-B-2

The initial syllable stressed and unstressed words were then subjected to perceptual evaluation by twenty five judges (Ten graduate students with a mean age of 20 years with their mother tongue as Kannada, ten Kannada Scholars with mean age of 36 years and five Kannada Speakers with mean age of 28 years).

Five judges at a time were seated in a quiet room and were provided with a sheet containing the subject's code and the words produced by them. The judges were then given the following instructions. "You will hear the words produced by subjects, whose code is given in your sheet. Please listen carefully to the words produced by these subjects and judge if the initial syllable of each word in the six sets of word lists were stressed or not stressed. If stressed, you should put a ' ✓ ' and ' X ' if not stressed on a response sheet provided to you for each word". With these instructions the speech samples were played on a " Sony " tape recorder at comfortable loudness to the judges. The response sheet used is provided in the Appendix.

The responses of the judges thus obtained were further analyzed and only those sets containing all the words with initial syllables stressed were chosen and were subjected to acoustic analysis.

ACOUSTIC ANALYSIS :

MATERIAL :

Based on the responses of the judges it was decided to use the |t| set of words, since only this set was found to have all the words stressed in the initial syllable.

INSTRUMENTAL SET UP:

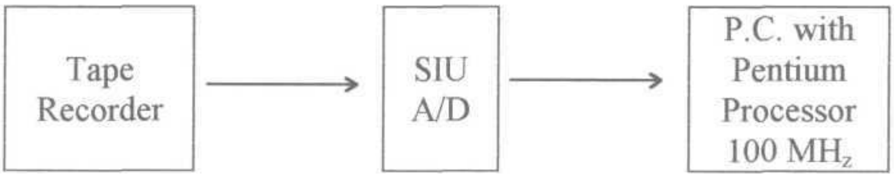


Fig.3: Block Diagram of the instrumental set up.

The words so selected were then digitized at a rate of 16 k samples/second with a 7.5 KH_Z low-pass antialiasing filter setting and 12 bit quantization by feeding the speech signal from tape recorder to the speech interface unit and using the programme RECORD of Vaghmi software (VSS Bangalore). The "DISPLAY, SPGM and FO-INT" programme of SSL software (VSS Bangalore) were used to measure the various parameters as follows.

The waveform of the target word was displayed on the screen using the programme DISPLAY and the following parameters were measured from the waveform.

WHOLE WORD DURATION :

"The duration from the word initial consonant to the word final vowel was considered as the whole word duration".

To measure the whole word duration the waveform of the target word was zoomed so that the word initial consonant and word final vowel could conectlv be identified. This was followed by placing the cuisor on the word initial consonant and moved towards the word final vowel simultaneously highlighting it. The duration in msec (the highlighted portion) was shown on the monitor.

INITIAL SYLLABLE DURATION :

"The duration from the word initial CV syllable consonant to the end of the initial CV syllable vowel was called as the vowel duration".

Measurement of mitial syllable duration was achieved by placing the cursor on the word initial CV syllable consonant and moved towards the end of the initial CV syllable vowel. The initial syllable duration thus measured was displayed on the side of the computer in msec.

CONSONANT DURATION :

"The duration from the word initial CV syllable consonant to the point just before the initial CV syllable vowel was considered as the consonant duration".

The consonant duration was measured by placing the cursor at the point where the consonant was just initiated and was moved till the point just before the vowel of the initial CV syllable began. The duration thus measured was shown on the side of the screen.

VOWEL DURATION :

"The duration from the end of the initial CV syllable consonant to the end of the vowel in the initial CV syllable was considered as the vowel duration".

Measurement of vowel duration was again done by placing the cursor at the point where the consonant of the initial CV syllable ended and moved to the point where the vowel in the initial CV syllable ended. Acoustic measure of the vowel segment of the initial CV syllable of each word was done as past data had indicated that vowels are more affected by stress than adjacent consonants (Klatt 1976, Oiler 1973).

Some of the difficulties encountered during the measurements of these temporal parameters were -

- It was very time consuming.

- In most of the speech samples, clear demarcations between the consonant and vowel in the initial CV syllable and between the syllables of the target word could not be seen even after being zoomed, therefore, the portion highlighted as consonant, vowel and syllable for each word were evaluated perceptually by the examiner and this was followed by necessary adjustments done on the waveform till the labelled initial syllable consosnant and vowel reached its perceptual quality.

The frequency characteristics of the vowels of the initial C V syllable of the target word was measured using the "SPGM" and "FO-INT" programme.

MEAN FUNDAMENTAL FREQUENCY :

Fundamental frequency is the lowest frequency that occurs in the spectrum of a complex tone. In voice also, the fundamental frequency is considered the lowest frequency in voice spectrum, since fundamental frequency of the vowel portion of the initial CV syllable was measured, "Fundamental frequency here was the lowest frequency that occured in the vowel spectrum".

The fundamental frequency was measured using the "FO-INT" programme, wherein the starting and ending point of the vowel in the initial C V syllable was noted and fed to the "FO-INT" programme. The fundamental fiequency thus measured was displayed on the screen.

FORMANT FREQUENCIES (F_1 & F_2):

Since the first two formants were thought to contribute maximum towards the perception of vowel, only the measurement of F_1 and F_2 was done. The measurement of these formant frequencies was done by using the "SPGM" programme.

A formant frequency is a natural mode of vibration (resonance) of the vocal tract. It refers to a peak in the acoustic spectrum. There are infinite number of formants, but for practical purposes only the lowest three - four are of interest. Each formant is described by two characteristics : Centre frequency (formant frequency) and bandwidth (a measure of the breadth of energy in the frequency domain.

The steady-state portion of the vowel in the initial C V syllable was fed to the "SPGM" program which displayed the Fi and F_2 in the form of peaks. The first peak corresponded to F_1 and the second peak to F_2 formant. Thus the F_1 in H_z was obtained by moving to the next prominant peak.

Thus the following measurements were made.

- Whole word duration.
- Initial syllable duration
- Consonant duration of the initial CV syllable.
- Vowel duration of the intial CV syllable.
- Fundamental frequency of the vowel
- F_1 of the vowel.

- F_2 of the vowel.

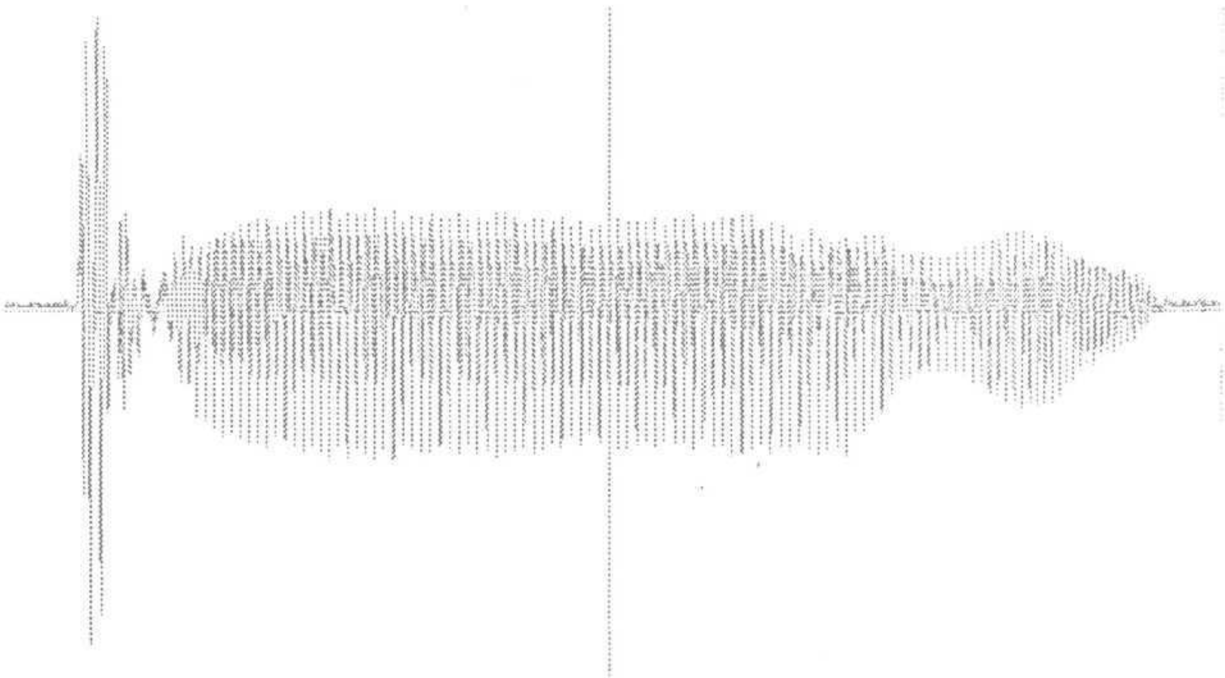


Fig.4: Showing the speech waveform used for measurement of different parameters

STATISTICS :

The mean duration and standard deviation of different parameters thus measured for each of the subject under study were computed using the "Descriptive and inferential statistical analysis". Later "WALSH TEST" was performed to find significance of difference between the groups.

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

RESULTS:

The present study aimed at comparing the effect of stress on the temporal pattern of the initial syllable in multi-syllablic words of Kannada language among the non-fluent aphasics, Right Hemisphere Damaged individuals and normals. The aim of the current study was accomplished by studying the following parameters.

- Whole word duration.
- Initial syllable duration.
- Consonant duration of the initial C V syllable.
- Vowel duration of the initial CV syllable.
- Fundamental frequency of the vowel.
- F_1 and F_2 of the vowel.

PART-A (Part-A-1 and Part-A-2) of the study was mainly aimed at preparation of the test materials and recording of data respectively. Six sets of words varying in length were prepared and they were administered to the subjects of the current study and then recorded on a cassette for the next part of the study.

The PART-B (Part-B-1 and Part-B-2) was mainly aimed at perceptual analysis of the subject's responses by judges and acoustic analysis of the words found stressed in the perceptual evaluation. The study revealed that among the six sets of words produced, only one set (| t | set) of words had all the words completely stressed in contrast to their unstressed counterparts. The responses of the judges to other sets of words revealed that among the words to be stressed only few words in each set were found to be stressed. Therefore, only the |t| set of stressed words were used for the acoustic analysis.

The 216 responses of 18 subjects obtained were divided into three groups : - The non-fluent aphasics (N=4), Right Hemisphere Damaged/Right Hemisphere Damaged (N =4) and Normals (N = 10). The specific and general results obtained are therefore discussed under the following headings.

- Right Hemisphere Damaged group
- Non-fluent aphasia group
- General Results.

The results of the acoustic analysis in terms of seven parameters measured from each of the words produced by the Brain Damaged and the normals are described.

WHOLE WORD DURATION :

Word length	Normals		Right Hemisphere Damaged		Non-fluent Aphasics	
	Mean	SD	Mean	SD	Mean	SD
2 Syllable word	1030	48.8	553.3	92	1153	138
3 Syllable word	1230	60.9	722.6	85	1228.3	153.3
4 Syllable word	1300	52.7	859.3	99.6	1476	139.7
5 Syllable word	1532.3	42	974.3	64.5	1486.3	156.7

S.D. - Standard deviation.

Table 3: Table showing the mean and standard deviation of the whole word duration for the various words and groups.

As it can be seen from the study of Table - 3, the whole word duration (mean duiation) across words varying in length was found least among the Right Hemisphere Damaged group and was generally higher among the non-fluent group.

A steady increase in the word duiation noticed across words of varying length for all the three groups.

High degree of variability was noticed among the non fluent group which was evident from the SD scores. The variability in general was found high among the brain damaged (Right Hemisphere Damaged and non-fluent) compared to normal group.

Word length	Normals and Right Hemisphere Damaged	Right Hemisphere Damaged and Non-fluent aphasics	Non-fluent aphasics and normals.
2 Syllable word	+	+	-
3 Syllable word	+	+	-
4 Syllable word	+	+	-
5 Syllable word	+	-	-

+ Ú Significant at 0.05 level in WALSH test.

- Ú Not significant at 0.05 level in WALSH test.

Table 4: Table showing significance difference between groups across words of varying length for the whole word duration.

From the above table it becomes clear that the durational pattern among the Riglit Hemisphere Damaged group differ significantly from the normals across words of varying length. Thus the Riglit Hemisphere Damaged group had significantly shorter duration compared to normals across words varying in length.

Comparison of the non-fluent and normal group showed no significant difference across words in terms of word duration.

Significant difference between Right Hemisphere Damaged and non-fluent aphasic was seen across words of varying length except at penta-syllabic word showing that the durational of words in case of non-fluent aphasics were significantly larger than in Riglit Hemisphere Damaged group across words except at penta-syllable words.

INITIAL SYLLABLE DURATION :

Word length	Normals		Right Hemisphere Damaged		Non-fluent Aphasics	
	Mean	SD	Mean	SD	Mean	SD
2 Syllable word	453.4	56.3	297.	98	536.6	140.3
3 Syllable word	396.4	60.8	262.6	79.5	475.3	149.9
4 Syllable word	395	53.7	248	83.2	431.3	119
5 Syllable word	391.9	57.4	275.6	82.2	396.3	92.2

SD. - Standard deviation

Table 5: Table showing the mean and standard deviation of the initial syllable duration for the various words and groups.

The following observation were made from the examination of the above table.

As observed regarding the word duration, the initial syllable duration across words varying in length was found least among the Right Hemisphere Damaged and highest among the non-fluent aphasics, with normals showing values in between the non-fluent aphasics and right hemisphere damaged groups.

A steady decrease in the initial syllable duration was noticed across words of varying length among the normals and non-fluent aphasic group. Tliougli a study decline in initial syllable duiation was noticed among the Riglit Hemisphere Damaged, a sudden increase in the initial syllable duiation was noticed at the penta-syllabic words.

Based on the standard deviation scores it was concluded that the variability was maximum among the non-fluent group and in general the brain damaged population showed higher variablility compared to normals.

Word length	Normals and Right Hemisphere Damaged	Right Hemisphere Damaged and Non-fluent aphasics	Non-fluent aphasics and normals.
2 Syllable word	+	+	-
3 Syllable word	+	+	-
4 Syllable word	+	+	-
5 Syllable word	+	-	-

\+ Ú Significant at 0.05 level in WALSH test.

\- Ú Not significant at 0.05 level in WALSH test

Table 6: Table showing significance difference between groups across words of varying length for the initial syllable duration.

From the table above it is evident that -

The initial syllable duration among the Right Hemisphere Damaged group was significantly lower compared to the normals across words of varying length. The initial syllable was not found significantly different among the non-fluent-aphasics and normals across words varying in length.

Except penta-syllabic word, the initial syllaibic duration was found significantly different among the Right Hemisphere Damaged and non-fluent group. In general, the intitial syllable duration of the Right Hemisphere Damaged was significantly lower campere to non-fluent aphasics across words varying in length except at penta-syllabic words.

VOWEL DURATION OF THE INITIAL CV SYLLABLE :

Word length	Normals		Right Hemisphere Damaged		Non-fluent Aphasics	
	Mean	SD	Mean	SD	Mean	SD
2 Syllable word	437.7	59.6	251.6	89	499.3	149.6
3 Syllable word	370.5	47	235	77.8	429.3	156
4 Syllable word	370.5	48.8	226.6	64.5	393.6	126.8
5 Syllable word	369	48.1	260.3	88.7	370	101.6

S.D - Standard deviation.

Table 7: Table showing the mean and standard deviation of vowel duration of the initial C V syllable for the various words and groups.

Like the initial syllable duration and word duration, the vowel duration of the initial CV syllable across words of different length was found least among the Right Hemisphere Damaged and highest among the non-fluent aphasics.

Like the results obtained for the initial syllable duration, a steady decrease in the vowel duration of the initial syllable noticed across words of varying lengtli among the nonnals, non-fluent and Riglit Hemisphere Damaged groups, however a sudden increase in the vowel duration was noticed at the penta-syllabic words for the Riglit Hemisphere Damaged group.

The pattern of variability observed for the vowel duration among different groups was similar to that observed for the initial syllable duration i.e., vaiiability maximum among the non-fluent aphasics and in general high among the brain damaged than the normals.

Word length	Normals and Right Hemisphere Damaged	Right Hemisphere Damaged and Non-fluent aphasics	Non-fluent aphasics and normals.
2 Syllable word	+	+	-
3 Syllable word	+	+	-
4 Syllable word	+	+	-
5 Syllable word	+	-	-

\+ Ú Significant at 0.05 level in WALSH test.
\- Ú Not significant at 0.05 level in WALSH test

Table 8 : Table showing significance of difference between groups across words of varying length for the vowel duration of the initial C V syllables.

The results obtained for the vowel duration was similar to the pattern of results obtained for initial syllable duration i.e., the vowel duration of the initial syllable among the Right Hemisphere Damaged was significantly lowered compared to the normals across words varying length. The vowel duration of the initial syllable was not found significantly different among the non-fluent aphasics and normals across words varying length.

Except penta-syllabic word, the vowel duration of the initial sylalble was found significantly different among the Right Hemisphere Damaged and non -fluent aphasic groups. Thus it can be concluded the vowel duration of the initial syllable among the Right Hemisphere Damaged was significantly lowered compared to non-fluent aphasics across words varying in length except at penta-syllabic words.

INITIAL CONSONANT DURATION :

Word length	Normals		Right Hemisphere Damaged		Non-fluent Aphasics	
	Mean	SD	Mean	SD	Mean	SD
2 Syllable word	19.1	7.4	45.6	40	39.3	31.7
3 Syllable word	18.9	8.8	43	24.2	45.6	20.2
4 Syllable word	19	8	48	43	39	26.9
5 Syllable word	19.6	10.6	32.3	28.5	33.6	15.8

S.D - Standard deviation.

Table 9: Table showing the mean and standard deviation of the consonant duration for the various words and groups.

The pattern of results obtained for this parameter was different from the other durational patterns discussed till now. A great variability in the durational patterns among the groups was noticed. In general the variations in duration was greater among the brain damaged compared to normals. No steady increase or decrease in consonant duration noticed across words of varying length for all the groups.

Word length	Normals and Right Hemisphere Damaged	Right Hemisphere Damaged and Non-fluent aphasics	Non-fluent aphasics and normals.
2 Syllable word	-	-	-
3 Syllable word	+	-	+
4 Syllable word	+	-	-
5 Syllable word	-	-	-

+ Ú Significant at 0.05 level in WALSH test.

- Ú Not significant at 0.05 level in WALSH test

Table 10 : Table showing significance of difference between groups across words of varying length for consonant duration.

The table above shows no significance of difference for consonant duration among the Right Hemisphere Damaged, non-fluent aphasics and normals.

The consonant duration was found significantly different only at three and four syllable words among the Right Hemisphere Damaged and normals and only at 3 syllable words among the non-fluent aphasics and normals. The consonant duration was not very devient among the three groups, however, the devience noticed for the consonant duration across words varying in length were inconsistent.

FUNDAMENTAL FREQUENCY :

Word length	Normals		Right Hemisphere Damaged		Non-fluent Aphasics	
	Mean	SD	Mean	SD	Mean	SD
2 Syllable word	158.9	32	147	13	174.3	50.8
3 Syllable word	163	28.3	150.3	9.2	177.6	49.7
4 Syllable word	166.1	31.3	148.3	16.5	171.3	47.8
5 Syllable word	166.1	35.1	149.3	15.8	167.3	47.2

S.D - Standard deviation.

Table 11: Table showing the mean and standard deviation of the fundamental frequency for the various words and groups.

A general increasing pattern in the fundamental frequency noticed among the normals across words of varying length. However, no such pattern was noticed among the Right Hemisphere Damaged and non-fluent groups.

The fundamental frequency was in general low among the Right Hemisphere Damaged and high among the non-fluent group.

The S.D. scores clearly showed that the variability was maximum for the non-fluent group and least for the Riglit hemisphere Damaged Group.

Word length	Normals and Right Hemisphere Damaged	Right Hemisphere Damaged and Non-fluent aphasics	Non-fluent aphasics and normals.
2 Syllable word	-	-	-
3 Syllable word	-	-	-
4 Syllable word	-	-	-
5 Syllable word	-	-	-

\+ Ú Significant at 0.05 level in WALSH test.

\- Ú Not significant at 0.05 level in WALSH test

Table 12 : Table showing significance of difference between groups across words of varying length for fundamental frequency.

The results showed no significant difference among the tluee gioups for words varying across lengtli across words in terms of fundamental fiequency.

FIRST FORMANT FREQUENCY (F_1) :

Word length	Normals		Right Hemisphere Damaged		Non-fluent Aphasics	
	Mean	SD	Mean	SD	Mean	SD
2 Syllable word	668.5	57.6	699.5	65.6	562.7	107.7
3 Syllable word	696.8	43.1	730.2	70.3	736.1	32.3
4 Syllable word	706.7	48.2	725.7	44.8	761.3	31.3
5 Syllable word	704.6	34.5	729.1	63.8	750.9	43.3

S.D - Standard deviation.

Table 13: Table showing the mean and standard deviation of the First Formant of the vowel in the initial C V syllable for the various words and groups.

The results showed that the F_1 was higher in general among the brain damaged compaied to normals. No typical pattern seen as seen for vowel duiation, initial syllable duration and whole word duration. The variability (standard deviation) was found maximum for the 2 syllable words compred to various other words.

Word length	Normals and Right Hemisphere Damaged	Right Hemisphere Damaged and Non-fluent aphasics	Non-fluent aphasics and normals.
2 Syllable word	-	-	-
3 Syllable word	-	-	-
4 Syllable word	-	-	-
5 Syllable word	-	-	-

\+ Ú Significant at 0.05 level in WALSH test.

\- Ú Not significant at 0.05 level in WALSH test

Table 14 : Table showing significance of difference between groups across words of varying length for the first formant frequency.

The results revealed that F_1 was not significant among the three groups for words varying across length.

SECOND FORMANT FREQUENCY (F_2) :

Word length	Normals		Right Hemisphere Damaged		Non-fluent Aphasic s	
	Mean	SD	Mean	SD	Mean	SD
2 Syllable word	1248.9	38.6	1384.1	100.3	1342	105.4
3 Syllable word	1246.8	34.5	1393.7	16.7	1354	127.8
4 Syllable word	1275.4	45.2	1410.2	89.4	1329.8	128.5
5 Syllable word	1280	43.6	1494.7	44.4	1338.5	99.7

S.D - Standard deviation.

Table 15: Table showing the mean and standard deviation of the second formant frequency for the various words and groups.

The study of Table-15 showed that the formant - 2 in general was higlier among the brain damaged compared to normals. Among the brain damaged the F_2 was higher in the Right Hemisphere Damaged subjects.

A general pattern was seen among the Right Hemisphere Damaged. In these subjects, as the word increased in syllables, the value of the F_2 formant increased, however, this pattern was absent among the non-fluent aphasics and normals.

The standard deviation scores revealed that there was a high variability among the non-fluent aphasic group and in general the variability was high among the brain damaged group compared to the normals.

Word length	Normals and Right Hemisphere Damaged	Right Hemisphere Damaged and Non-fluent aphasics	Non-fluent aphasics and normals.
2 Syllable word	-	-	-
3 Syllable word	-	-	-
4 Syllable word	-	-	-
5 Syllable word	+	+	+

\+ Ú Significant at 0.05 level in WALSH test.

\- Ú Not significant at 0.05 level in WALSH test

Table 16 : Table showing significance of difference between groups across words of varying length for the second formant frequency.

The results of the WALSH test showed above revealed that the F2 was sigmficantlv different in nonnals and Riglit Hemisphere Damaged, normals and non-fluent aphasics and Right Hemisphere Damaged and non-fluent aphasics only at the penta-syllabic word.

Thus based on these results it is clear that only Initial syllable duration, Vowel duration of the initial syllable. Duration of the whole word, F_1 of the vowel of the initial syllable and F_2 of the vowel of the initial syllable were found significant among the groups whereas consonant duration of the initial C.V. Syllable and fundamental frequency of the initial syllable vowel were found to be insignificant among the groups.

Among these, only the first five parameters were studied in details as the other parameters were found to be insignificant.

RIGHT HEMISPHERE DAMAGED GROUP

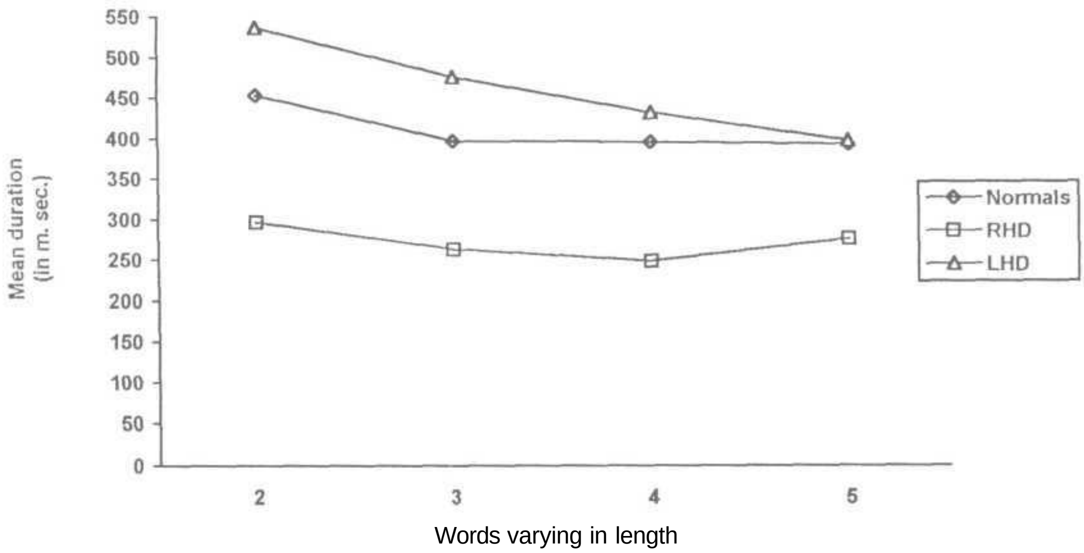


Fig. 5 : Mean duration of initial syllable across words varying in length among normals, Right Hemisphere Damaged (RHD) & Non - fluent aphasics (LHD)

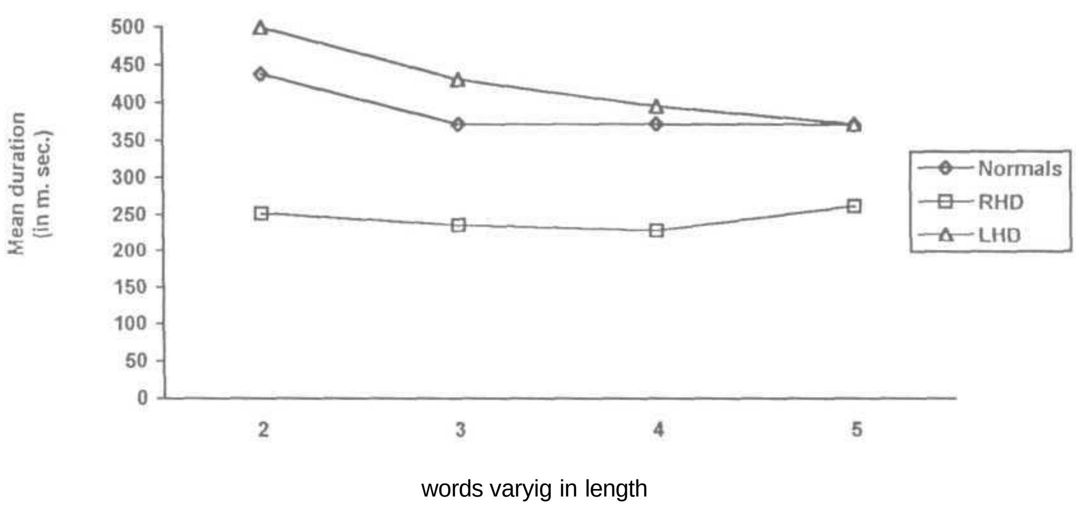


Fig. 6 : Mean duration of vowel of the initial syllable across words varying in length among normals, Right Hemisphere Damaged (RHD) & Non - fluent aphasics (LHD)

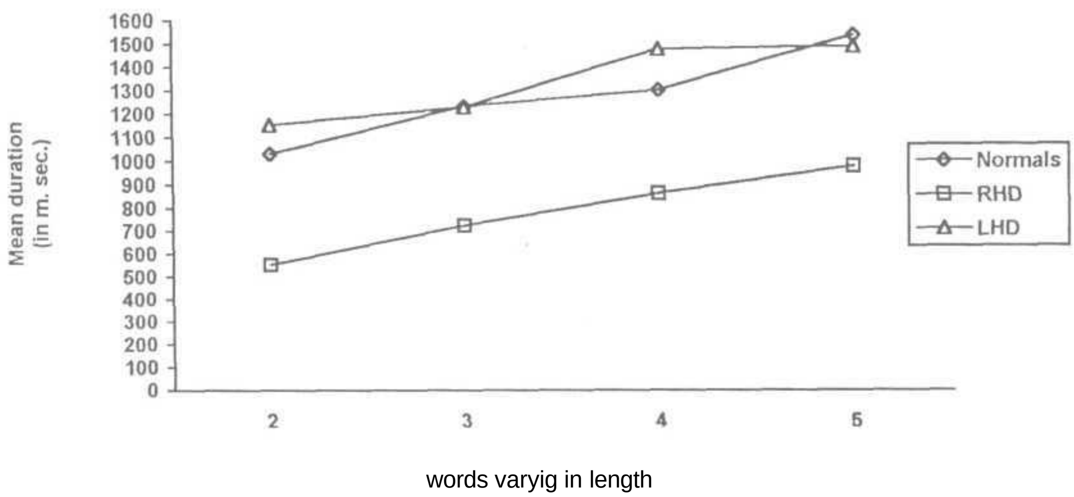
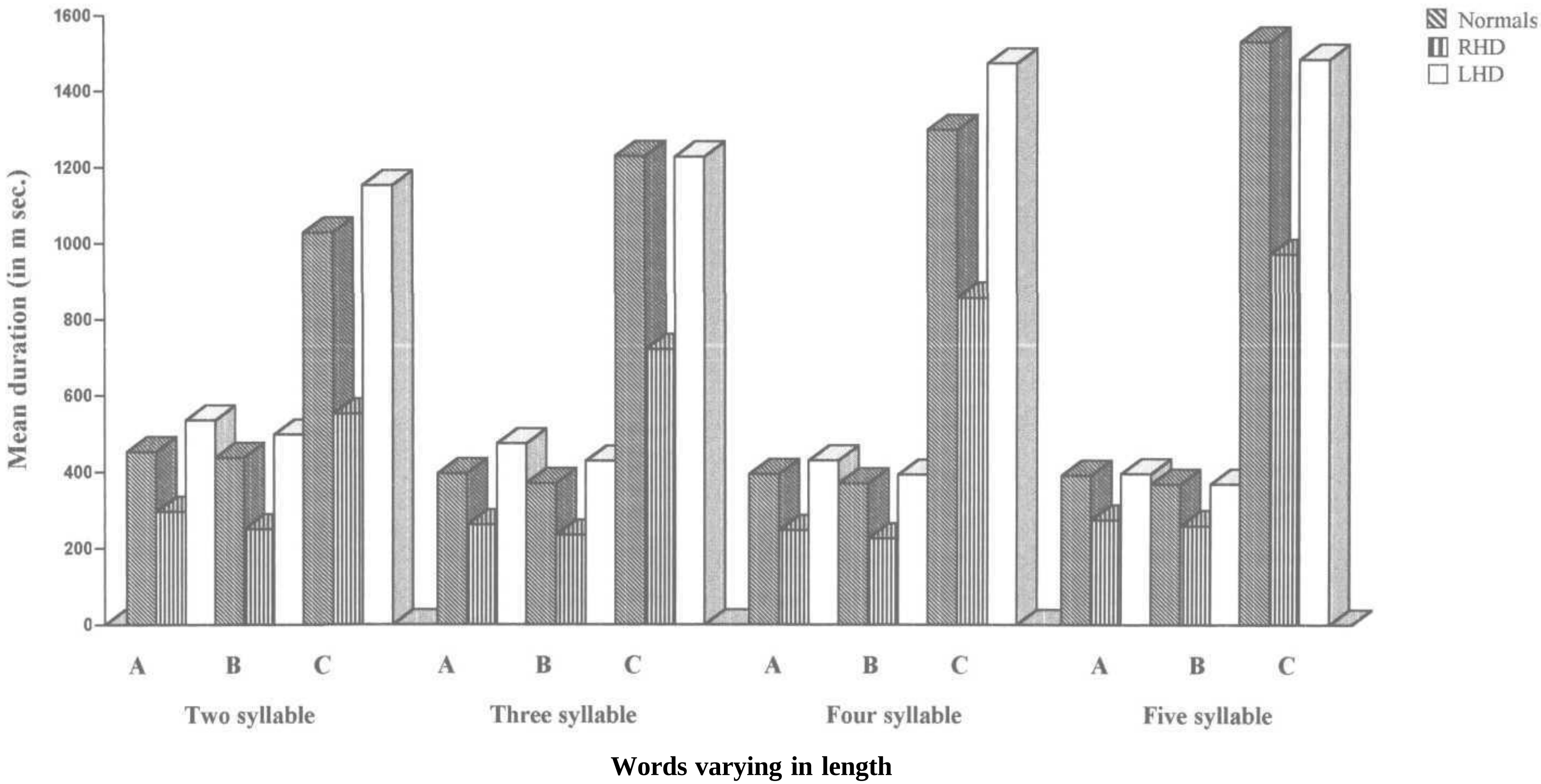


Fig. 7 : Mean duration of words across words varying in length among normals, Right Hemisphere Damaged (RHD) & Non - fluent aphasics (LHD)

Table 17, Fig. 5, Fig. 6 and Fig. 7 shown above reveal a very interesting findings among the Right Hemisphere Damaged.

It was seen that in the Right Hemisphere damaged, as the words increased in length, a constant increase in word duration (Fig. 7 and Table 3) and a constant decrease in initial syllable duration and vowel duration of the initial syllable were noticed, however, a sudden increase in the initial syllable duration and vowel duration of the initial syllable in penta-syllabic word was observed (Table -17, Fig.5 and Fig.6).



A = Initial syllable duration,, B = Vowel duration of initial syllable, C = Word duration

Fig. 8 : Mean duration of whole word, initial syllable & vowel across words varying in length among normals, Right Hemisphere Damaged (RHD) & Non - fluent aphasics (LHD).

A close inspection of Fig. 8 and Fig. 5,6 and 7, gives a clear picture of the duiational aspects of the vaiious groups under study. It may therefore be maintained that the durational aspects are diminished maximally in the Riglit Hemishpere Damaged group.

NON-FLUENT APHASIA GROUP

Word length	Right Hemisphere Damaged and Normals					Right Hemisphere Damaged and Non-fluent aphasics					Non-fluent aaphasics and normals.				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
2 syllable word	+	+	+	-	-	+	+	+	-	-	-	-	-	-	-
3 Syllable word	+	+	+	-	-	+	+	+	-	-	-	-	-	-	-
4 Syllable word	+	+	+	-	-	+	+	+	-	-	-	-	-	-	-
5 Syllable word	+	+	+	-	+	-	-	-	-	+	-	-	-	-	-t-

Right Hemisphere Damaged Right hemisphere damaged

A - Syllable duration

B - Vowel duration

C - Word duration

D - F_1 Formant

E - F_2 Formant

\+ - Significant at 0.05 level in walsh test.

Not significant at 0.05 level in walsh test.

Table 18 : Table showing results of Walsh test between different groups across words of varying length.

The current study did not show any unique pattern among the non-fluent aphasic group.

Table - 17 and 18 and Fig. 5,6 and 7 show that the durational pattern of syllable, vowel and words across words of varying length were significantly greater than the durational pattern observed among the Right Hemisphere Damaged group. However, the duiational pattern, though been greater than normals, did not show statistical significance.

GENERAL RESULTS

Table - 18 leads towards the notion that neither word lengthening nor position of stress on the units of the words had a significant effect in non-fluent aphasic group but when Right Hemisphere Damaged and non-fluent aphasic groups were compared a devient pattern was observed at the penta syllabic word level. This showed that the smaller units of the multisyllabic words (specifically pentasyllabic word onwords) are better indication of deviancy in the Right Hemisphere Damaged population.

The current study also revealed a general pattern in the rate of speech among the brain damaged individuals - the rate being faster for the Right-Hemisphere Damaged Group and slower for the non-fluent aphasic group.

The standard deviation scores in table -17 indicates the variability exhibited among the brain damaged population. As expected, the variability was found to be higher among the brain damatged subjects of the study. The variability was found to be maximum among the non-fluent aphasic's production than the Right Hemisphere Damaged subjects. This supports the findings of the study by Ryalls (1986) and Gandour et.al (1992).

Analysis of F_1 and F_2 forment frequencies of the vowel in the initial syllable of the word (Table -13, 14, 15, 16 and 17) showed a general deviancy in the F_2 among brain damaged. It was found to be higher, however, showed significance of difference only at penta-syllabic word.

	Right Hemisphere Damaged			Non-fluent Aphasic			Normal		
	Durational drop for (msec)		Durational increase for (msec)	Durational drop for (msec		Durational increase for (msec)	Durational drop for (msec)		Durational increase for (msec)
Word length	A	B	C	A	B	C	A	B	C
2 - 3 syllable word	34.4	16.6	169.3	61.3	70.0	75.3	57	67.2	200
3 - 4 syllable word	14.6	8.4	136.7	44	35.7	247.7	1.4	0	70
4 - 5 syllable word	27*	33.7*	115	35	23.6	10.3	3.1	1.5	232.3

Riglit Hemisphere Damaged Right Hemisphere Damaged.

A - Syllable duration.

B - Vowel duration

C - Word Duration

* - Durational increment.

Table -19 : Table showing durational increment for word and durational drop for initial syllable and vowel between the various multi syllabic words.

Another interesting result in the current study was that both the Riglit Hemisphere Damaged and non-fluent aphasics showed maximum drop in syllable duration and vowel duration at 2 - 3 syllabic words and only the Right Hemisphere Damaged subjects showed maximum increase in the word duration at 2 - 3 syllabic word (Table - 19).

In sum the results of the present study supported that both the stress and word length had a greater effect on acoustic characteristics specifically the durational characteristics of the Riglit Hemisphere Damaged speech in Kannada language.

DISCUSSION :

Brain damage is a multifaceted problem and has been studied using different frame works. The present study was an attempt to compare the effect of stress and word length on initial syllable duration among the non-fluent aphasics and right hemisphere damaged population. This aim was accomplished by making the subject produce list of initial syllable stressed words varying in length and followed by acoustic analysis of these words. The study revealed interesting results. The durational characteristics among Right Hemisphere Damaged was found to be devient from that of the non-fluent group. The result so obtained can be explained from various perspectives.

A physiological explanation has been attributed to the pattern seen in the Riglit Hemisphere Damaged group. The rate of speech was generally higher among all the four subjects in the Right Hemisphere Damaged Group. With increase in word length, a tendency to further increase the rate of speech was noticed among three of the four subjects under study. To prevent this tendency of the subjects a clear instruction to maintain stress on the intial syllable and same rate of speech throughout the production of all words were given. Following the instruction, the subjects did control their rate of speech but they compensated their tendency to increase the rate of speech at longer words by increasing the degree of stress in the initial syllable of the longer words (specifically penta-syllabic words). With increase in the degree of stress, the entire speech muscularative was energetized to a greater extent resulting in increased tension of the supralaiyngeal system. Since the effect of stress is best seen on the syllable and hence on the vowel, the syllable and vowel durations are likely to be affected. Thus the physiological explanation accounts for the sudden increment in the initial stressed syllabic duration and the vowel duration of the initial syllable seen in the Right Hemisphere Damaged subjects. The data is supported by Netsell (1970) and also by the Oilman's energy pulse hypothesis which speculates that the entire speech musculature is energetised for stress and that this energy is manifested differentially in the sublaryngeal, laryngeal and supralaiyngeal system as a function of the degree of stress.

The durational pattern seen among the Right Hemisphere Damaged can also be explained by the concept of **"phonetic vowel reduction".** In vowel reduction the formants of the vowel do not reach its target value due to articulatory intertia i.e., before the steady vowel reaches its target value, the vocal tract shape changes to articulate the next sound (Fourakis 1991) talks about two types of vowel reduction

Phonological vowel reduction

Phonetic vowel reduction

The phonological voewl reduction is concerned with unstressed vowels and phonetic vowel reduction with stressed vowel.

"Vowel Reduction" generally occurs when there is an increased rate of speech and increase in word length. Hence in Right Hemisphere Damaged, phonetic vowel reduction occurs because of lengthening of words and because of the increased speech rate of the Right Hemisphere Damaged subjects and thereby resulting in the compression of vowel duration and hence syllable duration. However, as the length of the words increase from three syllable to four syllable, tliere is a tendency for the patient to increase the degree of stress on the initial syllable which nullifies the effect of phonetic vowel reduction and increases the tension in the supralaryngeal system and thereby a sudden increment in the vowel and syllable duration noticed.

The phenomenon of vowel reduction also explain the maximum durational drop at 2 - 3 syllable word compared to 3 - 4 and 4 - 5 syllabic words i.e., the vowel reduction is maximum at 2 - 3 syllabic words and as the syllable increase, the stress effect dominates the effect of vowel reduction.

It may be hypothesised that the articulatory implementation deficits (proposed by Alaiavanina, omoredone and Dorand 1939, Blumstein et.al 1977, 1980, Tuller 1984) among the anterior aphasics may also be applicable to the Right hemisphere Damaged group and thus can be considered to explain the devient durational pattern seen at smaller units of the complex words produced by the Right Hemisphere Damaged group.

According to this hypothesis it may be conceived that the Right Hemisphere Damaged population may have a general deficit in implimenting articulatory gestures and articulatory features. As the words become complex (word length increasing with induced stress in the initial syllable) the deficit is implementing articulatory gestures (which may be thought as a pure motoric deficit) becomes dominant as a result of which there is an exaggeration in the articulatory movements which becomes evident at pentasyllabic words and at smaller units i.e., syllable and vowel. On the other hand, a deficit in implementing articulatory feature (More of a planning deficit) becomes dominant in the production of less complex words resulting in a general decrease in the overall durational pattern noticed among the Right Hemisphere Damaged compared to normals and non-fluent aphasics.

At this point an important question may arise. Since duration is a very important acoustic correlate for the perception of stress, how is it that the listeners (perceptual evaluation by listeners in part 'B' of the methodology) perceived the production of Right Hemisphere Damaged as stressed, when one considers that the durational pattern was significantly diminished among the Right Hemisphere Damaged subject.

This question can be answered by considering the way the stress was produced by the subjects. Since the subjects were asked to induce stress, a concious effort was put by the subjects while inducing stress. This concious effort/induced stress would have increased the other acoustic correlates of stress, thus maintaining the perceputal quality of the stress.

Another view point would be that, though duration increment was generally associated with stress, a significant decrease in duration can also stress the intended word or syllable. Thus the significant durational decrease in the Right Hemisphere Damaged would have maintained the perceptual quality of stress.

An obvious pattern noticed when the Braindamaged individuals were compared with the normals. In general the durational pattern of the non-fluent aphasics were higher (although not statistically significant) and the durational pattern of Right Hemisphere Damaged were significantly diminished.

The aiticulatoiy implementation deficit already mentioned earlier can serve as an important aid to explain the devient duiational pattern among the Right Hemisphere Damaged and non-fluent aphasics. The deficit in implementation of aiticulatoiy gestures is an important characteristics of anterior aphasics (Tuller 1984, Blumstein et. al 1977, 1980). Stressed syllables are characterised by aiticulatoiy gestures that are longer in duration or spatially more extensive (Potisok et. al 1994). All these results in exaggerated aiticulatoiy movement pattern leading to increased duiational pattern among the non-fluent aphasics. Since there is an obvious motoric involvement among the non-fluent aphasic group, anticipation of the abnormal motoric pattern in the forward speech can affect the duiational pattern of the speech out put. Thus anticipation of the abnormal motoric pattern by the non-fluent apha;sic will give rise to deficit in implementation of articulatory gestures which in turn leads to devient durational pattern

The compensatory slowing hypothesis suggested by several investigators (Darley, Aronson and Brown 1975) may serve as a good explanation for the slow rate of speech among the non-fluent aphasics which in turn results in increased durational pattern in the various units of the word. According to this hypothesis, the aphasics deliberately slow their rate of speech which in turn help them to produce easy speech.

In the current study a general slow rate of speech among the non-fluent aphasics and high rate of speech among the Plight Hemisphere Damaged was noticed. Therefore, it can be maintained that the **syllable commands** for syllables spoken with stress show less temporal overlap as a result of slow rate among the non-fluent aphasics resulting in increased duration of syllables, vowels and words produced. Another explanation for the behaviour of non-fluent aphasics may be that, the temporal relations of the syllable commands reaching the articulators may be intact but some amount of weakness in the articulators mat results from Brain damage may still persists, because of winch there is an overall slow movement of the articulators resulting in increased durational pattern. In Right Hemisphere Damaged on the other hand, because of the general increase in the rate of speech, the **syllable commands** show more extensive temporal overalp thus resulting in lower durational pattern in syllable, vowel and words.

The slow rate of speech and the durational pattern observed among the non-fluent aphasics can also be explained on the basis of the "speech timing control". Smith (1980) maintained that the anterior motor speech area is some way involved in speech timing control. Therefore damage to this area, which commonly occurs in the non-fluent aphasics, would lead to a deficit in speech timing control as a result of which the integration of the articulatory movement takes a longer time, thus resulting in slow rate of speech and concomitant durational deficits.

Various studies on hemispheric dominance are in general agreement that the linguistic functions are controlled by the left hemisphere and the prosodic functions by the Right Hemisphere. Though the present study has involved both linguistic and prosodic aspects, the major concern of the study was to find the effect of stress and word length on the durational aspects, since stress is one among the important prosodic featuies, damage to the Right Hemisphere would affect the stress and thus accounting for the diminished durational pattern among the Right Hemisphere Damaged population.

Moreover studies of Crystal and House (1990) have revealed that the duration of syllable is a function of both its stress condition and number of its phonemes. Therefore, it was expected that there would be an increase in the syllable duration with stress and an increase in the number of phones. This pattern has been noticed both in normals and non-fluent aphasics in the plresent study, However, a significant decrease in duration with stress and increase in the number of phones have been noticed in the Right hemisphere Damaged subjects. Together, the findings from various studies support the hypothesis of differential lateralisation for the processing of different acoustic parameters. (Behrens 1989, Cooper et.al 1984, Danly and Shapire 1982, Grandour et al 1989, Ryalls 1982). When duration cues any linguistic aspects, for example, duration of vowel acting phonetic in nature in some language and phonemic in some other language, then duration/speech timing may be thought to be under the control of left hemisphere/dominant hemisphere. When duration cues prosody (Stress specifically) then it is under the control of Right Hemisphere. Since the present study mainly aimed at finding the effect of stress on the durational aspects, duration acted more of a cue for prosody which was under the control of Right Hemisphere. Thus showing the dominance/active involment of the Right Hemisphere in the processing of stress and durational aspects.

It is common to see that if a speaker is asked to produce a word which contains a particular speech sound, there would be a great deal of variability in what is produced, since variability is a phenomenon that is commonly seen even in normals, one can expect a great variability among the Brain Damaged population. Variability appears to be a general feature of all aphasic syndromes - anterior and posterior alike (Ryalls 1986, Baum et.al 1990). The current study also supports the findings that variability is generally high among the Brain damaged specially among the non-fluent aphasics.

Various explanations can be presented to this high variability.

1. The variability may be because of the immediate neighbouring sounds.
2. May be due to the stress pattern itself. The degree of stress used by the brain damaged subjects of the present study were highly variable. The Right hemisphere Damaged subjects produced far more constant stress across words of varying length compared to non-fluent aphasics whose degree of stress varied across words of varying length.
3. The increased variability may be thought due to abnormal coarticulatory effect. Mac.Neilage, 1970; Ohman, 1967; reported that a shape template or target for a speech sound is stored in the nervous system. Coarticulation occurs when there is overlapping of several of these targets at any moment of time. Genially when there is a Brain Damage, the control of shape template or targets in the nervous system might be affected as a result of which there is abnormal overlapping at any moment of time resulting in high degree of variability in the speech.
4. Variability may also be attributed to age and sex. The subjects under the non-fluent aphasic group differed in age and also out of four subjects, one was female. In the Right Hemisphere Damaged group the age of the subjects differed, however were not as devient as the non-fluent aphasic group. Moreover, all the subjects in Right Hemisphere Damaged group were males. Thus the subject

characteristics also contribute to the pattern of variability exhibited by the Brain damaged population.

An acoustic-phonetic-analysis of vowels could address the question whether the Brain Damaged individuals make stable vocal tract configuiation in the same manner as do normal speakers. It is known fact that F_1 are the most important acoustic cues for vowels. Measuring the fust two fonnants would therefore give infomiation about how a vowel was produced. Generally the average first and second fonnant frequencies over a number of vowel tokens give the infomiation about phonemic targetting. An accurate fonnant average would tell how a speaker had aimed his production.

When these informations are applied with the present study, it is seen that for words across varying length, F_1 and F_2 of both the Right Hemisphere Damaged and non-fluent aphasic groups were found slightly higher than normals and only F_2 reached statistical significance at penta-syllabic words. This clearly indicated of a phonemic targetting deficits in both Right Hemisphere Damaged and non-fluent aphasics at longer words. Thus as words became longer, a large, spatially more extensive articulatory gestore occurs which in turn is associated with a increment in formant frequencies and an increase in total vowel duration in the acoustic domain.

The sudden increase in initial syllable duration and vowel duration of the initial syllable of the Right Hemisphere Damaged subjects at penta-syllabic words may also be attributed to this phonemic targetting deficit.

The current study has adopted **"The mixed speech production Model"** by Mlcoch and Noll (1980) to explain most of the results obtained. In order to understand the mixed speech production model and its usefulness in explaining the speech enors associated with riglit Hemisphere Damage and non-fluent aphasics in the current study, it is desirable to know about the model especialy the functional importance of each of its components.

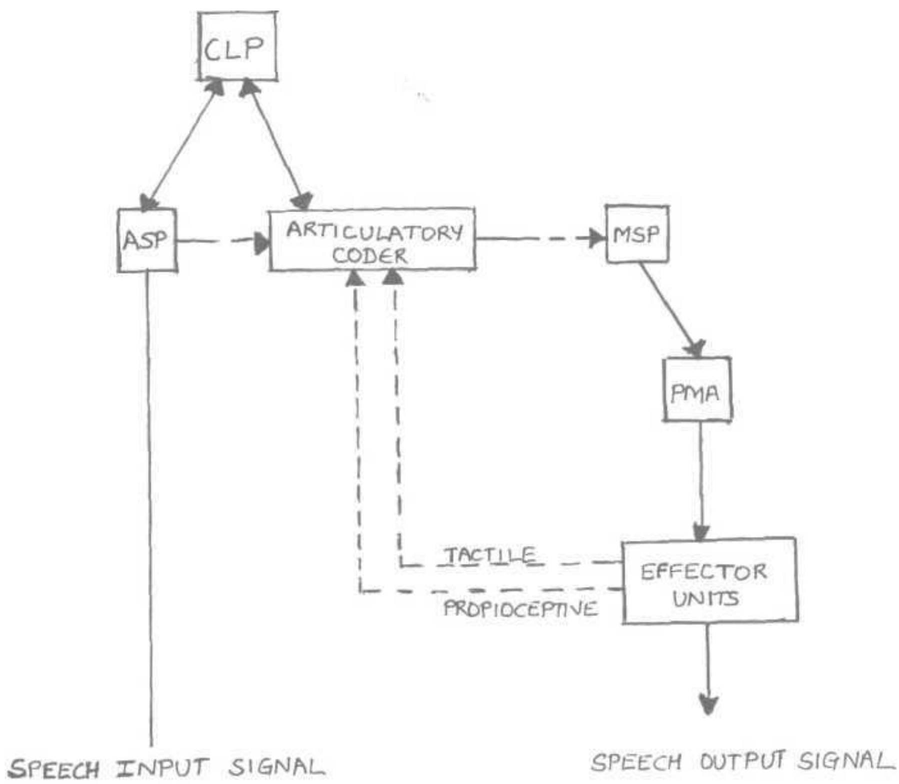


Fig. 9: Mixed speech production model.

ASP	-	Auditory speech processor.
CLP	-	Central language processor.
MSP	-	Motor speech programmer.
PMA	-	Primary motor area.

The first component of this model is the auditory speech processor (ASP) whose anatomical location is considered to be in the mid temporal lobe region of the dominant cerebral hemisphere. Its function is two-fold. First it is responsible for what Luria (1976) calls "phonematic hearing". In other words, this component has the ability to receive incoming acoustic speech signals, to detect differences between specialized properties of the signal, and to compare it against a store of phonemes so that the phonological configuiation of the signal can be determined. The second responsibility of the ASP deals with speech signals self-created by the speaker, ones not generated by outside stimulation (ie., repetition). Here, the ASP function to select appropriate phonemes from an internal store in order to form the phonological structure of the intended utterance.

From the ASP, the phonological configuiation of the intended utterance could be sent directly to one of two components, either via the arcuate fasciculus to the articulatory coder located at the oral-facial region of the postcentral gyras or via the auditory association cortex to the central language processor (CLP) located in the angular gyms region. The CLP seems to be a more logical choice since it is considered to be responsible for attaching meaning to the configuiation created by the ASP.

The next component to which the intended signal is routed, after passing through the CLP, is the articulatory coder. Unlike the auditory speech processor and central language processor, which are more concerned with determining the form and meaning of the phonological signal, the articulatory coder (AC) is responsible for translating tliis configuration into articulatory specifications. That is, instead of selecting phonemes from an internal store, the AC selects the articulatory parameters, such as placement, manner, and voicing associated with the various segments of the phonological signal, to form an articulatory configuration. In addition, considering that this component is neuroanatomically located at the oral-facial region of the postcentral gyrus, it is the primary cortical area for the reception of tractile and proprioceptive feedback information from the speech musculature. In this way, the articulatory coder can be thought of as a comparator - a component which compares the articulatory characteristics of the speech musculature with the intended articulatory configuration. The result of such a comparison would be to correct any discrepancies between these signals in order to maintain and control the accuracy of the speech output. In other words, the articulatory coder is the focal point of a closed loop control system.

Now that the articulatory configuration of the intended signal is formed, the next step would be to program this configuration into a series of neuromotor commands. This appeals to be the function of the motor speech programmer (MSP) considered to be located at the inferior portion of the third frontal convolution.

The set of neuromotor commands programmed by the motor speech programmer is then sent, via the primary motor area (PMA) (located at the oral-facial area of the precentral gyrus) and the corticobulbar fibers, to the effector units (speech musculature) for execution.

Among the various components described, the contribution of the articulatory coder has been considered very important. The two major functions of the Articulatory coder are:

1. Formation of an articulatory configuration.
2. In the reception of the tactile and proprioceptive feedback information from the speech musculature, thus acting as a comparator.

The speech error in general varied depending upon the extent of damge to the articulatory coder - a severe impairment or impairment that affects the articulatory configuration function of the articulatory coder would result in very obvious speech error however mild impairment or damage that affects the ability of the articulatory coder to receive the tactual and proprioceptive feedback information from the speech musculature would result in suttle errors which often noticed only when probed i.e., it is often not obvious.

The error pattern noticed in the Right Hemisphere Damaged and non-fluent aphasic subjects in this study can be considered to be the consequence of damage (mild) to the articulatory coder. The articulatory coder can be used to explain the error pattern only based on the following assumptions.

1. A general impairment of the articulatory coder occcurs when there is a Brain Damage irrespective of whether the damage is in the left hemisphere or Right hemisphere. As the condition of the Brain

Damaged individual resolves, the impairment to the Aarticulatory coder also recovers. If the individual does not recover, the impairment to the articulatory coder also remains unrecovered thus obvious symptoms like no speech or speech with lot of articulatory errors are seen. As the individual recoveres maximally the impairment of articulatory coder becomes very mild, thus no obvious symptoms in speech are noticed. However, when probed deeply subtle errors are noticed.

2. In non-fluent aphasics complete recovery of the part of the articulatory coder mat deals with articulatory configuration takes place however mild impairment still persists in the part of the articulatory coder that deals with the reception of tactile and other types of feed backs.

3. In the Right Hemisphere Damaged population, recovery is seen, but recovery never becomes complete because of existance of a mild impairment to the whole articulatory coder. As a result, there is impairment to both the areas of the articulatory coder that deals with the articulatory configuration and the area that deals with the reception of tactile and proproceptive feedback. However a differential impairment pattern noticed - the areas of the articulatory coder dealing with articulatory configuration is slightly more affected than the other areas of the artieulatory coder.

The slow rate of articulation and thereby an increase in durational pattern of syllable, vowel and words among the non-fluent aphasics can be attiibuted to the impaired compaiator system which takes more time to validate the production to the internal target formed in the articulatory coder. The greater variability in the durational pattern noticed among the non-fluent aphasics can also be explained based on the impaiied compaiator system ie., the time taken by the comparator system to validate the production to the increase in duration of the syllable and vowel (only syllable and vowel because as mentioned before, the deficits are often noticed only for the smaller units in Right Hemisphere Damaged). Thus accounting for sudden increase in the syllable and vowel of the penta-syllabic words in Right Hemisphere Damaged, since the involvement of the area of the articulatory coder that receives tactile and proprioceptive feedback begins at 3 syllabic words, maximum durational drop occurs at 2 - 3 syllable word level in the Right Hemisphere Damaged subjects.

SUMMARY
AND
CONCLUSION

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The basic act of communcation is the characteristic of any living being. Speech and language can be thought as the means for communication. Any language in consideration can be thought to have sound segments and sound features. The sound features or the prosodic features can be viewed as decorative ornamentation, functioning to make speech more aesthetically pleasing. Prosody is intensic and critical in both perception and production of speech.

The physical correlates that aid in the perception and production of prosody and its types are the fundamental frequency intensity and duration. Among tliese physical conelates, duration/speech timing has drawn attention of researchers.

The durational aspect of speech has been extensively investigated among normal and the Brain Damaged population. The results of these studies are often found to be scattered. The current study aimed at finding the effect of stress and word length on the durational aspects among normals, Right hemisphere damaged and non-fluent aphasics.

To accomplish the aim, four Right Hemisphere Damaged, four non-fluent aphasics and ten normals were taken as subjects. These subjects were asked to produce a list of words varying in length, wherein the initial syllable of each word had to be stressed. The words thus produced were subjected to perceptual evaluation and later detailed acoustic analysis. The parameters measured under acoustic analysis were -

1. Whole word duration.
2. Initial sressed syllable duration.
3. Vowel duration of the initla CV syllable.
4. F_1 and F_2 of nthe vowel
5. F_o of the vowel
6. Consonant duration of the initial C V syllable.

Among these only the first four was found to be significant aong the various groups studied. The result of the current study revealed that:

- Durational pattern found to decrease significantly among the Right hemisphere Damaged Group across words of varying length.
- A sudden increase in the duration of initial syllable and vowel was noticed among the Right Hemisphere Damaged.
- Duiational drop for syllable and vowel were found maximum at 2-3 syllable word level among the Right hemisphere Damaged.
- Duiational pattern was generally found higher among the non-fluent aphasic group.
- High degree of variability was found among the Brain damaged Subjects.

These results obtained from the current study are discussed based on various concepts, phenomenon, hypothesis and the "Mixed speech production model".

Conclusion:

1. The durational pattern seen in the Right hemisphere Damaged group was found significantly different from that of the non-fluent aphasic group. In general the duration was significantly reduced among the Right Hemisphere Damaged and the duration was found generally high among the non-fluent aphasics.
2. Detailed analysis of the smaller units of the linguistic stimuli than considering the whole word would often provide more information about the Riglit hemisphere Processing abnormality.
3. The pattern of error among the non-fluent aphasics may be attributed to articulatory gesture deficits and a phonetic feature deficit may be attributed to the error pattern seen among the Right Hemisphere Damaged.
4. Rate of speech was generally found faster for the Right hemisphere Damaged group and slow for the non-fluent aphasic group.
5. Based on the pattern of variability noticed from this study, it was concluded that both rate and stress had equal effects on word initial syllable and vowel duration in Kannada language.
6. Variabiality was generally high among the Brain Damaged and was found highest for non-fluent aphasic group.
7. Duration /speech timing has been considered to be differentially controlled by the Brain. When duration cues any linguistic aspects, the left hemisphere may be thought to control duration and when duration cues prosody (especially stress), the Right Hemisphere may be thought to control duration.

The limitation of the present study is that it does not consider other physical correlates of stress like fundamental frequency and intensity in detail. Moreover it is not possible to generalize the results obtained from this study because of limited number of subjects studied.

Suggestions for future research:

1. Much needs to be done further on the durational aspects in Kannada and other Indian languages. The research is still in the infant stage and much has to be done on the development of timing in children and understand about the various aspects of speech production and perception. It might be expected that further quantitative explanations on the segmental duration may lead to the formulation of the properties of the mechanism for the storage of timing in speech.
2. It remains to be determined whether all the physical correlates of stress are devient among the Brain damaged individuals. This can be studied by conducting a similar study giving due emphasis to fundamental frequency and the intensity correlates of stress.
3. It is recommended to conduct such study on other Indian languages which would enable us to comment upon the specific contribution of language.
4. The present study has used only Kannada speaking Brain Damaged individuals, it would be interesting to find if the same results are obtained among Bilingual Brain Damaged population.
5. The current study provides some insight into the issue of hemisphere dominance for the processing of durational/speech timing. However, systematic research is warranted in this direction to resolve the debate on hemisphereic dominance of durational/speech timing control.
6. The study has compared only non-fluent aphasic and the right hemispheree damaged group. A systematic comparison of various types of aphasics and

other neurological conditions may throw some liglit towards evaluation and diagnosis.

7. Last, but not the least, larger sample may need to be considered for inductively drawing inferences from such experiments in Brain Damaged.

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APPENDICES

APPENDICES

- Sample of response sheet of one of the judge in the perceptual analysis task.
- The three point rating scale used
  - a) for familiarity
  - b) Ease of production.
- Word lists used in the current study.
- Sample of the card showing how to stress the word.

NAME = Suresh B.   AGE/SEX = 21 years.   MOTHER TONGUE = Kannada

Cases Name/code	ಹುಲಿ	ಹುಲಿಯು	ಹುಲಿಗಳು	ಹುಲಿಗಳಿಂದ	ಮರ	ಮರಕ್ಕೆ	ಮರಗಳು	ಮರಗಳಿವೆ
(1) →	✓	×	×	✓	✓	✓	✓	✓
(2) →	×	×	✓	✓	✓	✓	✓	×
(3) →	✓	×	✓	✓	✓	✓	×	✓
(4) →	✓	✓	✓	×	✓	✓	×	✓
(5) →	✓	✓	×	×	✓	✓	✓	✓
(6) →	✓	✓	×	×	×	✓	✓	×
(7) →	✓	✓	✓	✓	✓	×	✓	×
(8) →	×	×	✓	✓	✓	✓	✓	✓
(9) →	×	✓	✓	×	✓	✓	×	✓
(10) →	×	✓	×	×	✓	✓	✓	✓
(11) →	×	✓	✓	✓	✓	✓	✓	×
(12) →	✓	×	×	✓	✓	✓	✓	✓
(13) →	✓	×	×	✓	×	✓		✓
(14) →	×	✓	×	×	×	✓	×	✓
(15) →	✓	✓	×	✓	✓	✓	✓	✓
(16) →	×	✓	✓	✓	✓	✓	✓	✓
(17) →	✓	✓	×	×	✓	×	✓	×
(18) →	✓	✓	×	×	✓	×	✓	✓

Case Name	Code	ತಾಯಿ	ತಾಯಿಯು	ತಾಯಿಯಿಂದಿದೆ	ತಾಯಿಯಿಂದ ಬಂದ	ದಾರ	ದಾರವು	ದಾರಗಳು	ದಾರಗಳಿಂದ
(1) →		✓	✓	✓	✓	✓	✓	✗	✓
(2) →		✓	✓	✓	✓	✓	✗	✓	✓
(3) →		✓	✓	✓	✓	✓	✗	✓	✓
(4) →		✓	✓	✓	✓	✓	✗	✓	✓
(5) →		✓	✓	✓	✓	✗	✓	✓	✓
(6) →		✓	✓	✓	✓	✓	✓	✓	✗
(7) →		✓	✓	✓	✓	✓	✓	✓	✗
(8) →		✓	✓	✓	✓	✗	✓	✓	✗
(9) →		✓	✓	✓	✓	✗	✓	✗	✗
(10) →		✓	✓	✓	✓	✗	✗	✓	✓
(11) →		✓	✓	✓	✓	✗	✓	✓	✓
(12) →		✓	✓	✓	✓	✓	✗	✗	✓
(13) →		✓	✓	✓	✓	✓	✓	✗	✓
(14) →		✓	✓	✓	✓	✓	✓	✗	✓
(15) →		✓	✓	✓	✓	✓	✗	✗	✓
(16) →		✓	✓	✓	✓	✗	✗	✗	✓
(17) →		✓	✓	✓	✓	✓	✓	✓	✓
(18) →		✓	✓	✓	✓	✓	✗	✓	✓

	ಬಾಳೆ	ಬಾಳೆಯು	ಬಾಳೆಗಳು	ಬಾಳೆಗಳಿಂದ	ಗಾಡಿ	ಗಾಡಿಯು	ಗಾಡಿಗಳು	ಗಾಡಿಗಳಿಂದ
1 →	✗	✓	✓	✗	✓	✗	✗	✓
2 →	✗	✗	✗	✗	✓	✗	✓	✓
3 →	✓	✓	✓	✗	✓	✗	✗	✓
4 →	✓	✓	✗	✗	✓	✓	✓	✗
5 →	✓	✓	✗	✗	✓	✓	✓	✓
6 →	✓	✗	✗	✗	✗	✗	✗	✗
7 →	✓	✗	✓	✓	✓	✓	✓	✓
8 →	✓	✗	✓	✓	✓	✓	✓	✓
9 →	✓	✓	✓	✓	✓	✗	✗	✗
10 →	✗	✗	✗	✗	✓	✓	✗	✗
11 →	✗	✓	✓	✓	✓	✓	✗	✓
12 →	✗	✓	✓	✓	✗	✓	✓	✗
13 →	✓	✓	✓	✗	✗	✓	✓	✗
14 →	✗	✗	✓	✓	✓	✗	✓	✓
15 →	✓	✗	✓	✗	✗	✗	✗	✗
16 →	✗	✗	✓	✗	✗	✗	✗	✓
17 →	✗	✓	✓	✗	✗	✓	✗	✗
18 →	✓	✓	✓	✓	✓	✓	✓	✓

WORD LIST USED IN THE CURRENT STUDY

|a|	|d a|	| b a |
ತಾಯಿ	ದಾರ	ಬಾವಿ
ತಾಯಿಯು	ದಾರವು	ಬಾವಿಯು
ತಾಯಂದಿರು	ದಾರಗಳು	ಬಾವಿಗಳು
ತಾಯಂದರಿಂದ	ದಾರಗಳಿಂದ	ಬಾವಿಗಳಿಂದ

| ka|	|g a|	|p a|
ಕಾಯಿ	ಗಾಡಿ	ಪಾಕ
ಕಾಯಿಯು	ಗಾಡಿಯು	ಪಾಕವು
ತಾಯಿಗಳು	ಗಾಡಿಗಳು	ಪಾಕಗಳು
ಕಾಯಿಗಳಿಂದ	ಗಾಡಿಗಳಿಂದ	ಪಾಕಗಳಿಂದ

	ಬಾಳೆ	ಬಾಳೆಯು	ಬಾಳೆಗಳು	ಬಾಳೆಗಳಿಂದ	ಗಾಡಿ	ಗಾಡಿಯು	ಗಾಡಿಗಳು	ಗಾಡಿಗಳಿಂದ
1 →	✗	✓	✓	✗	✓	✗	✗	✓
2 →	✗	✗	✗	✗	✓	✗	✓	✓
3 →	✓	✓	✓	✗	✓	✗	✗	✓
4 →	✓	✓	✗	✗	✓	✓	✓	✗
5 →	✓	✓	✗	✗	✓	✓	✓	✓
6 →	✓	✗	✗	✗	✗	✗	✗	✗
7 →	✓	✗	✓	✓	✓	✓	✓	✓
8 →	✓	✗	✓	✓	✓	✓	✓	✓
9 →	✓	✓	✓	✓	✓	✗	✗	✗
10 →	✗	✗	✗	✗	✓	✓	✗	✗
11 →	✗	✓	✓	✓	✓	✓	✗	✓
12 →	✗	✓	✓	✓	✗	✓	✓	✗
13 →	✓	✓	✓	✗	✗	✓	✓	✗
14 →	✗	✗	✓	✓	✓	✗	✓	✓
15 →	✓	✗	✓	✗	✗	✗	✗	✗
16 →	✗	✗	✓	✗	✗	✗	✗	✓
17 →	✗	✓	✓	✗	✗	✓	✗	✗
18 →	✓	✓	✓	✓	✓	✓	✓	✓

THREE POINT RATING SCALE

Rating Scale for Familiarity

Name. . . . . Date. . . . . Tester. . . . .

Instruction : "you have been provided with a list of words and numbers - 0, 1 and 2 besides each word. You will have to read tliese words and give your judgement as to the familiarity of these words. Circle 'O' if the word is very familial', '1' if the word is familiar and '2' if the word is not familiar". (Instruction translated from Kannada to English).

Wordl	0	1	2

Word 2	0	1	2

Rating Scale for ease of production :

Name. . . . . Date. . . . . Tester. . . . .

Instruction : "You have been provided with a list of words and numbers - 0, 1 and 2 besides each word. You will have to read these words and give your judgementas to how easy are tliese words to say. Circle 'O' if the word is very easy to say, '1' if it is just easy and '2' if the word is difficult to say". (Instruction translated from Kannada to english).

Wordl	0	1	2

Word 2	0	1	2

Sample of the card showing how to stress the word.