STRESS - DEVELOPMENT IN TAMIL SPEAKING CHILDREN (2-8 years)

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MAY 1992

TO

my guide Dr.S.R.Savithri

for her

CONSTANT CONCERN & RESOURCEFUL HELP

AND

my PARENTS AND ANNAS

for INSPIRATION & MORAL SUPPORT

CERTIFICATE

This is to certify that this Dissertation entitled: "STRESS - DEVELOPMENT IN TAMIL SPEAKING CHILDREN (2-8 years)" is the bonafide work, done in part fulfilment for Final Year M.Sc., (Speech and Hearing) of the student with Reg.No.M9004.

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CERTIFICATE

This is to certify that this Dissertation entitled: "STRESS - DEVELOPMENT IN TAMIL SPEAKING CHILDREN (2-8 years)" has been prepared under my supervision and guidance.

Mysore
1992

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DECLARATION

This Dissertation entitled: "STRESS - DEVELOPMENT IN TAMIL SPEAKING CHILDREN (2-8 years)" is the result of my own study undertaken under the guidance of Dr.S.R.Savithri Lecturer in Speech Science, 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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INTRODUCTION

Learning phonology of a language involves not only segmental inventories and rules affecting them but non-segmental aspects of phonology as well. Two views exist regarding the relation between segmental and suprasegmental aspects. One view holds that like icing on the cake, the suprasegmentals are added as a final touch to the segments, another view and more satisfactory one is that suprasegments and segments blend and mutually influence each6ther. One of the oldest and most tantilising question concerning early language development is the role of suprasegmental aspects of speech - intonation, rhythm and stress. Studies concerned with the prosodic aspects of language have become increasingly more frequent in the literature. A substantial proportion of the research has been directed to the study of stress.

Stress can be defined from the listener's point of view or speaker's point of view. Bloom-field (1933) defines stress as increased loudness on a particular syllable. Lehiste (1970) defines stress in terms of greater effort that enters into the production of a stressed syllable as compared to an unstressed syllable. Stress is defined as the property that endows sequential syllables with differentiating grades of acoustic prominence (Gaitenby, 1975).

The prosodic features, acoustic as well as perceptual parameters that interact in signalling stress have been reported by different investigators. Fant (1957,in Swedish) considers lengthening of the syllables as the most obvious physical correlate of stress. Fry (1958, in English) considers duration as the most reliable correlate. For Bolinger (1958, in English) the primary cue for stress is the pitch prominence and Lieberman (1960, in English) attributes peak amplitude as a reliable correlate. Savithri (1987) and Rajupratap (1991, in Kannada) attributed intensity prominence and duration as important correlates of stress. Though differences of opinion exist among investgators regarding the prominent cues of stress, all of them do agree that increments in fundamental frequency, duration, intensity and alterations in the vowel quality are the primary cues of stress.

Stress research is complicated by the fact that the parameters acknowledged as cosignals to stress also apparently share in signaling another speech attribute namely intonation. A further problem in investigating stress is that there are several types of stress that should be distinguished; lexical, semantic which includes contrastive and emphastic stress and positional stress. Another fact that makes stress description and analysis

difficult is that stress perception is dynamic, but acoustic display of speech such as spectrograms immobilise the speech wave, leading to descriptions of the physical record that appear to deal with static events. Due to these difficulties there is a paucity of studies in the area of stress. Several attempts have been made towards the understanding of child's perception and production of stress (Weir, 1962; Miller and Erwin, 1964; Atkinson-King, 1973; Perkins, 1973; Tingley and Allen, 1975; Spring and Dale, 1977). At least three factors have been implicated in learning to stress (Klein, 1984). These are,

i) perceptual discrimination of the stressed syllable,

ii) awareness of semantic differences between grammatical categories differentiated on the basis of stress (Eg. noun-verb pairs),

iii) association of stress with the weight of syllables (ie light vs heavy).

It is generally agreed that infant's perception of stress precedes production.

Stress develops as the children grow. Infants of 1-4 months have the ability to discriminate syllables only in placement of stress (Spring and Dale, 1977). Blasdell and Jensen (1970) using acoustically defined levels of stress showed that subjects were more likely to imitate words that have been stressed and they used nonsense mono-

syllables. Risley and Reynolds (1970) have also shown that their 4-5 year old subjects were more likely to imitate words that have been stressed. Even experiments in contrastive stress indicate that children can imitate contrasts before they can comprehend or produce (Eraser, Bellugi and Brown, 1963).

Several researchers have found that preschool children use stress to signal new information. Hornby and Hass (1970) have presented data indicating that by age four,children regularly employ stress to contradict incorrect descriptions. Weieman (1976) revealed that the primary factor influencing stress placement in young children's (1.9 - 2.5 years) spontaneous speech is new information. Macwhinney and Bates (1978) found that 3 year olds across three different languages use stress to encode new information in picture descriptions. Progressing to the older population, Atkinson-King (1973) studied the development of nonemphatic stress and non-contrastive stress in 300 children aged between 5-13 years. The results showed that by the age of 12 years, her subjects were perceiving and producing stress in a fully adult manner.

The results of these studies indicate that although infants perceive and produce atleast some stress differentiations by the age of 2.0 - 2.6 years (Blasdell and Jensen,

1970) or even earlier if melodic contours of a child's poly-syllabic utterances are considered to be correlated with phrasal stress (Fonagy, 1972; Konopezynski, 1975), the development of the child's stress system may not be complete until much later at about 10-12 years of age (Atkinson-King, 1973; Malikouti-Drachman and Drachman, 1975).

Stress is an important factor for normal speech and language development. There are studies detailing the stressing skills of individuals who are autistic (Baltaxe and Simmons, 1985), hearing-impaired (McGarr and Harris, 1983; Weiss, Carney and Leonard, 1985), learning disabled(Donahue, 1984; Highnam and Morris, 1987) and mentally retarded (Remmel, 1986). These studies report inappropriate judgement and use of stress in these population.

It has also been emphasised that stress is an important aspect of fluency (starkweather, 1987). As it takes more time and additional effort to produce stressed syllables, they may be considered as momentary decrease in the fluency of speech production. Also, the importance of linguistic stress in stuttering is highlighted by several investigators (Brown, 1938; Eisenson and Horowitz, 1945; Wingate, 1967). Hence, it would be important to understand the dimension of stress, When one wants to understand these disorders.

Most work to date on stress has been for the languages English (Bolinger, 1958; Fry, 1958; Lieberman, 1960), Swedish

(Schmitt, 1956), Welsh (Williams, 1985), Spanish (Hochberg, 1987b), Hindi (Firth, 1950), Tamil (Balasubramaniyan, 1981) and Kannada (Savithri, 1987; Rajupratap, 1991). As stress is dependent on the phonetic structure of a language (Cruttenden, 1986) it would be appropriate to study stress in different languages especially in a multilingual country like India and to apply it clinically. In this context, the present study was planned to identify the developmental trend, if any, in the production of stress in Tamil* speaking children in the age range of 2-8 years.

Specifically, the study includes two experiments, the first aiming to develop the material and the second to understand the development of stress in Tamil speaking children between 2-8 years. The material is also analysed to identify the perceptual and acoustic cues of stress in Tamil.

* Tamil is a Dravidian language spoken by millions of people in Indian subcontinent (Hockett, 1976) and 85% of the population in Tamil Nadu (Vasantha Kumari, 1989).

REVIEW OF LITERATURE

The review is compiled under the following subheadings:

I - Stress - definitions

II - Types and functions of stress

III - Cues of stress

IV - Measurement of stress

V - Development of stress in children

I - Stress - Definitions:

There are two major views depending on whether one emphasizes the productive or receptive aspects of loudness;- the psychophysiological and the psychological. Only occasionally does one get the required blend of two views in the work of an individual scholar.

When the speaker's activity in producing stressed syllables is in focus, stress may be defined in terms of greater effort that enters into the production of a stressed syllable as compared to unstressed syllable (Lehiste, 1970). When stress is defined from a listener's stand-point the claim is often made that stressed syllables are louder than unstressed syllables (Bloom-field, 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. Stress spans both the transmission and reception phase of speech.

In the common usage, succeding 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". Classe (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".

According to Heffner (1949)"stress is referable to kineesthetic sensation of muscle and pressure changes." 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 "stress is 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).

II - 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 a belief that stress and pitch are independent of each other.

Jones (1950, 1962) listed level stress, crescendo stress, diminuendo stress and cescendo-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 presuppose 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 stressed and unstressed 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 utterance 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 shifting 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 a certain syllable is fixed and is determined with reference to the word. The position of stress identifies the word as a phonological unit (Jakobson, 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 first 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 stress, the position of stress 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 übersétzen, "to translate" and ǘbersetzen "to take across". Weinrich (1954) calls this type of stress constructive stress.

In Tamil, the placement of stress is not fixed (Raghavendra, 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 the 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 fulfil important functions in speech perception and production. Perceptually, prosodic information assists the

listener in segmenting 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 differentiating 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) 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 carry 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 ˈoverflow", "to overˈflow" - in this pair the noun has the stress on the first syllable, the verb has it on the last. The placement o± stress indicates the syntactic function of the word. Similar oppositions occur in cases where two word phrases form compounds such as "a ˈwalk out", "to ˈwalkˈout", "a ˈput-on", "to ˈputˈon". In these cases, there is a stress only on the first 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 ˈhotdog'" and an adjective followed by a noun as in the phrase "aˈhotˈdog". 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.

III - 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 syllables is the most obvious physical correlate of stress. He proposes to measure the area under syllable peak combining intensity and duration in a single measure. Bolinger (1958) considers "stress as accent". Thus,for Bolinger the primary cue of what is usually termed 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 seen as underlying the perception of stress. For Savithri (1987) intensity and duration are the important cues.

Though difference of opinions exist, all of them agree that increments in F_o, 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 for languages English (Bolinger, 1958; Fry, 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 the 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 ie stress. The exact cue still remains unknown.

The relative importance of F_o, intensity and duration in perception of stress have been studied experimentally 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 1.	Language 2.	Subjects 3.	Cues 4.
Stetson (1951)	English		Vowel quantity
Fry(1955)	English	100	Duration Intensity
Fant(1957)	Swedish	—	Lengthening of the syllables

1.	2.	3.	4.
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.
Lieberman (1960)	American English	16	1) Higher F_o (2) Peak envelope amplitude (3) Longer duration.
Rigault (1962)	French	-	1) Frequency (2) Duration
Shearme and Holmes (1962)	English	-	Acoustical vowel diagram
Lehiste & Ivic(1963)	Serbo-croatian	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 Ist syllable 2) Quantity, intensity
Jassem and Morton and Steffen Botog (1968)	Polish	-	F_o variations, durations

1.	2.	3.	4.
Lehiste (1968a)	Estonian	-	Duration
*Berinstein (1979)	Kechi	10	1) Change of F_0,(2) Intensity (3) Duration.
*Bertinetto (1980)	Italian	-	Duration
Balasubramanian (1981)	Tamil	-	Prolongation of a vowel that is phonologically long. Prolongation of a consonant and glottal onset. Addition of one of the two emphatic particles /e:/ and /ta:n/
*Rathna, Nataraja and 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_0 (2) Duration (3) Intensity(4) F_2.
Savithri (1987)	Kannada	4	1) Durational changes 2) Intensity changes
*Rajupratap (1991)	Kannada	10	1) Durational changes 2) Loudness changes

Table-1: Studies on cues of stress

* denotes perceptual studies.

Thus we see that though majority of cues are same, there are some differences and thus the cues vary with languages. For English and Polish the major cues seems to be F_0, duration, intensity whereas for Swedish, Estonian and Kannada duration is the major cue.

IV - 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)

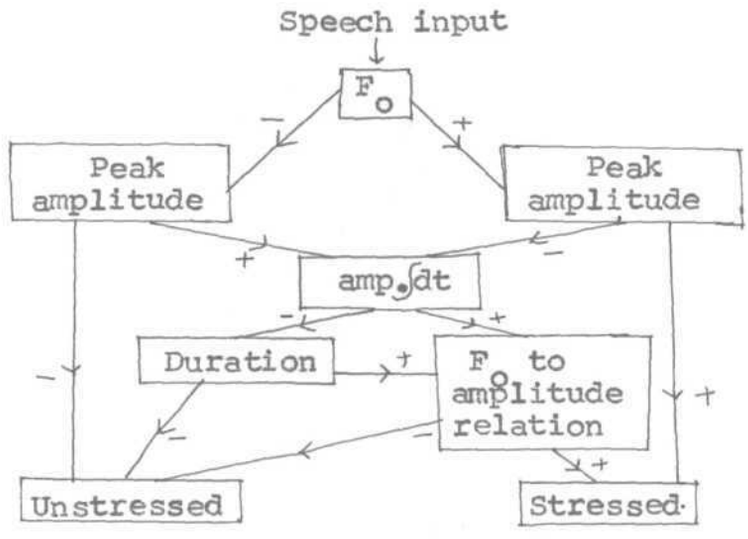

Figure-1: Program for mechanical recognition of stressed syllable Lieberman, (1960).

The F_o 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.

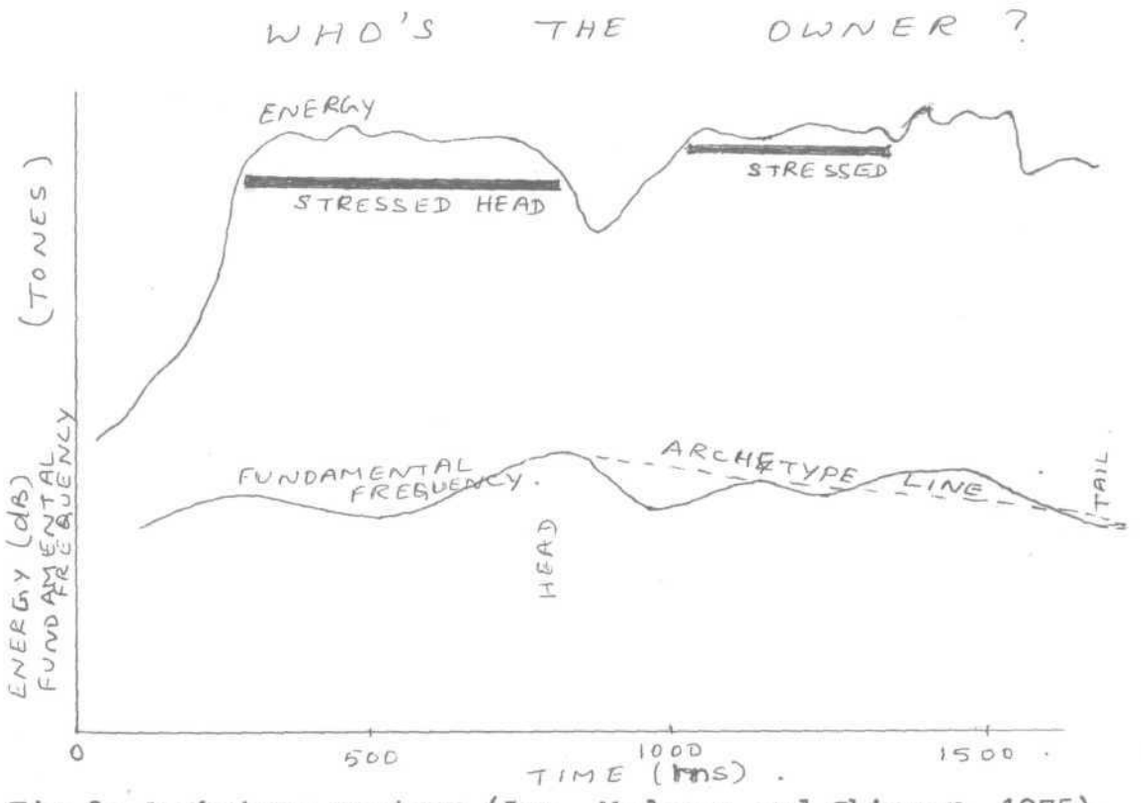

Fig.2: Archetype contour (Lea, Medress and Skinner, 1975).

Figure-2 illustrates how the acoustic correlates of rising F_o and large energy integral are used 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 F_o 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 F_o ie local rises above the gradually falling F_o contour.

Thus, there are different opinions about locating stress. Some locate it by F_o prominence, some by intensity prominence and some by both F_o and intensity prominence.

V - Development of stress in children:

Two hypotheses have emerged from the literature regarding children's initial state in stress. The first, which one can term as the neural start hypothesis holds that children begin the learning process with no stress preferences. The child begins presumably with level stress or within difference to the distribution of stress both in babblings and at the outset of speaking. Then the stress habits of community assert themselves quickly and decisively (Leopold, 1947). In contrast, Allen and Hawkins (1977, 1979, 1980) have hypothesised that children have a natural bias towards producing words with Trochaic rhythm (an accented syllable followed by an unaccented syllable).

This review discusses (a) Perception of stress in children (b) Production of stress in children. Both production and perception studies are arranged developmentally.

a) Perception of stress: Children's ability to understand and use stress develop as they grow. Also, it is generally agreed that infants perception of stress precedes production.

Even very young infants show some sensitivity to prosodic aspects,of speech of adults (Morse, 1972; Mehler and Bertoncini, 1979). It has rather been argued that infants

respond first to suprasegmental patterns in the speech around them (Lewis, 1951; Crystal, 1970). Spring and Dale (1977) discovered that 1-4 months old infants correctly discriminated disyllables with differing only in the placement of stress as signalled by F_o, duration and intensity differences. Infact, infants were able to discriminate syllables differing only in duration.

Spring and Dale's study was directed towards two goals. First, was to explore the ability of young infants to discriminate syllabic stress ie. the contrast which differentiates the meaning of two words eg. Blácк bird vs. Black bird. Second, was to evaluate the ability of young infants to discriminate stimulus differences on the basis of duration cues alone.

They took 224 infants in the age range of 4-17 weeks and used modified high amplitude sucking paradigm. The infants were placed in a reclining seat and were given an artificial non-nutritive blind nipple for sucking. The nipple was attached to a pressure transducer. A level defining a high amplitude sucking was preset after monitoring the trials of non-reinforced sucking. They divided the infants into experimental and control group randomly. The base line was determined which was the response of infant after 7-12 minutes acquisition phase in which the child gets habituated. The sucking rate gradually decreases with habituation.

The infant was presented with an auditory stimuli which was an artificially synthesized disyllabic babá and the base line was determined. Then the experimental group was presented with a new stimuli bába while the control group received the same stimuli. It was found that young infants were able to discriminate the acoustic correlates of stress location (F_o, intensity and duration) and also could discriminate durational difference alone, without concomittant variations in the naturally correlated parameters of F_o and intensity. Spring and Dale (1977) concluded that, infants have atleast some stress related information available which may serve as the foundation for lexical and syntactical learning.

Hornby (1971) found that first and third graders performed essentially chance in interpreting stress cues to topic-comment structure. Macwhinney and Price (1980) replicated and extended this finding.

Macwhinney, Pleh and Bates (1985) in a study of sentence understanding in Hungarian found that 6 year olds could use stress as a cue to thematic role assignment almost as efficiently as adults could; 3 and 4 years, however failed to make use of the stress cue.

Solan (1980) studied 33 children with the age range of 5-7 years. The intent of the study was to trace the children's

development of rules for interpreting contrastive stress. Children were presented with sentences such as "John hit Bill and then he hit Sam". An act out procedure with toys was used as a response. It was found that when pronoun was stressed, the children performed better (80%) than when it was unstressed (60%). This gap was closed at higher age group.

Studies concerned with contrastive stress generally show that children both use and understand contrastive stress as a make of focus at a young age. Hornby (1973) compared children's understanding of sentences, whose focus was marked by a syntactic device (clefting), with their understanding of simple sentences whose focus was marked by means of contrastive stress. Results showed that the stressed sentences were significantly easier for the children's identification of focus than were the clefted sentences indicating that for children talking loudly is easier than learning syntax.

Atkinson-King (1973) studied the development of non-emphatic/non-contrastive stress in 300 children from 5-13 years of age. In one part of the study, the experimenter measured the children's ability to use stress to distinguish between nouns and corresponding noun phrases that differed

only in the location of stress. Words and phrases such as hot dog / hot dog, red sox / red sox were spoken by the examiner. The children were asked to identify them by pointing to a picture of the object. The words were spoken alone Ist, then in a sentence. The children were also, asked to respond to a sentence in which the meaning suggested one form but the other form was used, such as "Flowers grow in a green house". In all three of these tasks, development was interrupted by a lag at grades 4 and 6 although only the former was a significant deviation from the trend. In addition, in the identification tasks girls performed consistently better than the boys. In the preference task, however, there was no lag in development at any grade level and no sex difference. The identification task might be considered harder than the preference task in that the subjects had to be more sure of the correct response. In the preference test, a forced choice procedure was used so there was less uncertainty. In the third task, where the content of the sentence was at odds with the placement of stress, there was another clear developmental trend. Older children tended to rely more on the placement of stress and less on context. In addition, the girls did better than the boys in this test.

She also studied comprehension of contrastive stress using noun-verb in 125 children and 19 adults. Three pairs

of contrasting nouns and verbs were used as a stimuli. They were embedded in the sentences such as "Let's record his voice", "Let's record his voice". The results indicated that the ability to select the noun and verb in sentences with these pairs is mastered mainly as a function of age. A steady developmental increase in percent of correct response, starting with Grade I's as 65% till Grade 7 and 8's 100%. Also,it was found that the children reach a high level of accuracy with these nouns and verbs much earlier than they do with the compounds and phrases tested.

Myers and Myers (1983) examined normal children (k-6) in their ability to judge the appropriateness of the stress patterns of sentence pairs. They discovered a steady progression in this capacity but with marked variation, even among their older children. The study indicated that skill in judging the correctness of stress cues which distinguish emphasis in meaning seem to be one that matured even into adolescence.

Cross linguistic studies have been conducted on the development of stress. Gleitman and Wanner (1982) have argued persuasively that cross linguistic asymmetries in the acquisition of certain morphosyntactic features can be explained as the universal application of a strategy "pay

attention to stressed syllables". Thus, language specific interrelations of stress patterns and morphology underlie language specific acquisition patterns. The prosodic perception of young children is in some cases better than might be predicted. Allen (1983) showed that 4 year old French children can correctly perceive stress contrast not found in their language (but typical of English and other stress languages), whereas the same children at the age 5 more fully in command of the prosodic structures of their own language, can no longer reliably distinguish the non native contrasts.

b) Production of stress: Children's use of stress also begins in young age. Brown (1973) noted that one of his subjects used the contrastive stress technique to introduce new information prior to the age of 2 years. His subject eve, aged 18 months contrasted the sentences "that papa nose" and "that eva nose" by application of contrastive stress. Evidence of early use of contrastive stress was also provided by Weir (1962) who noted extra heavy stress for the emotive function of language, in her 2 1/2 years old son's speech. Slobin and Welsh (1967) found contrastive stress generally imitated by the 2 year old child they studied.

Klein's (1984) study of a 2 year old's lexical stress patterns found that although this child had considerable difficulty imitating lexical stress. Patterns, his spontaneous productions of words familiar to him used consistent and correct stress placement. At the utterance stress level, Macwhinney and Bates (1978) showed that children can use stress to distinguish new given information by age 3. In a similar context, Weiman (1976) also showed, that children whose mean length of utterance measured 1.3 - 2.3 morphemes already showed an established stress pattern and that stress assignment highly correlated with semantic content, in particular with the introduction of new information.

Raju Pratap (1991) studied the development of word stress in the range of 3-4 years old normal children who were native Kannada speakers. 12 children were studied with one male and one female each in the interval of two months. Audio-recorded clauses (22) and sentences (9) which were judged to have the key word stressed by more than 80% listeners were taken. This material was audio presented and the children were instructed to imitate or repeat the recorded version which they heard. The model and children's imitation was audio recorded. Perceptual judgement by 2 listeners were used to identify the percentage of correct response for

each child. Results indicated that the production of word stress increased from 3 - 4 years in both males and females for clauses and sentences. However, even at 4 years children did not achieve 100% score except for female children in the age range of 3.10 - 4 years.

Allen and Hawkins (1980) analysed the acoustic properties of 3 types of syllables, namely nuclear accented (stressed), non-nuclear accented and heavy unaccented syllables in the speech of 3 children aged 36 + 4 months. Recordings were made of each child playing in home with his mother present, on two or more occasions, two weeks apart. From each session, 50 utterances were chosen, each consisting of two or more words spoken at adequate level in a normal voice register and containing an identifiable nuclear syllable. One evaluator transcribed the events, another assigned stress to each syllable and the third checked the segments and stress assignment. The duration and F_o of each heavy and accented syllable in the 50 utterances from each of two sessions for each child was measured spectrographically and in some cases, oscillographically also.

In most respects, the acoustic patterning associated with stress accent and position of a syllable in the phrase in 3 year olds speech closely resembled the pattern found

in adult speech and indicates that children have internalised the basic rules of stress or accent in English ie they have mastered the production of stress at the age of 3 years.

In another study, Allen and Hawkins (1980) tested the children's ability to produce and discriminate minimal pairs of nonsense names for toys with names within pairs differentiating only in stress placement within each pair. One had initial stress ie. Trochaic while the other had final stress or non-trochaic. All the children aged 3.7 - 6.7 were able to discriminate the pairs easily but when names had to be produced, some errors were seen.

In a subsequent study in French children, Allen (1982) found that of '181' one-word utterances produced by 6 children aged 1 year 9 months - 2 year 8 months which were analysed using spectrograph, a plurality had falling intensity contours. He suggested that these show a trace of some 'primitive' trochaic rhythm or stress. , Hochberg (1987 b) studied the acquisition of stress in Spanish language and he opines that by 3 years of age children learn the rules of stress.

Progressing to somewhat older population, Hornby and Hass (1970) found that the normal 4 year old children were able to mark comment in an utterance by use of contrastive stress. They had 20 subjects in the age range of 3.8 - 4.6

(10 males and 10 females) years and the mean age was 4 year. They used 24 drawings of simple events which were grouped into 12 pairs in which only one element of pictures differed in each pair. All the pictures had a subject, verb and object. They presented the pair of pictures one after another ie the picture was introduced and later its pair was introduced. They asked the childred to describe the pictures and the descriptions were recorded and analysed. Their results suggest that there was a clear tendency to stress the part of description corresponding to contrasting element. They concluded that contrasting stress patterns are mastered by children by the age of 4 years.

It was found that the number of times each sentence constituent received contrastive stress for the first (initial) picture was few but for the second picture (contrasting) ie new element was presented,it was very frequently stressed. When stress did occur on some of the initial picture descriptions, it was most prevelant for the object (18.75%) constituent and scarcely ever occured for the verb (3.75%) constituent.on the other hand, stress was most prevalent in response to contrastive picture for the subject (80.00%), less for verb (56.25%) and still less for the object (43.75%). It shows that the tendency to

stress the new element in the contrasting picture is affected by its position in the sentences. This extends the role of word order in the functioning of the topic comment distinction,

Contrastive stress is a more primitive device than word order for expressing topic-comment discussions (Atkinson-King, 1973). Hornby, Hass, and Feldman employing a different method, found that 7 year old children were able to employ word order for determining the topic-comment distinction ie they choose the later part of a simple sentence (the grammatical predicate) as the comment more frequently than the earlier part (grammatical subject). But the earlier work by Hornby and Hass (1970) suggested that children as young as 4 years may be sensitive to the role of word order in making the topic comment distinction. Thus when the new or contrasting element appears toward the end of the utterance, it is less likely to be marked with contrastive stress than when it appears earlier in the utterance. In English the predicate generally carries the role of comment.Contrastive stress is particularly variable technique for drawing attention to the subject.

Chomsky (1971) examined the effect of contrastive stress on person reference. She found that contrastive stress was successfully established by the age of 6 years for the subjects she studied.

Atkinson-King (1973) studied the production of stress using compounds and phrases. Twentyfive children were used as subjects in the various production tasks. Grades 1 through 4, and their ages ranged from five to eight years. The following tasks were given to the children:- Experimenter identification, self identification, production, imitation and the pair production. Judgements of two adult listeners indicated that the majority of the children particularly the youngest, failed to produce compounds and phrases correctly, in most productions of test stimuli,primary stress was on the first syllable. This was more evident in younger children who had succeeded in the earlier comprehension tasks.

In the self identification task only five children in grades 3 and 4 were able to identify correctly a significantly better than chance number of their own productions, and all five had significant score on the production test. There was good correlation between the adult listener's judgements and the children's identifications. If the children could identify, the adults could too, if the children failed, so did the adults.

Children appeared to have success in correctly producing both members of a minimal pair in succession emphasising

the differences (the pair production test), than in producing such member randomly in isolation (the production test). Although the children failed to produce these stimuli consistently and correctly, children were able to imitate the stress patterns of the compounds and phrases correctly. Also, children who were successful in producing the test items correctly were also successful in comprehending them, but the reverse was not always true.

An informal contrastive stress test was also given to the same children. Questions and test phrases were constructed to elicit answers. For eg. Experimenter: Are these—?, red shoes, blue socks, Children: No, they are—— red socks, red socks. Results indicated that contrastive stress rule has been acquired and is used correctly by the time children reach the age of five or six.

Atkinson-King (1973) showed that by the age of 12, her subjects were perceiving and producing stress in a fully adult manner.

The results of these studies indicate that stress develops from infant stage and continuous upto 12-13 years and is language dependent. Studies in Indian languages are scanty and only Kannada has been partially studied. The present study aims at understanding the development of stress in Tamil speaking children in the age range of 2-8 years.

METHODOLOGY

The methodology is described under two experiments, experiment I - material development and experiment II - development of stress in children.

Experiment-I: Material development

As the study was conducted with children in the age range of 2-8 years, different material was developed for different age groups on the basis of vocabulary and grammatical development in that particular age group. The material was selected An personal communication with Dr.Ramasamy, Lecturer in Tamil, Southern Regional Language Centre, Mysore.

Material:

2-4 years: Fifteen meaningful bisyllabic Tamil words were selected. The words were of CVCV combination where the consonant was same in both syllables of the words and the vowel varied. Stress was assigned to one of the syllables of the word randomly.

4-6 years: Phrases with mean length utterance of two words were selected in the following grammatical categories - Noun + Noun, Noun + Noun, Noun + verb. Noun + Verb; Adverb + Verb, Adverb + Verb, Adjective + Noun, Adjective + Noun (Stress indicated by /) . Six phrases were selected under each category and totally 48 phrases were choosen.

6-8_%ears: Sentences with mean length of utterance of three words were selected. Noun + Adverb + Verb, Noun + Noun + Verb, Adjective + Noun + Verb were the grammatical categories choosen. Six sentences each with stress on each of the grammatical categories were selected. For eg. in the Noun + Adverb + Verb combination, six sentences with stress on noun , six sentences with stress on adverb and six sentences with stress on verb were selected. Thus, totally. 54 sentences were considered.

All the phrases, sentences were statements with all the three tenses (past, present and future) distributed equally among the grammatical categories. These material were written one on each card and the key syllable or word to be stressed aas underlined. (Appendix-I).

Subject: A female Tamil speaker aged 22 years with normal speech and hearing served as the subject. She was a master's student in Speech and Hearing. She was familiarised with the material and was visually presented with the material one at a time. She was instructed to utter the words, phrases and sentences with stress on the underlined syllable or word into a microphone kept at a distance of 10 cm. from the mouth. For eg. in the phrase /tāi māma/, she was to stress the word /tāi/. She was also instructed to repeat 3 words, 4 phrases and 5 sentences which were randomly selected

from the constructed material to check for intrasubject variability. These were audiorecorded on a cassette in a sound treated room. The subject listened to the recording and was allowed to repeat any words, phrases or sentences which she felt was not uttered with proper stress. A final audio-recording of this was prepared.

Method: Ten female native Tamil speakers in the age range of 19-23 years with the mean age of 20.7 years served as subjects. The subjects were experienced listeners and they were students undergoing master's training in speech pathology and audiology.

The audio-meterial was presented to the subjects one at a time and they were instructed to write the syllable or word which they perceived as stressed. However, they were not provided with any definition of stress. Also, the subjects were instructed to write-down the perceptual cues of stress for each syllable/word.

Analysis: Three tasks were performed in which first two tasks involved percent identification of stressed syllable/word and their cues and task III involved the acoustic analysis.

Task-I: Percent identification of stressed syllables/words:

A response was considered as correct,when the subject identified the intended syllable or word as stressed. Each

correct response was assigned a value of 'one' and the total number of correct responses of all the ten subjects for each wordy phrase or sentence was computed. The percent of correct response was calculated using the formula.

$$\frac{\text{Total number of correct responses for a word/phrase/sentence}}{10} \times 100$$

The words, phrases and sentences which were correctly identified as stressed by 80% and above of the subjects were considered for the second experiment. Of the 18 words (15 + 3 repeated), 52 phrases (48 + 4 repeated) and 59 sentences (54 + 5 repeated) all the 18 words, 45 phrases and 50 sentences were selected. Remaining 7 phrases and 9 sentences were rejected since the correct response score was less than 80%.

Age group	Type of material	No.of items selected initially	No.of repeated items	Total no. of items	NO.of items selected finally
2-4 years	Disyllabic words	15	3	18	18
4-6 years	Two word phrases	48	4	52	45
6-8 years	Three word sentences	54	5	59	50

Table-2: Material selected for the study.

Table-2 presents the type and number of material selected for various age groups. Interjudge reliability was measured by using Walsh test.

Task-II: Identification of perceptual cues of stress.

The perceptual cues were tabulated for all the subjects and the number of times a cue was identified by each subject was found out. Then the mean number of times a cue was used was calculated by the formula:

$$\frac{\text{Total number of times a cue was identified by all the subjects}}{10} \times 100$$

The percent times a cue was identified was also calculated. The weightage on each cue was calculated using the following formula:

$$\text{Percent weightage on each cue} = \frac{\text{Percent identification of the cue}}{\text{Total percent for all the cues}} \times 100$$

Task-III: Acoustic analysis of stress.

The speech samples were fed to the pitch analyser (PM 100) from a tape recorder. Peak F_o, peak intensity and total duration for each syllable was measured for all the words. Since the duration of the words can vary with the word length and inherent properties of the phonemes which constitute a word, duration was not measured for the words in phrases and sentences. Only peak F_o and peak intensity were measured for each word in all phrases and sentences. The cursor of the PM 100 was moved to the peak Intensity and F_o and the readings were noted down.

The syllable duration was measured as the duration between the onset of low intensity to the offset of high intensity as in Fig.3.

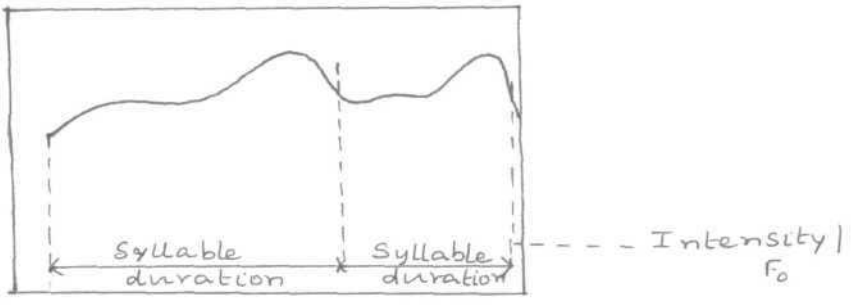

Fig.3: Duration of syllables (example)

When the stressed syllable or word was in initial position, the peak F_o, peak intensity and duration of the following syllable/word was taken as a reference. In other positions, the reference was the previous syllable/word.

Each increment in F_o/Intensity/Duration on a stressed syllable/word was assigned a value of "1" and each decrement was assigned a value of "0". For eg. as in Table-3 the first word has increment in F_o which was assigned a value of "1" and the third word has decrement in F_o and intensity increment which was assigned a value of "1" as in Table-4.

	$Word_1$	$Word_2$	$Word_3$
	135	132	131
Intensity	44	42	45

Table-3: Peak F_o /intensity of words (example)

	$Word_1$	$Word_2$	$Word_3$
F_o	1	0	0
Intensity	0	0	1

Table-4: Assigned values for F /intensity increments (example)

The total number of times F_o /Intensity/Duration, F_o + Intensity, F_o + Duration, Intensity + Duration, F_o + Intensity + Duration increased and decreased were calculated and percent of this was computed by the formula:

$$\frac{\text{Total number of times } F_o \text{ /Intensity/Duration, } F_o + \text{Intensity, } F_o + \text{Duration, Intensity + Duration, } F_o + \text{Intensity + Duration increased/decreased}}{\text{Total number of stressed syllables/words}} \times 100$$

Also the weightage on each acoustic correlate was calculated by the formula:

$$\frac{\text{Percent times an acoustic correlate increased/decreased}}{\text{Total percent of acoustic correlate}} \times 100$$

Experiment-II: Development of stress in children.

Material:

Audio recorded samples of 18 words (15 + 3 repeated), 45 phrases (42 + 3 repeated) and 50 sentences (45 + 5 repeated) which had 80% and above correct identification in experiment I (Task I) were used as material.

Subjects: Twelve (6 males and 6 females) Tamil speaking children each in the age range of 2-8 years with one year interval served as subjects. All of them had normal oral mechanism and normal speech as judged by a speech pathologist and none of them reportedly had any history of speech, language and/or hearing problems. All these children were from middle socio-economic class and were selected from various schools in Tamil Nadu (Periyar District).

Table-5 gives the details of the subjects selected for the study.

Age in years	2 -3		3		4 - 5		9 -		6 -1		"7 - S	
	M	F	M	F	M	F	M	F	M	F	M	F
NO.of children	6	6	6	6	6	6	6	6	6	6	6	6
Mean age	2.4	2.4	3.4	3.4	4.4	4.4	5.4	5.4	6.4	6.4	7.4	7.4

Table-5: Subjects selected for the study.

Method: The recorded material was audio presented from a tape recorder to the children, one at a time in a quite room. They were instructed to listen to it carefully and repeat (imitate) the words or phrases or sentences (2-4 year children were presented with bisyllabic words, 4-6 year old with two word phrases and 6-8 year children with three word sentences). Each child was given a trial before the experiment. Children

were allowed to listen to the model as many times as they liked. No specific effort was made to make the child aware of the stressed syllable or word. The response of the children and the model were audio-recorded.

Analysis: The recorded samples of the model and imitation were given to two judges for perceptual judgement. The first judge was the experimenter and the second judge was a post-graduate student in speech pathology and audiology. The judges were instructed to listen to the model and the imitation. They had to mark "S" if the perceived stressed syllable or word in words, phrases and sentences was same in the model and imitation and to mark "D" if the perceived stressed syllable or word in the imitation were different from the model. Also, the judges were instructed not to consider any of the misarticulations if present.

The total number of "S" and "D" were calculated for each child and the total number of "S" was converted into percent by using the formula:

$$\frac{\text{Total "S"}}{\text{Total number of words/phrases/ sentences}} \times 100$$

A rank correlation test was performed to test the inter-judge reliability and 't' test was performed to find out the significance of difference between means of various age groups. The data was then tabulated to bring about an emerging pattern of stress in children between 2-8 years.

RESULTS AND DISCUSSION

RESULTS:

Experiment-I:

Task - I: Material Development.

As the study consisted of three age groups, the material developed for each group is described below.

2-4 years: words - Of the 18 bisyllabic words (15 + 3 repeated) all were rated to have stress on the key syllable by more than 80% of the judges. 12 were identified to have the key syllable stressed by 100% of judges and 6 words scored 90%.

4-6 years: Phrases - Among the 52 phrases (48 + 4 repeated) 45 phrases were judged tqnave stress on the key word by more than 80% of judges. Of the 45 phrases, 28 phrases were rated to have the key word stressed by 100% of judges and 17 phrases scored 90%.

6-8 years: Sentences - Initially 59 sentences (54 + 5 repeated) were choosen. Of these, 50 sentences obtained more than 80% of judges rating. Of these 50 sentences, 30 were identified to have the key word stressed by 100% of judges and 20 sentences scored 90%.

Table-6 depicts the responses (in percent) of ten judges in the identification of stressed syllables/words.

Age group and material	Number of syllables/ words stressed		Percent scores
2-4 years words	Syllables	12	100
		6	90
4-6 years phrases	Words	28	100
		17	90
		7*	80
6-8 years sentences	Words	30	100
		20	90
		9*	80

* = No.of items (scores $\leq$ 80%) not included for the study.

Table-6: Percent response for stressed syllables/words.

Intra subject reliability: To test the intra subject reliability, three words, four phrases and five sentences were repeated. Of these, all the three words and five sentences were judged to have the key syllable or word stressed in both utterances by >80% of the judges. However, of the four phrases repeated, only three scored >80% in both the utterances.

Table-7 gives the responses of the judges for repeated words, phrases, and sentences. The results of the Walsh test indicated that no significant difference existed between the trials suggesting high intra judge reliability.

Material	Trial I in %	Trial II in %
Words		
1	100	100
2	100	90
3	100	90
Phrases		
1	60	70
2	90	90
3	100	100
4	100	100
Sentences		
1	90	100
2	90	90
3	90	90
4	100	100
5	100	100

Table-7: Percent response for stress in two trials for repeated items.

On the basis of the results, seven phrases and nine sentences were deleted and a total of 18 words, 45 phrases and 50 sentences were selected for further analysis and Experiment-II. (Appendix I gives the details of the words, phrases and sentences selected).

Task-II: Perceptual cues of stress.

A total of eight cues were identified by the ten judges as follows,

1. Prolongation of sressed word,
2. Extra effort in production,
3. Pause before or after stressed words or intersyllabic pause in the stressed word,

4. Raising or falling intonation in stressed word,
5. Clear articulation,
6. Shortening of stressed word end,
7. Shortening of preceding or following word,
8. More stress (undefined).

It appears that the judges have indicated that the stressed word is emphasised using one or the other physical dimensions;- increased effort, lengthening, pause or changed pitch. These cues along with the mean and percent identification by judges are in Table-8.

Perceptual cues	Words		Phrases		Sentences	
	Mean	Percent	Mean	Percent	Mean	Percent
Prolongation	12.6	70	23.9	53.11	23.1	46.2
Effort	6.7	37.32	15.4	34.22	17.4	34.8
Pause before or after stressed word	0	0	10.3	22.88	13.0	26.0
Raising or falling intonation	1.1	6.11	8.7	19.33	8.6	17.2
Articulation	0.9	5	4.30	9.55	5.0	10.0
Shortened stressed word end	0.9	5	0.9	2	1.6	3.2
Shortening of proceeding or following word	0	0	0.7	1.55	0	0
More stress (undefined)	0.1	0.56	1.6	3.55	1.5	3

Table-8: Perceptual cues of stress

These cues were pooled together and grouped as provided in Table-9 under six headings. Their percent weightage is also shown in the same table.

Perceptual cues	Average percent	Weightage on each cue(present study)	Weightage on each cue Savithri (1987) (Kannada)	Weightage on each cue Raju Pratap (1991) (Kannada)
l.Durational changes	56.37	42.4	35.75	34.5
2.Loudness changes	35.44	26.7	21.51	34.5
3.Pause	16.30	12.3	14.34	8.6
4.Intonation dhanges	14.21	10.7	12.57	8.6
5.Articulation changes	8.18	6.2	10.71	4.3
6.More stress (undefined)	2.51	1.8	3.6	8.6

Table-9: Perceptual cues of stress and their percent weightage.

From Table-9 it is evident that durational changes have the maximum weightage followed by loudness changes, pauses, intonational changes and articulatory changes.

Task-III: Acoustic analysis of stressed syllables/words.

Table-10 depicts the results of the acoustic analysis for 18 words, 45 phrases and 50 sentences. It appears that an increase in intensity concurred with the stressed syllable

or word. The second major correlate was increase in duration in words (not measured for phrases and sentences) and increase in F_o for phrases and sentences. Negligible percent of decrements in F_o and intensity was also observed. In these items, vowel quantity (Stetson, 1951), larger vowel diagram (Tiffany, 1959) and peak envelope amplitude (Lieberman, 1960) could have resulted in stress.

Acoustic correlates	Words		Phrases		Sentences	
	Per-cent	Weight-age	Per-cent	Weight-age	Per-cent	Weight-age.
Increase in intensity	94.44	22.66	84.44	43.18	82	43.15
Increase in duration	83.33	19.99	NC	NC	NC	NC
Increase in Intensity & duration	83.33	19.99	NC	NC	NC	NC
Increase in F_o	50	12.00	53.33	27.27	52	27.37
Increase in F_o and Intensity	50	12.00	46.67	23.87	44	23.16
Increase in F_o & duration	50	12.00	NC	NC	NC	NC
Increase in F_o, intensity & duration	5.56	1.33	NC	NC	NC	NC
No change in F_o	0	0	0	0	0	0
No change in intensity	0	0	2.22	1.14	10	5.26
No change in duration	0	0	NC	NC	NC	NC
Decrease in F_o & intensity (measured only for phrases & sentences)	NC	NC	8.89	4.55		

2 1.05

Table-10: Acoustic correlates of stress and their percent weightage for the items used in the study

NC: Not considered for calculation

Experiment-II: Development of stress in children.

This experiment aimed at understanding the development of production of stress in children using words, phrases and sentences from experiment-I.

Table-11 depicts the performance of children in terms of percent scores for both the sex at different age intervals on an imitation task.

Age group in years	Mean scores				Mean percent scores			
	J_1		J_2		J_1		J_2	
	F	M	F	M	F	M	F	M
2-3	12.00	11.83	12.00	11.83	66.66	65.72	66.66	65.72
3-4	13.16	13.00	13.16	13.00	73.11	72.22	73.11	72.22
4-5	35.33	34.5	35.33	34.5	78.51	76.66	78.51	76.66
5-6	40.83	37.33	40.83	37.5	90.74	82.96	90.74	83.3
6-7	39.5	39.00	39.66	39.00	79.00	78.00	79.32	78.00
7-8	44.83	40.83	44.83	41.00	89.61	81.66	89.66	82.00

Table-ll:.Percent scores obtained by children at different age intervals.

J - Judge.

It was observed that the performance of children imitating stress improved from 2-8 years. However, even at the age of 8 years the children were not able to obtain 100% score which indicated that even at 8 years, children did not master the use of stress. Considering the mean percent scores, there

was a dip noticed at 6-7 years of age in both the sex. Except for this, there was a linear relation between the age and capacity to produce stress, as evidenced by the imitation task.

The 't' test indicated a significant (P 0.01) difference between the scores of 2-4 years and 4-6 years , 2-4 years and 6-8 years. However, no significant difference (P 0.01) was noticed in the development of stress between 4-6 years and 6-8 years. (Table-12).

Age group in years.	2-4 years vs. 4-6 years	4-6 years vs 6-8 years	2-4 years vs 6-8 years
't' value	6.62	0.03	6.98

Table-12: 't' values for the mean percent scores of different age groups.

Also, the results of 't' test indicated no significant difference (P 0.01) between males and females in any of the age groups. However, there were some differences in their performance at all age groups. Females performed better than males in all the age groups.

The results of the product moment correlation test indicated a near perfect correlation between the two judges for phrases and sentences with an "r" of 0.96 and 0.97 respectively. This indicates a high interjudge reliability.

For words the correlation was 0.64. The results obtained for 2-3 years using words were not reliable as wide variations were observed between the judges rating children's responses. Also, children's responses were found to be difficult to rate due to factors like poor imitation of model by the children and more back ground noise in recording.

DISCUSSION: The results reveal several interesting points. First of all the results indicate that durational and loudness changes were the major perceptual cues for the perception of stress and others (pause, articulation intonation and stress) were the minor cues.

These results are in concurrence with the results of the studies by Pant (1957) in Swedish, Lehiste and Ivic (1963) in Serbocrotian, Lindblom (1963) in English and Swedish, Lehiste (1968a) in Estonian, Savithri (1987) and Rajupratap (1991) in Kannada. In these studies, duration and loudness are reported to be the two major perceptual cues of stress. However, the results do not agree with the results of the studies by Bolinger (1958), Fry (1958), Lieberman (1960) in English, Morton and Jassem (1965) in Polish and Rigault (1962) in Polish. All these studies found pitch prominence as the major cue.

Comparing the data of the present study with that of Savithri (1987) and Rajupratap (1991) it appears that the

(Table 9, PP49)

data is in consonance mere with that of Savithri (1987). However, in the earlier study (Savithri, 1987), quality changes were also reported by the listeners which were not reported in the present study. Also, in the previous study by Savithri (1987) more weightage was observed for changes in articulation. It appears that perceptual cues differ in different languages. This might be because of organisation of durational properties of speech sounds and set rules for stress in different languages. Cruttenden (1986) opines that "the importance of length varies across languages, depending on whether a language uses length for phonemic contrasts on the segmental level". Tamil language uses length as phonemic contrasts at the segmental level (Vasanthakumari, 1989). Perhaps because of this, Tamil speakers are more tuned to the durational variations.

Second, the major acoustic cues were intensity and duration. These results are in consonance with the findings of Fry (1955, 1958), Pant (1957), Lehiste and Ivic (1963), Lindblom (1963) and Savithri (1987). While in the earlier study, Savithri (1987) reported that the acoustic analysis revealed durational changes as the first major cue and F_o as the second cue, the present study reports intensity changes as the first major cue and duration as the second relevant cue for words (not measured for phrases and sentences) and F_o changes for phrases and sentences.

Also, Savithri (1987) reported that in words, increased intensity, increased duration, increased F_o and wider formant frequency boundaries in vowels served as cues. But only increase in intensity and wide formant frequency boundaries were observed in sentences. In the present study, increase inintensity was found for stressed items in both words and sentences.

However, the results of the present study, contradict those of studies by Bolinger (1958), Lieberman (1960), Morton and Jassem (1969) and Westin and Abrecht (1960). All these studies reported F_o as the most relevant cue which again supports the notion that the perceptual and acoustic correlates of stress are language dependent.

Third, on comparing the results of acoustic and perceptual analysis, it was observed that the results of the acoustic analysis partly agreed with those of the perceptual analysis. While perceptual analysis revealed increase in duration as the major cue, increase in intensity was the major cue in acoustic analysis. The second major cue for perception of stress was increase in effort and acoustically it was increase in duration for words and increase in F_o for phrases and sentences. These results partly agree with the findings of Fant (1957) and

Fry (1958). Fant (1957) comments that loudness depends on duration and "the experience from speech analysis and synthesis that shortening alone can have the effect of changing a listener's stress response", motivates the dependency of loudness on duration.

In Kannada, Savithri (1987) found that both acoustically and perceptually,duration was the major cue for stress. In the present study, it was true only for the findings in perceptual analysis. In acoustic analysis, increase in intensity was the second major cue whereas in the earlier study (Savithri, 1987) increase in F_o was the second relevant cue. However, perdeptual data revealed intensity changes as second relevant cue in both studies.

Fourth, there is a developmental trend in the production of stress in Tamil speaking children between the age of 2-8 years. The performance of children at the age of 2-3 years of both males and females show that there is some information present in this age regarding stress. Infants perceive and produce atleast some stress differentiations by the age of 2.0 - 2.6 years (Blasdell and Jensen, 1970). However, it is not completely mastered. Rajupratap (1991) reported that there was some stress information present in children in the age of 3.0 - 3.2 years, and even at the age of 4 years, children did not obtain 100% scores.

While in the earlier study (Rajupratap, 1991) 90% is achieved by 4 years, in the present study children scored 90% only at the age 5-6 years. The results of this study indicate that even at the age of 8 years, children did not obtain 100% scores indicating that the mastery of stress is not completed yet. This could be attributed to the difference in the material used. This finding concers with the study of Atkinson-King (1973). According to her, the development of stress is complete only by 12 years of age. In the present study the children of 5-6 years achieved a score of 90% (females) and 83% (males). Even the 't' values indicate significant difference (P 0.01) in the mean percent scores between 2-4 years and 4-6 years. This indicates that the majority of the stress production is learnt during the age of 4-6 years. However, a dip was noticed at 6-7 years of age in both the sex. The higher scores in the age range of 5-6 years could be due to the fact that the children found the material (phrases) easy to repeat though the material was constructed considering the vocabulary and grammatical development in that particular age group.

Fifth, when the results of the present study are compared with those of earlier studies (Table-13), several universal facts are observed. (1) Whether it is word stress or contrastive

Name of the author 1.	Age group studied 2.	Type of stress 3.	Method 4.	Results 5.
Spring and Dale(1977)	4-17 weeks	Syllable stress	High amplitude sucking	Can discriminate syllables differing in stress
Brown(1973)		Con-trastive stress	Production	Prior to 2 years used con-trastive stress.
Slobin and Welsh(1967)	2 years	Contrastive stress	Imitation	Can use constrastive stress.
Allen and Hawkins(1980)	2.8-3.4 years	Neuclear accented, heavily unaccented,non neuclear accented.	Production	Mastered production of stress at 3 years.
Allen and Hawkins(1980)	3.7-6.7 years	Initial syllable final syllable stress	Discrimination	Can discriminate easily
Allen(1982)	1.9-2 years	Trochaic rhythm	Production	Primitive trochaic rhythm seen
Hochberg (1987b)				By 3 years acquires rules of stress.
Hornby and Hoss(1970)	3.8-4.6 years	Contrastive stress	Picture description,production	By 4 years, they use the contrastive stress.
Chomsky(1971)		Contrastive stress		By 6 years contrastive stress is established.
Atkinson-King (1973)	.5-13 years	Contrastive stress	Perception, pointing pictures & production	By 12 years, the children perceive & produce in adult form. In 4-6 grade level girls perform better.

1.	2.	3.	4.	5.
Rajupratap (1991)	3-4 years	word stress	Imitation	By 4 years children have not comple-tely acquired the production of stress.
Present study	2-8 years	Syllabic(2-4 years) & word(4-8 years)stress	Imitation	By 8 years children have not comple-tely mastered the production of stress.

Table-13: Studies of stress in comparison with the present study.

stress, children seem to pass through a developmental stage which is indicated by all the studies and their capacity to produce, imitate and perceive stress increases as a function of age. (2) While contrastive stress seems to be established by 6 years of age, acquisition of syllable or word stress is not mastered completely even at 8 years. (3) Though not significantly, girls seem to perform better than boys in the acquisition of stress in all the age groups. At very young age ie 2-3 years,girls and boys exhibit, almost equal percent of scores and the difference in the scores between girls and boys seem to increase in the use of stress with the development of age.

The results of the present study, indirectly assist one to Hypothesize or confirm on the physiological mechanisms of stress. Several physiological mechanisms a.e related to

stress. It is opined that a small surge of subglottic air-pressure accompanies stressed syllable and seem to be produced by the respiratory mechanism, giving a little push and momentarily increasing the airflow (Netsell, 1970). All the changes that are known to occur on stressed syllables, increased intensity and duration of syllables higher fundamental frequency and increased intra oral air pressure (Subterly, Worth and Sakuda, 1966; Malecot, 1968) could be produced by a pulse of increased rate of airflow or they could be produced by adjustments of glottis. Brown and McGlone (1974) say that stress might be primarily a laryngeal function. Starkweather (1980) says that most probably, respiratory, phonatory and articulatory mechanisms combine their effort to produce stress as they do for other aspects. The use of several systems to produce stress ensures that it can still be produced correctly even when one of the systems is being preemptied for some other purpose.

Studies on intra oral air pressure reveal that stressed syllables are produced with more intra-oral air pressure. "The difference in intra-oral air pressure values for males and females and for children and adults reflect the larger size of the adult male vocal tract. On the other hand childs lung volume is smaller" (Starkweather, 1987).

Subtenly (1968) reported two findings which have been confirmed by recent investigations. The first of these

findings is that consonants at the beginnings of words have higher intra oral air pressure values than the same consonants located at the end of words. Therefore, consonants at the beginning of words are longer in duration. The other important finding that Subtenly et al. (1966) reported is that there are greater intra oral air pressure values for consonants within stressed syllables as compared with consonants within unstressed syllables.

Hixon (1973) has shown that there are brief pulsatile elevation in subglottic air pressure associated with stressed syllables. Both the additional subglottic air pressure and the additional duration of consonants contribute to the elevated intra oral air pressure during consonants produced in stressed syllables. If intra oral air pressure can be equated or correlated with the effortfulness of speech sound production, then it is interesting to note that consonants in stressed syllables and consonants at beginning of words are less fluently produced in normal speakers than consonants at other locations.

Keeping these two facts in mind;-(1) High intra oral pressure is used in the production of stressed syllables and (2) children have small oral cavities and lung volumes compared to adult; - it is evident that the physiological structure in children will be inadequate for the production of stress. As the physiological structure in the child

matures, the lung volumes and oral cavity size increases, thus providing the prerequisites for stress. Hence, the ability to produce stress increases with the growth of the physiological structure in children.

Also, the results that increased loudness/intensity and duration cue stress report the view that stress might be primarily a respira ory and articulatory function. How, ever, the activities of several systems might depend on the use of cues in various languages.

SUMMARY AND CONCLUSION

Learning the phonology of a language involves not only segmental aspects, but suprasegmental aspects as well. suprasegmental features include intonation, rhythm and stress. Stress refers to increased effort and it is found to be affected in many speech and language disorders like autism, hearing impaired, learning disabled, mentally retarded etc. It would be important to consider the parameter effort when one wants to understand these disorders. In this context, the present study was planned. It aims at studying the development of stress in the age range of two to eight years old normal children who were native Tamil speakers.

As the study consisted of three age groups of children, materials appropriate for each group was developed. Disyllabic words for 2-4 years, phrases for 4-6 years and sentences for 6-8 years were selected considering the grammatical development and vocabulary in that particular age group.

Initially 18 words (15 + 3 repeated), 52 phrases (47 + 5 repeated) and 59 sentences (54 + 5 repeated) were spoken by a 22 year old female Tamil speaker. She was instructed to utter these with stress on the word underlined.

The items were written on cards and they were visually presented one after another. These were audio-recorded. The recorded sample was then given to ten listeners who had to identify the stressed word and to indicate the perceptual cues for stress on each word.

Those items which were judged to have the key word stressed by more than 80% of listeners were considered for the study. Totally 18 words, 45 phrases and 50 sentences were taken (from these 3 words, 4 phrases and 5 sentences were repeated).

The material was further analysed to identify the acoustic correlates; F_o , Intensity and Duration of stress in Tamil.

The material was audio presented to 12 children (6 males and 6 females) each in the age group of 2-8 years in one year interval. The children were tested individually and were instructed to imitate or repeat the recorded version which they heard. The children's imitation with the model was audio recorded. This audio recording of the model and imitation were played to two listeners who had to indicate whether the imitated version was similar to that of the model or not for stress. Then the mean percentage of correct responses were calculated for each

age group. "t" test was applied to find out the difference between the age groups in the development of stress and between males and females. Product moment correlation was used to find out the correlation between the ratings of two judges.

The perceptual cues for stress identified were; - increased duration, increased loudness, raised frequency, clear articulation, shortening of stressed word end or shortening of the preceding or following word, pause before or after the stressed word and stress undefined. Of these, increased duration and loudness were the two major perceptual cues.

Acoustic analysis revealed increase in loudness and duration as major cues for words and increase in loudness and fundamental frequency as major cues for phrases and sentences (for which duration was not measured).

The results of the product moment correlation test indicated that there was high correlation between the judges ($r = 0.97$ for sentences, $r = 0.96$ for phrases and $r = 0.64$ for words) indicating that both the judges agreed on the imitation of children. The results revealed that the production of stress increased from 2 years to 8 years.

No significant difference between males and females were observed. However, there was a significant difference noticed between the age groups of 2-4 years and 4-6 years and 2-4 years and 6-8 years. No significant difference was found between 4-6 years and 6-8 years. The scores revealed that even at 8 years, children did not achieve 100% score.

This development could be attributed to the physiological development in the speech production mechanism - the increasing vital capacity and the increasing intra oral breath pressure in children.

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APPENDIX I

Material used in the study:

The underlined syllables/words are stressed and the phrases/sentences with as'terisks are delted in the final experiment (Experiment II).

R - indicates the repeated word/phrase/sentence for test-re-test reliability.

2-4 years: words

1. pīpi
2. vaivai^{R}
3. popō
4. ṭiṭi
5. kokku
6. vāva
7. paipai^{R}
8. kaikai
9. māmi
10. kākkā
11. tātta
12. pāpa^{R}
13. ṭāṭa
14. pupū
15. māma

4-6 years - phrases:

1. tennai maram
2. tāi māma
3. pudiya caṭṭai
4. *pōy pārttēn^{R}
5. pārttu naḍanadā
6. aḷakkup pai
7. pāḷaik kāicuhirā
8. tiruḍan ōḍinān
9. *kārai ōṭṭuvār
10. tēn kūḍu
11. *amma samaikkirār
12. kuḷandai aḷudadu
13. *surusuruppāha iruppā
14. pū parittēn^{R}
15. kadaṛi aḷuhirārha
16. puḷippup paḷam
17. suvaittu sāppiḍuhirān
18. urakkap paḍittān
19. idi minna
20. sērndu pāḍuvārha

21. *tūkkik kuḍippān
22. cinna bommai
23. āḷamāna kinaru
24. sūḍāna kāppi
25. paḷā paḷam[R]
26. iruttu nēram
27. *guṇḍu paiyan
28. vēhamaha ōḍinān
29. iraṇḍu māḍuhaḷ
30. kambi mātāppu
31. nīḷa niram
32. aḷahāna pu
33. kāḷai āṭṭuhirāḷ
34. katavait tirandēn
35. sivappu rōja
36. mēdu paḷḷam
37. nāi vāl
38. tangai tūnguvāḷ[R]
39. nanḍrāhap pāḍuvar
40. gavanamāha āḍuhirāḷ
41. niḷamāna penciḷ
42. meduvāha naḍakkiradu
43. pul pūṇḍu
44. vāḷai iḷai
45. pandu vilaiyāḍuvān
46. pasu nei
47. uḷavan uḷuhirān

6-8 years : sentences

1. ārriḷ veḷḷam varum
2. kūḍaiyiḷ paḷam irundadu
3. kūrāna penciḷ uḍaiyum
4. pūnai eḷiyaip piḍittadu
5. suttamāna taṇṇir kiḍaikkum[R]
6. mangai veḷiye mirkirāḷ
7. avar kōbamāhak kattinār
8. *pudup pānai uḍaindadu
9. pāttirattiḷ taṇṇīr uḷḷadu
10. āsiriyar tiramaiyāhak karpittār[R]

11. *paḻaiya vīdu iḏindadu
12. appa kaḏaiyiḽirundu tirumbinār
13. sivappu rōja aḽahānadu
14. bus mysūrukkup pōhiradu
15. *pasu pāḽ koḍukkum
16. kāṛṛu vēhamāha vīsuhiradu
17. veḽḽaip pura parakkiradu
18. karumbai suvaittuc cāppiduhiran
19. *bus sīkkiramāhak kiḽambiyadu
20. marattai vāṭṭāḽ veṭṭuvārhaḽ
21. sirumihal sērndu pāḏuvārhaḽ
22. *puttahattaip paḍittu mahiḽvar
23. maḽai mēle ērinan
24. mān tuḽḽi ōḏum
25. tōṭṭakkārar puḽḽai veṭṭuhirār
26. akka pū toḏuppaḽ
27. siruvan baṭṭiḽai uḏaittān
28. kaṇṇan kaḏarkaraikkuc celvān
29. totti tōṭṭattiḽ irukkiradu
30. sūdahap pāḽ kuḍikkirār[R]
31. ahaḽāmana mēsaiyil eḽudinān
32. paḽaya paḍam pārttēn
33. mūṇḍru āḏuhaḽ irukkiradu
34. pēna uḽḽe irundadu
35. kuruvihaḽ parandu ceḽḽum

36. vaḷḷi nandrāhap paḍippāḷ
37. mani ōyamaḷ uḷaittām
38. periya mēḍaiyiḷ naḍittān
39. *siriya kuḷandai aḷuhiradu
40. kadaiyai aḷahaha viḷakkuvār
41. ennuḍaiya amma ūrilirukkirār
42. laḍḍu kīḷe viḷundadu
43. sattamāhap pāḍam paḍikkirān
44. pudiya caṭṭai vānguvār
45.*aḷahaha mayiḷ ādum.
46. āsiriyar pāḍam naḍattinār^{R}
47. amma samaiyaḷ seivār
48. aṇṇaniḍamirundu kaḍidam vandadu
49. *kombuhaḷukku varnam pūsuvārhaḷ
50. teruvil tēr varuhiradu
51. kala vīṭṭiḷ tunguhirāḷ
52. tiruḍanait turattip piḍippārhaḷ
53. kuḷandai pāḷ kuḍittadu
54.*kuḷandaihaḷ kūdi viḷaiyaḍuhirārhaḷ

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APPENDIX II

System of transcription used (Roman script)

a	ā	i	ī	u	ū	e	ē	ai	o	ō	au
அ	ஆ	இ	ஈ	உ	ஊ	எ	ஏ	ஐ	ஒ	ஓ	ஔ

k	g	ṅ	c	ñ	ṭ	ḍ	ṇ	t	d
க	க	ங	ச	ஞ	ட	ட	ண	த	த

n	p	b	m	y	r	l	ḷ	v	ḻ
ந	ப	ப	ம	ய	ர	ல	ழ	வ	ள

ṟ	n	h	s
ற	ன	ஹ	ஸ

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