

PRODUCTION OF WORD STRESS IN CHILDREN - 3 to 4 YEARS

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1991

TO
my Guide Dr.S.R.SAVITHRI
for her
TEACHINGS SUGGESTIONS SCOLDINGS

/AND/

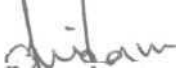
my PEDDANANNAGARU - & -ANMAKKAYYA

for
the ENCOURAGEMENT - AFFECTION they gave me.

CERTIFICATE

This is to certify that this
Dissertation entitled: Production of
word stress in children - 3 to 4 years:
is the bonafide work, done in part
fulfilment for Final year M.sc,
(Speech and Hearing) of the student
with Reg.No.M8916.

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C E R T I F I C A T E

This is to certify that this Dissertation
entitled : "Production of Word Stress in Children -
3 - 4 years" has been prepared under my supervision
and guidance.

Mysore
1991

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DECLARATION

This Dissertation entitled: "Production of word stress in children - 3 to 4 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.

Mysore

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INTRODUCTION

Speech, the basic act of communication, has been the focus of interest of several researchers. The features of speech are broadly studied under two categories; segmental and suprasegmental.

Segmental characteristics involve the description of size of phonemes or phonetic segments and their features. Suprasegmentals are characteristics of speech that involve larger units, such as syllables, words, phrases or sentences.

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 basic 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 utter 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 particular syllable. Jones (1950) defines stress as utterance of a 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 correlate of stress. He proposed to measure the area under the syllable peak combining intensity and duration in a single measure. 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 prominence and duration as important correlates of stress in Kannada. Though differences of opinion exist among investigators 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 acoustic cues of stress.

Learning the phonology of a language involves not only segmental inventories and rules affecting them but non-segmental aspects of phonology as well. 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). It is generally agreed that infants perception of stress precedes production.

Stress is an important gesture in the prosodic theory (Waterson, 1971a, 1971b). Erwin-Tripp (1966) stated that stress may influence the phonemic structure of a child's speech. When children attempt to produce the adult word, they tend to select and produce stressed syllable.

Children's use of stress develops as they grow. 1-4 months infants have the ability to discriminate syllables only in placement of stress. 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.

Atkinson-King (1973) studied the development of non-emphatic stress and non-contrastive stress in 300 children aged between 5-13 years.

In a part of the study, the experimenters measured the children's ability to use stress and distinguish between nouns and corresponding noun phrases that differ only in location of stress. Words such as Red sox/red sox were spoken by the examiner. The children were asked to identify them by pointing to a picture of object. These words were spoken alone first, then in sentences. The children were also asked to respond to a sentence in which the meaning suggested one form but other forms were used such as 'Flowers grow in a green house'.

In all these tasks there was a clear developmental trend. In the identification task, the development was interrupted at levels 4 and 6 and girls were better than boys but in preference task there was no lag in development at any grade level and no sex difference was found. Atkinson-King showed that by the age of 12 years, Her subjects were perceiving and producing stress a fully adult manner. The results of these studies indicate that stress develops starting from first word stage and continuous upto 12-13 years.

It has been emphasized 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, 1965; Wingate, 1967). Hence, it would be important to understand the dimension of stress* when one wants to understand stuttering. It would be an essential parameter a clinician should know for the assessment of stuttering by comparing the clients fluency with the level of fluency that is expected for a normal person of same age.

Most work to date on stress has been for the languages English (Bolinger, 1958; Fry, 1958; LSberman, 1960). Swedish (Schmitt, 1956) Welsh (Williams, 1985), Hindi (Firth, 1950), Spanish (Hosenberg, 1987b) and several of these are on syllable stress. 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 content, the present study was planned. The aim of this study was to delineate the production of word stress in Kannada speaking children between 3-4 years.

Specifically two experiments have been conducted in this study, the first aiming to develop the material and

the second to understand the development of word stress in children between 3-4 years. It is hoped that the results of the study will farther provoke research in this area, which will be useful in the understanding of fluency.

REVIEW OF LITERATURE

Learning the phonology of a language involves not only segmental inventories and rules effecting them but non-segmental aspects of phonology as well (ie) suprasegmental or prosodic features. Prosodic features, including intonation rhythm and stress fulfill 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 such as declaratives, question 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.

Of the suprasegmentals, stress refers to increased effort. This review is specific to stress and has been arranged as follows:

- (1) stress-definitions
- (2) Types of stress
- (3) Cues of stress and studies
- (4) Development of stress in children.

1. Stress-definitions: There are two major views depending on whether one emphasizes the productive or receptive aspects of loudness.- the psycho-physiological and the psychological:-only occasionally does one get the required blend of two views in the work of an individual scholar. A physiological definition of stress is the most common.

Sweet (1878) says "stress is the comparative force with which the separate syllables of a sound group are pronounced". According to Abercrombie (1923) "stress is force of breath impulse" and according to Heffner (1949) "it is irreferable to kinaesthetic sensation of muscle and pressure changes". Jones (1956b) defines stress as "the degree of force with which a sound or syllable is uttered." He considers it as essentially a subjective action. Fonagy (1966) considers stress as "the function of great speaking effort".

Bloomfield (1933) gives primarily a physiological definition with a bow in the direction of psychological criteria. According to him "Stress consists in greater amplitude of sound waves and is produced by means of more energetic movement such as pumping more breath bringing the vocal cords together for voicing and using the muscles

more vigorously for oral articulation but it also 'consists in speaking these syllables louder than the other or others'.

On the other hand, 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." 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".

Gimson (1956) in his discussion of confused definition of stress concludes that the only realization of stress which are linguistic in that they are capable of creating an effect of relative prominence of accent in a listener's mind are those which are affected with the complex help of pitch, quantity and quality variations.

2. Types of stress: It is traditional in phonetics to divide stress into dynamic or expiratory stress and musical or melodic stress (Lehiske.1970). This assumption seems to have been based on a belief that stress and pitch are independent of each other.

Stress types based on domain: The question concerning domain of stress can be looked from two different points of view. According to one, stress itself serves to divide the speech chain into units. According to the other, the units are determined either by phonetic boundary signals (Junctures) or by morphological lexical criteria, and the occurrence and distribution of stress is describable in terms of these units (Lehiste, 1970).

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 smallest unit that may carry stress must be approximately the size of a syllable. Eventhough the syllable may be considered to constitute the phonetic domain of stress placement, stressed and unstressed monosyllabic words can only be distinguished within a larger utterance. Thus, the minimal unit of contrastive stress 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, stress occupies an independent position within the phonology of the language. The term phonemic stress or free stress is applied to this kind of linguistically significant stress (Lehiste, 1970).

In a no. of languages, the placement of stress on a certain syllable is determined with reference to the word. Conversely, the position of stress identifies the word as a phonological unit (Jakobson, 1931). This type of stress is called bound stress. An intermediate type between the 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. Two degrees of stress: strong and weak are identified.

Sentence level stress: Bierwisch (1966) distinguishes 3 kinds of sentence level stress. Each sentence has first of all, a primary stress (non-emphatic sentence stress). Contrastive stress occurs in sequences of sentences with parallel constituents that are filled with different morphemes (ie) 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.

3. Cues of stress: and studies: 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.

According to Smith (1951) - loudness is the major factor in the perception of stress. Fant (1957) considers lengthening of syllables as most obvious physical correlate of stress. He proposes to measure the area under syllable peak combining intensity and duration in a single measure. According to Bolinger (1958) - the primary cue of what is usually termed stressed is the utterance is pitch prominence. For Fry (1958), it is the duration which is the most important cue. Lieberman (1960) - attributes peak amplitude as a reliable correlates of stress. Savithri (1987) - considers intensity and duration as important cues.

Though difference of opinions exist, 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 for language 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.

Fonogy (1958) - says that stress is not definable in acoustic terms and that the listeners simply use the various cues as a basis for judging the degree of force employed by the speakers. Cooper and Meyer (1950) - say that stress is a product of 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 intensity, fundamental frequency 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 (Rigault, 1962); Swedish (Westin, Buddenhagen and Abrecht, 1966); Kannada (Savithri, 1987). Table-1 presents a brief review of findings reported in these studies. In this table denotes acoustic studies.

Author 1.	Language 2.	Subjects 3.	Cues 4.
Stetson (1951)	English		Vowel quantity
Fry(1955)*	English	100	Duration (2) intensity.

1.	2.	3.	4.
Fant*(1957)	Swedish	-	Lengthening of the syllables.
Bolinger * (1958)	English	-	1) pitch prominence (2) duration.
Fry(1958)	English	-	1) Duration (2) intensity 2) pitch prominence.
Jassem * (1959)	Polish	-	Frequency
Tiffany* (1959)	American	-	Vowel diagram is larger for a stressed vowel.
Lieberman* (1960)	American English	16	1) Higher Fo (2) Peak envelope amplitude (3) Longer duration.
Rigault* (1962)	French	-	1) Frequency (2) Duration.
Shearme * & Holmes (1962)	English	-	Acoustical vowel diagram.
Lehiste * & Ivic(1963)	Serbo-croatian	14	Duration.
Lindblom* (1963)	English & Swedish	-	Length of syllable.
Morton*& Jassem (1965)	English	-	DVariation in Fo (2) Duration 3) Intensity.
Fonagy (1966)	Hungarian	-	Prominence produced by means of respiratory effort.
Westin* Buddenhagen & Abrecht (1966)	Swedish	-	1) Fo (specially of 1st syllable) 2) Quantity, intensity.
Jassem * & Morton & Steffen Botog (1968)	Polish	-	Fo variations (2) durations

1.	2.	3.	4.
Lehiste,* (1968 a)	Estonian	-	Duration
Savithr* (1987)	Kannada	4	1) Fo (2) Duration (3) intensity (4) F ₂ .
Savithri (1987)	Kannada	4	1) Durational changes 2) Intensity changes.

Table- 1: Studies on cues of stress.

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 Fo, duration, intensity whereas for Swedish, kannada Estonian, duration is the major cue.

4. Development of stress in children: Two hypothesis regarding childrens initial state in stress laming have emerged from the literature. The first, which aa\$ 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 with indifference to the distribution of stress both in babbling 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 hypothesized that children have a natural bias towards producing words with Trochaic rhythm (an accented syllable followed by an unaccented syllable).

Because of the difficulty in obtaining the data research in the area of the development of stress in children is restricted.

As might be expected, the childrens use of stress develop as they grow. 1-4 months old infants have the ability to discriminate syllables differing only in the placement of stress as signalled by fundamental frequency, duration and intensity differences. (Spring and Dale, 1977).

Spring and Dale's study was directed towards exploring the ability of young infants to discriminate syllabic stress (ie) the contrast which differentiates the meaning of two words eg. Black bird vs black bird. 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 teat and were given an artificial nonnutritive 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-rein-

forced sucking. They divided the infants into experimental group and a control group randomly. Then, the base line was determined. The base line 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 baba and the base line was determined. Then the experimental group was presented with a new stimuli ba ba while the control group received the same stimuli. It was found that there was a significant difference in the sucking rate of the infants of experimental group than the control group. 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.

Brown (1973) -noted that one of his subjects used the contrastive stress technique to introduce new information prior to the age of two years. His subject Eve, aged 14 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 21/2 years old son's speech, slobin and Welsh (1967) found contrastive stress generally imitated by 2 year old child they studied. In a similar context.

Weiman (1976) also showed that children whose mean length of utterance measured 1.3 - 2.3 phonemes already show an established stress pattern and that stress assignment was highly correlated with semantic content, in particular with the introduction of new information.

Allen and Hawkins (1980) - analyzed the acoustic properties of three 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 fundamental frequency of each heavy and accented syllable in the 50 utterances from each of 2 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 has internalized 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 name* 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 analyzed using spectrograph, a plurality had falling intensity contours. He suggested that these show a trace of some 'primitive' trochaic rhythm or stress. Mechberg (1987b) 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 pairs of pictures **one** after another (ie. the picture was introduced and later its pair was introduced. They asked the children to describe the pictures and the descriptions were recorded and analyzed\$ Their results suggest that there was a clear tendency to stress the part of discription corresponding to contrasting element. They concluded that contrasting stress patterns are mastered by children by the age of 4 years.

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

Atkinson-King (1973) studied the development of non-emphatic/non-contrastive stress in 300 children from 5 to 13 years of age. In one part of the study, the experimenter measured the childrens ability to use stress to

distinguish between nouns and the corresponding noun phrases that differed only in the location of stress, words and phrases, such as hot dog/hot dog were spoken by the examiner. The children were asked to identify them by pointing to a picture of the object. These words were spoken alone first then in sentences. The children were also asked to respond to a sentence in which the meaning suggested one form but other forms were used such as/flowers grow in a green house.

In all these tasks, there was a clear developmental trend. In the identification task, the development was interrupted at the levels 4 and 6 and girls more better than boys but in the preference tasks, there was no log in developmental any grade level and so sex difference was noticed. Atkinson-King 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. Cruttenden (1986) suggests that stress depends on the phonetic structure of a language. In this context, the present study is aimed at understanding the development of stress in Kannada speaking children in the age of 3-4 years.

METHODOLOGY

Two experiments were conducted in this study, the methods of which are described separately.

Experiment-1; Material development

Material: Twenty seven meaningful Kannada clauses and ten Kannada sentences were selected. The clauses were so selected that they were easy for the children and the sentences were selected from an earlier study (Savithri, 1987). These were written, one on each card and the key word to be stressed was underlined. A Kannada female speaker, aged 43 years, well versed in dramatics, served as the subject. She was familiarised with the material and was visually presented with the material, one at a time. She was instructed to utter the clauses and sentences into a microphone (Caraiode) kept at 10 cm. from the mouth while doing so, she was instructed to stress the word underlined in the card. For example in the clause /bili; hu: /; she was to stress the word / bili / She was also instructed to repeat six clauses and three sentences to check for intra-subject reliability. All these were audio-recorded on a cassette in a sound treated room. The subject listened to the recording and was allowed to

repeat, any clause, or sentence which she felt was not uttered with proper stress, to her satisfaction. A final audio-recording of these was prepared which served as the material. (The clauses and sentences which were selected for the experiment are given in Appendix-I).

Subjects: Ten native Kannada speakers, (five males and 5 females) in the age range of 17 to 23 years served as subjects (Table-2). The subjects had experience in listening in these types of tests and they were students undergoing training in speech pathology and audiology.

Age in years 1.	No.of males 2.	No.of females 3.
17	2	-
18	-	3
19	-	1
21	-	1
22	2	-
23	1	
Mean age in years	20.2	18.8

Table-2: Age of subjects selected for study.

The mean age of males was 20.2 years and that of females was 18.8 years.

Method: The audio-material was presented to the subjects one at a time and they were instructed to write the words which they perceived as stressed, when they did not perceive any stress on the words in the clause, they had to report so. However, no definition of stress was provided. They were also instructed to indicate the perceptual cues for stress. The data was tabulated and a response was considered as correct when the subject identified the intended word as stressed.

Analysis: Each correct response was assigned a value of '1' and the total number of correct responses by all the ten subjects for all the clauses and sentences was computed. The percent of correct responses was calculated by using the formula:

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

These clauses and sentences which were correctly identified as stressed by 80% of the subjects were considered for the second experiment of the 33 (27 + 6 repeated) clauses and 13 (10 + 3 repeated) sentences 26 (22 + 4 repeated) clauses and 12 (9 + 3 repeated) sentences were selected and the remaining seven clauses and one sentence were rejected as the correct response score was less than 80%.

Further, the perceptual cues were computed and the percent times * cue was Identified was calculated. The weightage on each cue was calculated by the formula.

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

Experiment-II:

Subjects: Twelve normal Kannada speaking children in the age range of 3-4 years, served as the subjects. Two children (1 male and 1 female) each in 2 months age interval were selected. All of them had normal oral mechanism and speech as judged by a speech pathologist and none of them reportedly had any history of speech, language and hearing problems. Table-3 gives the age of the subjects.

Age 1.	Males 2.	Female 3.
3.0	1	—
3.1	0	1
3.2	0	1
3.3	1	0
3.4	0	0
3.5	1	1
3.6	1	0
3.7	0	1
3.8	0	1
3.9	1	0
3.10	0	0
3.11	1	0
4.0	0	1

Table-3: Age of the children selected for the study.

Material: Audio-recorded samples of 26 clauses (22+4 repetitions) and 12 sentences (9+3 repetitions) which had 80% and above correct identification in experiment-I were used. Of these, four clause and 3 sentences were repeated for intra-subject reliability.

Method: The material (Henceforth model) was audio-presented to the children, one at a time and they were instructed to listen to dtmttate) it carefully and repeat (imitate) the clauses and sentences in the experiment. The model and the imitation of the children were audio-recorded in order. Before the starting of the experiment, each child was given a trial and they 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 word.

Analysis: The recorded samples of the model and imitation were then given to two judges for perceptual judgement. The first judge was the experimenter and the judge second was a postgraduate student in speech pathology and audiology. The judges were instructed to listen to the model and the imitation and to mark 'S' if they perceived the imitated clause or sentence to be the same as that of the model in terms of stress on the word and to mark 'D' if they perceived

the imitated clause or sentence to be different than the model in terms of word stress. No definition of stress was provided. 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 the following formula:

$$\frac{\text{Total 'S'}}{\text{Total no.of clauses/sentences}} \times 100$$

A rank correlation test was performed to test the inter-judge reliability and Walsh test was performed to find out the significance of difference between medians of various age groups. The data was then tabulated to bring about an emerging pattern of stress in children between 3-4 years.

RESULTS AND DISCUSSION

Experiment-I: Material Development: This experiment aimed at developing material for Experiment-II.

Table-4: depicts the results of the evaluation performed by tea judges regarding stress for clauses. Of the 33 clauses (27 + 6 repetitions) 26 were rated to have stress on the key word by more than 80% of judges and seven were rated to have stress by less than 80% of judges. Of the 26 clauses (22 + 4 repeated) 13 were identified to have the key word stressed by 100% of judges. Eight were identified as having the key word stressed by 90% of judges and five were identified to have the key word stressed by 80% of judges.

Among 13 sentences (10 + 3 repeated); 12 sentences (9 + 3 repeated) were judged to have the key word stressed by more than 80% of judges and one by 60% of judges. Out of these 12 sentences two sentences scored 100%. Six sentences scored 90% and four sentences scored 80%.

Target word	J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	Percentage
cikka	+	+	+	+	+	+	+	+	+	+	100
batte	+	-	+	+	+	+	+	+	+	-	80
nīli	+	+	+	+	+	+	-	+	+	+	90
betta	-	+	+	+	+	+	+	+	+	+	90
butti	+	+	+	+	+	+	+	+	+	+	100
putta	+	+	+	+	+	+	+	+	+	+	100
dappa	+	+	+	+	+	+	+	+	+	+	100
kallu	+	+	+	+	+	+	+	+	+	+	100
pensil	-	+	+	+	+	+	+	+	+	+	90
dodda	+	+	+	+	+	+	+	+	+	+	100
kempu	+	+	+	+	+	+	+	+	+	+	100
namma	+	+	-	+	+	+	+	+	-	-	70
hēlu	+	+	-	+	+	+	-	+	-	-	60
nāji	-	+	+	+	+	-	+	+	-	-	60
mūru	+	+	+	+	+	+	-	+	+	-	80
pennu	+	+	+	+	+	+	-	+	+	+	90
kappu	+	+	+	+	+	+	-	+	+	+	90
aidu	+	+	+	+	+	+	+	+	+	+	100
kāru	+	+	+	+	+	+	+	+	-	+	90
datta	+	+	+	+	+	+	+	+	+	+	100
ettu	-	+	+	+	+	+	+	+	+	+	90
betta	-	+	+	+	+	+	+	-	+	-	70
sīhi	+	+	-	+	+	+	-	+	+	+	80
saṇṇa	+	+	+	+	+	+	-	+	+	-	80
kōli	+	+	+	+	+	+	+	+	-	-	80
nīru	+	+	+	-	+	+	-	+	+	+	80
frāku	-	+	+	+	+	-	+	+	-	+	70
nīli*	+	+	+	+	+	+	+	+	+	+	100
putta*	+	+	+	+	+	+	+	+	+	+	100
kempu*	+	+	+	+	+	+	+	+	+	+	100
mūru*	+	+	+	+	+	+	+	+	+	+	100
frāku*	+	-	+	+	+	+	+	+	+	+	90
hēlu*	+	+	+	+	+	+	+	-	-	-	70

Table-4: Responses of 10 judges for identification of stressed words in clauses.

* indicates repeated clauses.

+ Indicates judge has identified the key word stressed.

- indicates judge has not identified the key word stressed.

J - Judge.

Target word	J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	Percentage
bilī	+	+	+	+	+	+	-	+	+	+	90
nāli	+	+	+	+	+	+	-	+	+	+	90
pennu	-	+	-	+	-	+	+	+	-	+	60
pōlīsu	+	+	+	+	+	+	-	-	+	+	80
sēbu	+	-	+	+	+	+	-	+	+	+	80
nāḷku	+	+	+	+	+	+	-	+	+	+	90
ā	+	+	+	+	+	+	-	+	+	+	90
tēbal	+	+	+	+	+	+	+	+	+	+	100
rāma	+	+	+	+	+	+	-	+	+	+	90
dappa	+	+	+	+	+	+	+	+	+	+	100
bilī*	+	+	+	+	+	+	-	+	+	+	90
pōlīsu*	+	+	+	+	+	+	-	-	+	+	80
dappa*	-	+	+	+	+	+	+	+	-	+	80

Table-5: Responses of ten judges for identification of stressed words in sentences.

* indicates repeated clauses.

+ indicates the identification by the judges as key words stressed.

- indicates that judge has not identified the key words stressed.

J-Judge.

To test the intra-subject reliability six clauses and three sentences were repeated. Table-6 presents score for repeated clauses and sentences. Of the six clauses repeated, were 5/judged to have key word stressed in both utterances by 80% of judges. However, two of the clauses were not and these were omitted in second experiment. Of the three sentences repeated all were identified to have the Key word stressed in both utterances by 80% or more of judges.

	Clauses						Sentences		
	1.	2.	3.	4.	5.	6.	1.	2.	3.
Trial I	90%	100%	100%	80%	70%	60%	90%	90%	100%
Trial II	100%	100%	100%	100%	90%	70%	90%	30%	80%

Table-6: Responses (in percentage) of the judges for repeated items.

To find out whether there was a significant difference between Trial I and Trial II for clauses, Walsh test was used and it was found that no significant difference existed suggesting high intra-judge reliability.

On the perceptual test, a total of eight cues were identified by the judges as follows:

1. Increased word duration
2. Shortening of stressed word end
3. Prolongation of stressed word
4. Extra-effort in production
5. Pause-before or after stressed word
6. Raising and falling intonation in stressed word
7. Articulation
8. More stress (undefined).

While males identified 6 cues (1, 2, 3, 4, 6, 8), females identified all the eight cues. These cues were pooled together

and grouped as provided in Table-7, under 6 headings. Their percentage weightage is also shown in the same table.

Perceptual cues	Males in per-cent	Females in per-cent	Average in per-cent	weight-age on each cue	Weightage on each cue Savithri (1987).
1. Durational changes	80	80	80	34.5	35.75
2. Loudness changes	80	80	80	34.5	21.51
3. Pause	-	40	20	8.6	14.34
4. Articulation changes	-	20	10	4.3	10.71
5. Intonation changes	20	20	20	8.6	12.57
6. Stress *	-	40	20	8.6	3.6

Table-7: Perceptual cues of stress and their percent weightage.

indicates - undefined.

It appears that durational changes and loudness were the major cues for the perception of stress and others (pause, articulation, intonation/were the minor cues).

This result contradicts the results of the studies by Bolinger (1958), Fry (1958), Lieberman (1960) in English,

Morton and Jassem (1965) in Polish, Rigault (1962) in French. According to all these studies, pitch prominence was the major cue. The results are in concurrence/results with the of the studies conducted by Fant (1957) in Swedish, Lehiste and Ivic (1963) in Serbocroatian, Lindblom (1963) in English and Swedish? Lehiste (1968a) in Estonian and Savithri (1987) in Kannada. In these studies, duration and loudness are reported to be the two major perceptual cues of stress.

While in the earlier study (Savithri, 1987), the weightage was more on durational changes, in the present study equal weightage was observed for durational and loudness changes. In the earlier study quality changes were also reported by the listeners which were not in the present study. Also, in the previous study more weightage was observed for changes in articulation, intonation and pause. It appears that perceptual cues differ in different languages. This might be because of organization of durational properties of speech sounds in various languages. It might also be because of 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

correlates on the segmental level". Kannada language uses length for phonemic contrasts of the segmental level (Hiremath, 1980). Perhaps because of this, Kannada speakers are more tuned to the durational variations.

On the basis of the results of the first experiment, out of the 33 clauses (27 + 6 repeated) and 13 sentences (10 + 3 repeated) five clauses and one sentence was discarded and 22 clauses and four repetitions and nine sentences and 3 repetitions were selected for the second experiment. Thus, a total of 26 clauses (22 + 4 repetitions) and 12 sentences (9 + 3 repetitions) were selected for experiment-II.

Experiment-II: Development of word stress in children

This experiment aimed at understanding the development of word stress in children using 26 clauses and 12 sentences from Experiment-I.

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

Age range	Judge I		Judge II	
	Male	Female	Male	Female
<u>Clauses:</u>				
3.0 - 3.2	45.4	59.02	45.4	59.02
3.2 - 3.4	59.02	68.1	59.01	68.1
3.4 - 3.6	72.6	68.1	72.6	72.6
3.6 - 3.8	68.1	72.6	68.1	72.6
3.8 - 3.10	77.1	86.26	77.1	86.26
3.10 - 4.0	90.8	86.26	86.26	86.26
<u>Sentences:</u>				
3.0 - 3.2	11.1	44.4	11.1	44.4
3.2 - 3.4	55.5	55.5	55.5	55.5
3.4 - 3.6	66.6	66.6	66.6	66.6
3.6 - 3.8	77.7	55.5	77.7	55.5
3.8 - 3.10	66.6	77.7	66.6	77.7
3.10 - 4.0	88.8	100	88.8	100

Table-8: Percent scores obtained by children at different age intervals.

It was observed that the performance of the children imitating the stressed words improved from 3-4 years. For the clauses however, even at 4 years age, the children were not able to obtain, 100%, score, which indicated that even at 4 years

children did not master the use of stress. Among the male children, there was a peak noticed at 3.4 - 3.6 years and a dip at 3.6 - 3.8. However, females exhibited a linear relation between the age and capacity to produce stress* as evident by the imitation task. (Fig.1).

For the sentences, male children exhibited a peak at 3.6 -3.8 years. However, female children in this age group exhibited a dip. Female children obtained 100% score in imitating stress at sentence level which indicates mastery of stress at 4 years in them (Fig.2).

The results of the Walsh test indicated no significant difference between males and females. However, there were some differences between the two sex in their performance. Among the clauses, there was no consistent difference between males and females. Though female children had higher scores in 3 - 3.4 and 3.6 - 3.10 years, they exhibited lower or equal scores at 3.4 - 3.6 and 3.10 - 4.0 years. Among the sentences, the performance of female children were equal to that of male children from 3.2 -3.6 years. However, between 3 to 3.2 years and 3.8 - 4.0 years, males performed poorly. The performance of male child drastically improved from 3.2 years onwards, and the same was not true for females. Their

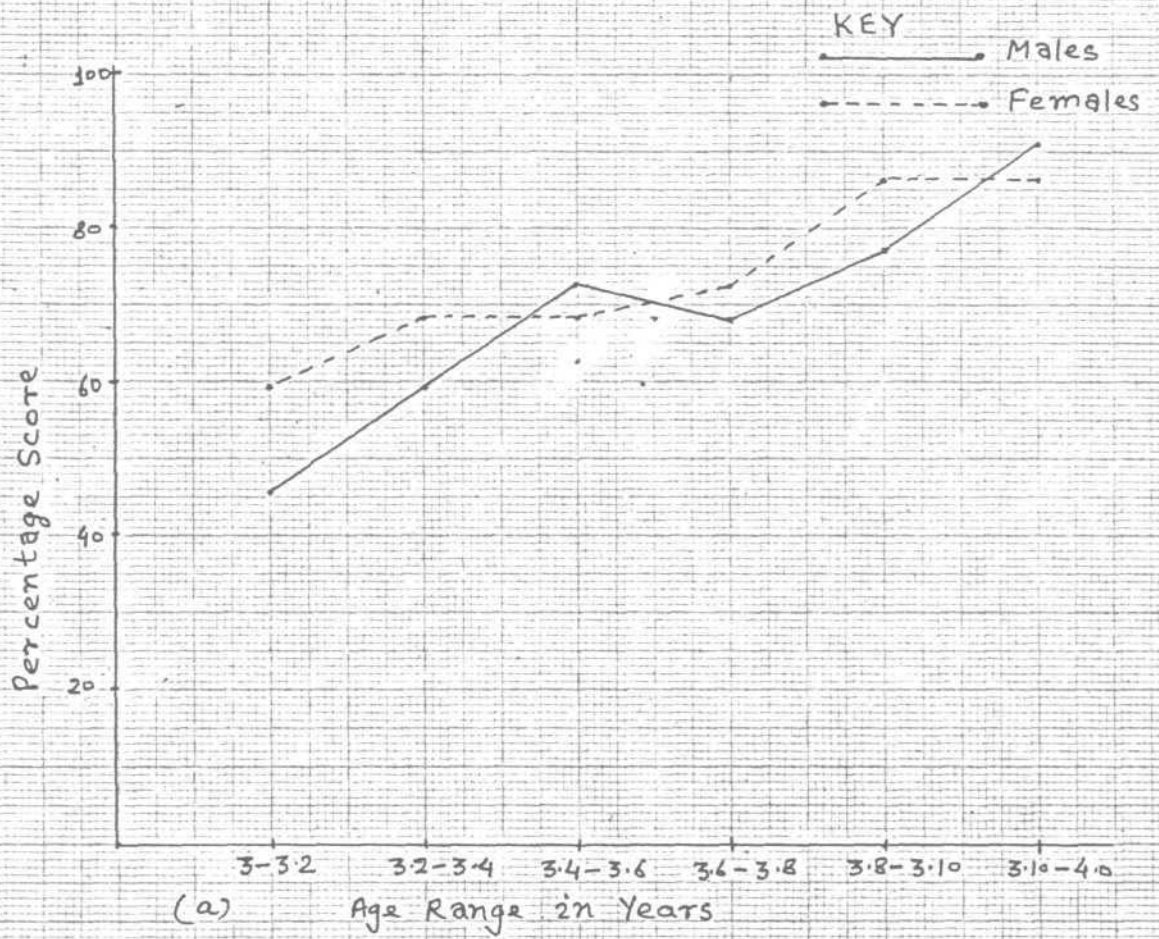


Fig-1- Performance of Clauses judged (a) by J_I (b) by J_{II}.

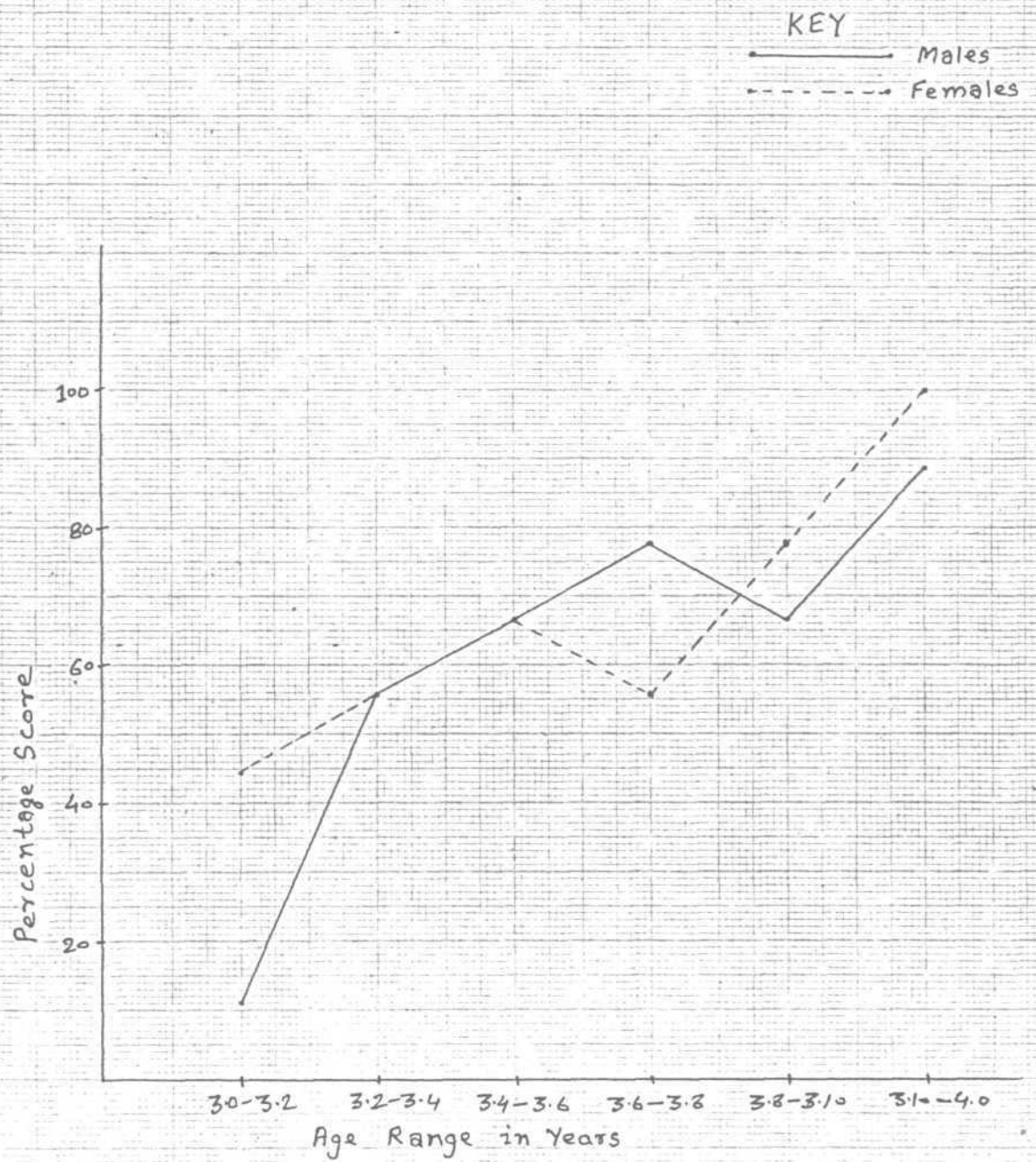


Fig-2- Performance of Sentences judged by JI & JII

performance consistently increased from 3+0 to 4.0 with a dip at age range 3.6 - 3.8 years.

For clauses, it was observed that males in age range 3.2 - 3.4 years were not able to imitate the stress on the word /butti/ the word /balte/ in the age range 3.4 - 3.6 years and the words /dodda/ and /Rapph/ in age range 3.6 - 3.8 years.

It was observed that females in the age range 3.0 - 3.2 were not able to imitate the stress on the word /titapa/ the word /muru/ in age range 3.2 - 3.4 years? the words /plappa/ /ballu/ in the age /maru/ range 3.4 - 3.6 years and the word /nuru/ in age range 3.6 - 3.8. However, there was no single grammatical category which was difficult for the children.

In sentences, it was observed that both males and females in the age range of 3 - 3.4 and 3.8 - 3.10 were unable to repeat stress on the word /rama/. Also, the male children in the age range of 3.0 - 3.2 were unable to imitate the stress on the words /bili/ and /pulis/

Females in the age range of 3.0 - 3.2 were unable to imitate stress on the word /tebal/. In the age range

Words not stressed	3.0-3.2	3.2-3.4	3.4-3.6	3.6-3.8	3.8-3.10	3.10-4.0
<u>Clauses:</u>						
cikpa	F					
batte			M			
butti		M				
dappa			F			
kallu			F			
pensil			F			
dodda				M		
mīru		F				
kappu				M		
nīru				F		
mūru			F			
<u>Sentences:</u>						
nālkū		F				
tēbal	F					
rāma	MF	MF	F		MF	F
bili	M					
pōlis	M					

Table-9: Words not repeated by different children in different age ranges for both clauses and sentences.

3.2 - 3.4, female children were not able to imitate the stress on the word /nāḷku/ and in age range of 3.4 - 3.6 they were not able to imitate the stress on the word /rāma/. All these are depicted in Table-9. Again in the sentences, no particular grammatical could be identified as being difficult to stress. However, the words which are stressed by the children in the sentences seems to be more familiar to them than the words which are not.

The inter-judge reliability was obtained by using spearman's rank correlation test and Table-10 and 11 depicts the scores for clauses and sentences.

Sample subject	Judge I		Judge II	
	Score	Rank	Score	Rank
1	10	(12)	10	(12)
2	13	(10.5)	13	(10.5)
3	13	(10.5)	13	(10.5)
4	15	(8)	15	(8.5)
5	16	(5.5)	16	(6)
6	15	(8)	16	(6)
7	15	(8)	15	(8.5)
e	16	(5.5)	16	(6)
9	17	(4)	17	(4)
10	19	(2.5)	19	(2)
11.	20	(1)	19	(2)
12	19	(2.5)	19	(2)

Table-10 : Spearman's rank correlation scores for the two judges (for clauses).

Sample subject	Judge I		Judge II	
	score	Rank	Score	Rank
1	1	(12)	1	(12)
2	4	(11)	4	(11)
3	5	(9)	5	(9)
4	5	(9)	5	(9)
5	6	(6)	6	(6)
6	6	(6)	6	(6)
7	7	(3.5)	7	(3.5)
8	5	(9)	5	(9)
9	6	(6)	6	(6)
10	7	(3.5)	7	(3.5)
11	8	(2)	8	(2)
12	9	(1)	9	(1)

Table-11: Spearman's rank correlation scores for the two judges (for sentences)

The results indicated that there was a near perfect correlation between the two judges, for clauses with an r of .95. For sentences, there was 100% correlation between the judges with an r of 1.00 which indicates a high inter-judge reliability.

Discussion:

This study shows that there is a developmental trend in the production of stress in the children between 3-4 years. The performance of children at the age of 3.0 - 3.2 of both males and females shows that there is some information present

in this age regarding stress. However, it is not completely mastered. Even at the age of 4 years, children did not obtained 100% scores which indicates that the mastery of stress is not completed yet. This concurs with the study of Atkinson-King (1973). According to her, the development of stress is complete only by 12 years of age. However, in the present study, females obtained 100% scores in sentences at 3.10 - 4.0 years which contrasts that of Atkinson-King (1973) and concurs with the finding of Hornby and Hass(1970), Allen and Hnwkins (1980) and Hochberg (1987b). According to them, the rules for stress is mastered by 4 years of age. Though the results of the, present study cannot be study compared with these of earlier studies (Table-12) as none of the earlier studies deal with word stress, several points could be emphasized. First, be it, word stress or contrastive 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 with age. Second, while contrastive stress seems to be established by 6 years of age word stress may be mastered earlier. The results of this study for sentences in females at 4 years shows 100% responses, indicating a mastery of stress at the end of four years by females. Third, though not significantly, female children seems to be ahead of male children in the acquisition of stress in atleast some age groups.

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

1.	2.	3.	4.	5.
Present study	3-4 yrs	Word stress	Imitation	By 4 years children have not completely acquired the production of stress.

Table-12: studies of stress in comparision with the present study.

Several physiological mechanisms are related to stress. It is opined that a small surge of subglottic airpressure 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 pleasure (Subtelny, 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 preempted for some other purpose.

Studies on intra oral air pressure reveal that stressed 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 child's lung volume is smaller". (Starkweather, 1987).

Subtenlly (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 Subtenlly 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 cavities size increase thus providing the prerequisites for stress. Hence, the ability to produce stress increases with the growth of the physiological structure in children.

This study being a preliminary one on the development of stress in children throws some light in this area. However, a test on stress, which is a parameter of fluency could be developed by selecting more number of clauses and sorting it according to the child's age. Further, the administration on a large population of children might prove its worth.

SUMMARY AND CONCLUSION

Learning the phonology of a language involves not only segmental aspects, but supra segmental aspects as well. Supra-segmental features include intonation, rhythm, and stress. Stress refers to the increased effort and effort is one of the parameters of fluency. It would be important to consider the parameter effort when one wants to understand fluency and its disorders. In this context, the present study was planned. It aims at studying the development of word stress in the age range of three to four years old normal children who were native Kannada speakers.

Initially 27 clauses and 10 sentences (from which 6 clauses and 3 sentences were repeated) were spoken by a 43 year old female Kannada speaker well versed in dramatics. 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 other. These were audio recorded. The recorded version was then given to ten listeners who had to identify the stressed word and to indicate the perceptual cues for stress.

Those words which were judged to have the key word stressed by more than 80% of listeners were considered for the study. Totally 22 clauses and 9 sentences were taken (from these 4 clauses and 3 sentences more repeated).

The audio recorded material was audio presented to 12 children in the age range of 3-4 years. There was one boy and one girl each in the interval of two months. The children were instructed to imitate or repeat the recorded version which they heard. The children's imitation 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. Then the percentage of correct responses were calculated for each child. Walsh test was applied to find out the difference/between males and females and spearman's rank Correlation test was used to find out the agreement or (correlation between two judges.

The perceptual cues for stress identified were;- increased duration, raised frequency, increased loudness, stress and better articulation)- of these, increased duration and loudness were the two major perceptual cues.

The results indicated that there was a high correlation between the judges (r = 0.95 for/sentences) indicating that both the judges agreed on the imitation of children. No significant difference between males and females were observed. The production of word stress increased from 3

years to 4 years in both males and females for clauses and sentences. However, even at 4 years children did not achieve 100% score. Only female children in the age of 3.10 to 4 years obtained 100% score.

The results, though cannot be directly compared to other studies, can be compared for several points. It was evident that, be it contrastive stress or word stress, the capacity of children in producing these increased from 3-4 years. The results also indicate that at 4 years development of word stress was not complete. 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.

It is recommended that similar clauses could be used as test material for word stress in Kannada and be administered to large population to standardize the test which will be of clinical use in fluency disorders.

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← F. II →

Clauses and Sentences Selected for the study

(R. III)

clauses

- | | | | | | |
|-------------------|-------------------|--------------|--------------|-------------------|------------------|
| 1) <u>Cikka</u> | angi *12) | namma | ūru | 23) <u>sihi</u> | bōddu |
| 2) <u>hale</u> | <u>batte</u> *13) | maggi | <u>hēlu</u> | 24) <u>Samma</u> | pustaka |
| 3) <u>nīli</u> | bassu *14) | onṭi | <u>nāyi</u> | 25) <u>haladi</u> | <u>kōli</u> |
| 4) <u>manjina</u> | <u>botta</u> 15) | <u>mūru</u> | dōse | 26) <u>bisi</u> | <u>nīru</u> |
| 5) <u>bili</u> | <u>butti</u> 16) | udda | <u>pennu</u> | 27) <u>hosa</u> | <u>Frāku</u> |
| 6) <u>putta</u> | gombe 17) | <u>kappu</u> | Su | 28) <u>nīli</u> | bassu (R) |
| 7) <u>dappa</u> | manusya 18) | <u>aidu</u> | baḷapa | 29) <u>putta</u> | gombe (R) |
| 8) <u>kallu</u> | dāri 19) | <u>eradu</u> | <u>kāru</u> | 30) <u>kempu</u> | gulābi (R) |
| 9) <u>hasiru</u> | <u>pensil</u> 20) | <u>datta</u> | kādu | 31) <u>mūru</u> | dōse (R) |
| 10) <u>dodda</u> | mara 21) | <u>jōdi</u> | <u>ettu</u> | 32) <u>hosa</u> | <u>Frāku</u> (R) |
| 11) <u>kempu</u> | gulābi *22) | <u>betta</u> | hattu | 33) <u>maggi</u> | <u>hēlu</u> (R) |

Sentences.

- | | |
|---|--|
| 1) <u>bili</u> hu cenāgide | 7) <u>ā</u> petṭige tegdide |
| 2) <u>nīli</u> bassu hōgta ide | 8) <u>tēbal</u> mele pustaka ide |
| *3) <u>kitaki</u> mele <u>pennu</u> ide | 9) <u>rāma</u> ravaṇannu <u>kōnda</u> |
| 4) <u>pōlisu</u> kallāna hōḍada | 10) <u>avaṇa</u> tamma <u>dappa</u> kōḍāne |
| 5) <u>illōndu</u> <u>Sēbu</u> ide | 11) <u>bili</u> hu cenāgide (R) |
| 6) <u>nānu</u> <u>nāḷku</u> dōse tinde | 12) <u>pōlisu</u> kallāna hōḍada (R) |
| | 13) <u>avaṇa</u> tamma <u>dappa</u> kōḍāne (R) |

Note :- The underlined word is the key word stressed
 * :- indicates that this word is not selected for second experiment (Experiment II)
 R :- indicates that the word has been repeated.

Appendix - II

System of transcription used
(Roman script)

a	ā	i	ī	u	ū	e	ē	ai
ə	ē	ɨ	ē	eu	eu	ɔ	ē	ɔ
o	ō	au	mi	h				
ʊ	ʊ	ɔ	o	:				
k	kh	g	gh	ni				
ʃ	ʃ	ɣ	ɣʰ	ɔ				
c	ch	j	jh	ɲ				
ʒ	ɛʃ	ɹ	ɹʰ	ɹ				
t	tʰ	d	dʰ	ɳ				
ɛ	ɔ	ɔ	ɔʰ	ɔ				
t	th	d	dh	n				
ɔ	ɔʰ	ɔ	ɔʰ	ɳ				
p	ph	b	bʰ	m				
ɛ	ɛʰ	ɹ	ɹʰ	ɛ				
y	ɹ	l	v	ʃ	ʃ	ʃ	h	
ɔ	ɔ	ɛ	ɛʰ	ɔ	ɔ	ɔ	ɔ	